A SYSTEMS APPROACH TO ORGANIZATION DESIGN,
EMPLOYING MINIMUM REQUIRED COORDINATION
AS A DESIGN PARAMETER

APPROVED:

Graduate Committee:

Kenneth Cox
Major Professor

R B T Mellor
Minor Professor

J. L. Simmons
Committee Member

John T. Thompson
Committee Member

Barry G. King
Dean of the School of Business Administration

Robert B. Toulouse
Dean of the Graduate School

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This investigation is concerned with the problem of designing organizations. The methodology developed by the research utilizes the interrelationships existing in a given organization to determine the optimum design which is based on the hypothesis that optimum structural design minimizes the amount of required coordination between suborganizational elements in accomplishing the functions and goals of the organization.

The purpose of the research effort was to investigate the relationships that exist between managerial functions and organizational structure with the specific objective of employing the managerial function of coordination as a design parameter in designing organizations.

The research strategy included a detailed simulation study of an existing organization in which four model organizations were designed specifically to require different amounts of coordination in accomplishing a given output. A one year period of operation of the existing organization was simulated in each of the four model structures.

A random sample of the outgoing correspondence of the existing organization for the test period of one year was

employed in the simulation process as the output of each of the existing and model organizations. Thus the simulation study consisted of varying the structure of an organization while holding the input and output constant and measuring the resulting required coordination for each structural variation in producing the given output.

A subjective evaluation of the existing and model organization structures was made through the use of a questionnaire response from managers in the existing organization.

Chapter I introduces the problem and states the purpose and organizational plan of the investigation. Chapters II and III reviews respectively the thrust for organization theory and the thrust for organization technique. Chapter IV describes the research strategy of the investigation including a statement of the problem, the working hypothesis, and the research design. Chapter V describes the existing and model organizations. Chapter VI is devoted to an analysis of the existing and model organizations with regard to the required coordination in producing the given output as represented by the random sample of the output of the existing organization.

Chapter VII is a statement of conclusions and recommendations. The results of the investigation are summarized tentatively accepting the hypothesis as valid but suggests further research in different kinds of organizations to determine the general validity of the working hypothesis.

A major implication of the research is that the structural design of organizations should be a continuing dynamic process especially in a changing environment. In other words, any internal or external force that tends to alter the interrelationship patterns in an organization may require structural adjustments in order to optimize the organization design to cope with these forces and adapt to the new situation.

A second implication of the research is that the importance of structural design of organizations is directly related to the rate of change of the internal and external environment. A static environment for example, may have very little impact on structural design since formal procedures can be developed and implemented in such situations which work quite well regardless of the particular design. In a dynamic environment, however, formal procedures become less effective and the structural design becomes more important for organizational effectiveness and managerial performance.

A SYSTEMS APPROACH TO ORGANIZATION DESIGN, EMPLOYING MINIMUM REQUIRED COORDINATION AS A DESIGN PARAMETER

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By

Wayne H. Goff, B. S., M. A.
Denton, Texas
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CHAPTER I

INTRODUCTION

Origin and Purpose of the Study

> The relativity theory of physics reduces everything to relations; that is to say, it is structure, not material, which counts. The structure cannot be built up without material; but the nature of the material is of no importance (6, p. 53).

Origin of the Study

Since early recorded history man has thought about organization in one way or another. Claude S. George, Jr. (1, p. XIII) traces the history of management thought from very early to modern times in his recent book The History of Management Thought. His analysis shows that the Egyptians in approximately 4000 B.C. recognized the need for planning, organizing, and controlling. According to March (9, p. IX), the study of organizations in a historical sense dates back to the ancients:

> The names associated with interest in the problems and phenomena of organizations are impressive. There is scarcely a major philosopher, historian or biographer who has overlooked the management and perversities of organization. The church, the army, and the state had to be managed. Aristotle, Ibm Kahldoun, Thucydides, Caesar, Marcilio, Aquinas, and Bentham were not reluctant to solve such problems in the course of determining the ultimate destiny and primordial nature of man.

Although exact origins are difficult, if not impossible, to determine with a high degree of accuracy, many modern concepts of organization theory can be traced to ancient civilizations. For example, the concept of "division of labor" dates at least several thousand years in the past. One of the earliest records of this concept is given in the eighteenth chapter of Exodus where Moses was advised by his father-in-law to divide his heavy workload and assign the lesser activities to others and thereby share the burden of management with them:

> So Moses hearkened to the voice of his father in law, and did all that he had said. And Moses chose able men out of all Israel, and made them heads over the people, rulers of thousands, rulers of hundreds, rulers of fifties, and rulers of tens. (Exodus 18: 24,25)

In addition to the concept of "division of labor," one can see also the concept of "delegation of authority" or "scalar process," and "span of control" in this early recording of organizational and managerial activity. In discussing the Ideal State in his Republic, Plato (8, p. 349) recognized the value of the principle of "division of labor." He emphasized that each person in the state should do the one thing only which was best suited to his nature: " . . . you remember the original principle which we were always laying down at the foundation of the state, that one man should practice one thing only, the thing to which his nature was best adapted." George (1) cites many examples of organization and management concepts from early Egyptian, Babylonian, Greek, and Chinese literature which show the early origin of management thought.

Notwithstanding the early historical setting in which organization concepts originated, organization thought, as a systematized body of knowledge, separate and identifiable as a field of study, is relatively young, dating back approximately five or six decades. Early management and organization literature was, for the most part, the product of practitioners and academicians whose writings were based on personal experience and judgment rather than on formal empirical research (10, p. 37).

From what has been said thus far it can be concluded that organization thought has been an important part of the overall development of human knowledge although not the focal point, until recently, of a separate field of inquiry. In recent times organization thought has been the center of much interest from many quarters, and as Learned and Sproat (8, p. v) put it, " . . . organization theory is very much like the tower of Babel--built by contributions from many people having points of view so different that they seem hardly to speak the same language."

The long delay of interest in organization theory may be accounted for on the basis of complexity and rate of change of internal and external factors which relate to organizations in various ways. Early organization, for example, dealt with fairly simple problems and interacted with relatively stable and benign environments. Modern organizations, on the other hand, deal with highly complex problems and with unstable and

hostile environments. This, no doubt, accounts for the increased emphasis in recent times on viewing organizations as "open systems" in which environmental factors as well as internal factors must be considered in developing models having highly predictive qualities.

The research undertook to analyze organization structure as found in a modern organization and to determine the relationships existing between the structure itself and the functions of management. Recent research in organization theory has pointed to the importance of relations both within the organization and between the organization as a whole and its environment. Lawrence and Lorsch (7), for example, have recently studied industrial organizations of various sizes and with varying degrees of performance. These researchers have developed a contingency theory of organization which is supported by their findings. According to contingency theory, organizations tend toward structures which are best suited to the environment in which they function.

Other studies cited by Lawrence and Lorsch (7, p. 15) support the contingency theory of organization. One finding, for example, showed that successful organizations in different industries with different technologies are characterized by different organization structures. Another finding indicated that organizations in stable industries tend to be more "mechanistic." That is, in such organizations there was more reliance on formal rules and procedures, decisions were made

at a higher level in the organization, and the span of management control was narrower. The same study reported that in a more dynamic environment, effective organizations were typically more "organic." Spans of supervisory control were wider, less attention was given to formal procedures, and more decisions were made at the lower levels of management.

Jasinski (2, p. 758) has also recognized the need for improving organization structure to conform with the requirements of a new technological process rather than to try to fit a new technological process into an existing organization structure. "The idea is this: A change in production or technology affects organizational relationships."

Purpose of the Study

The purpose of the research effort was to investigate the relationships that exist between managerial functions and organizational structure and thereby to make some contribution to organization theory. Specifically, the investigation was directed toward determining the relationship between the managerial function of coordination and organization structure. A thorough understanding of the relationship between coordination and organization structure should result in better decision-making capability in one of the most important functional areas of management. An attempt has been made, for example, to show how the managerial function of coordination may be utilized to measure the effectiveness of organization structure and thereby

may be used as a tool in the structural design of organizations. The research compared the efficiency of an existing organization with several alternate organizational structures specifically designed to require different amounts of coordination in accomplishing organizational goals. A figure of merit, equal in value to the ratio of required coordination in the existing organization to that in a model organization, was developed for each structure. The quantity of required coordination in each case was that required in accomplishing the output of the existing organization during the period of one year for which the experiment was conducted.

Limitations of the Study

There were three basic limitations which are indicative of the scope of the research design. These limitations were carefully chosen in order to maintain manageability and at the same time allow for sufficient significant detail to give reliable and predictable results with the necessary abstractions which must be made in order to have a workable model in this highly complex field of study.

Time Period of the Study

The first limitation was time. A period of one year was chosen as necessary and sufficient for achieving adequate results. The performance of an existing organization was studied for a period of one calendar year. This period of time seemed to be justified since it was sufficiently long to include

monthly, quarterly, and semiannual variations in the various activities of the organization and yet was not so long as to preclude a manageable investigation. A sampling technique, described in Chapter IV, facilitated the accomplishment of the research. Using a sampling technique was further justification for the time period of one year as compared to a much shorter time period in which the entire universe of data would have been used. It was felt that a shorter time period for the study would have resulted in the loss of significant seasonal variations in the activities of the organization.

Size of Organization

The second limitation was on the size of the organization. This factor was carefully chosen in order to achieve the objective of manageability and to retain sufficiency of detail to assure reasonably satisfactory results. The organization chosen was a field division of a relatively complex governmental agency with which the researcher was somewhat familiar. The division is basically composed of five branches organized on a functional basis. A detailed description of the existing organization is included in Chapter V. In addition to an existing organization, four model organizations were designed to simulate the performance of the existing organization over the same time period of one calendar year. A detailed description of the model organization structures is also given in Chapter V.

Justification for limiting the investigation to the size of the organization chosen and also to a single existing organization was based on the overall objective: the effort to develop an effective tool for use in just such situations. In other words, the management of an organization is normally faced with having to decide which way to organize, and without the benefit of a model which fits the existing situation. Much recent research (7) in organization theory has been centered around comparative studies in which several existing organizations were analyzed and compared with each other. The present effort is directed along a somewhat different line of approach, which is to provide a methodology which will enable a single management of a given organization to arrive at a rational decision for the optimum structure for the particular situation in which the organization exists.

Normally, a manager does not have access to other organizations for study and comparison with his own in order to arrive at decisions for optimum organization structure best suited to the needs and goals of management. A methodology in which such outside information is unnecessary is therefore desirable. The present research effort is directed toward just such methodology.

Scope of Managerial Functions

The third and last significant limitation bearing on the present study was the scope of managerial functions to be

included in the model. Most writers on management theory include four or five fundamental functions of management, the fifth, when included, being that of coordination. Coordination is considered to be a goal by some writers on the subject of management. According to Kazmier (5, p. 27), contemporary writers regard coordinating as an objective of management, rather than as a function in itself. Sisk's definition of management (11, p. 10) indicates that coordination might be somewhat different in character than planning, organizing, directing, and controlling. His statement more or less equates management with coordination (i. e., ". . . management is the coordination. . ."). Johnson, Kast, and Rosenzweig (3, p. 6) agree with this view of management and coordination. They state that coordination is the essence of management.

Whether coordination is a function, goal, or the essence of management will not be a concern of this study; however, an attempt is made to show how coordination is a common denominator of the four managerial functions of planning, organizing, directing, and controlling. This relationship was an important factor in arriving at the decision to limit the research model to the single managerial function of coordination. Variations in required coordination effort will result in corresponding variations in the total managerial effort required for a given output of the organization. Since managerial effort is expended through the processes of planning,

organizing, directing, and controlling, then presumably corresponding variations will occur in these managerial elements also. These relationships are implied in the definition of management given by many writers on the subject. For example, Sisk (11) defines management as " . . . the coordination of all resources through the processes of planning, organizing, directing, and controlling in order to attain stated objectives."

Therefore, the justification for limiting the research model to the single managerial function of coordination is based on the functional relationships between coordination and the managerial processes of planning, organizing, directing, and controlling. An evaluation of all organizational and managerial elements is included as part of the research effort in the overall analysis of the results of the study given in Chapter VI.

Values to be Derived from the Study

The main objective of the study was to test a hypothesis which the researcher believes holds some promise of value toward the development of organization theory. Simply stated, in accordance with the working hypothesis given in Chapter IV, an organization should be able to function more efficiently if the structure of that organization is so arranged that a maximum effort may be exerted in each suborganizational entity toward attaining organizational goals with a minimum amount of

required interrelated activity with other suborganizational elements. If this theory does fit the facts of empirically determined relations and structure found in organizations, then the potential value to be gained will be significant. The results of this study indicate that to be the case. Implications for future research are included in Chapter VII.

Possibly, as a result of this and further research, a practical tool for managers will evolve, one which will supply a much needed basis for rational decision-making in this important area of management. There is a great void in available decision-making criteria relating to the managerial function of organizing. This statement is based on personal experience of the researcher over a period of many years in which the design and implementation of several organizations and reorganizations were observed at close range.

The main ingredient in the decision-making process seemed to be intuitive judgement rather than sound theoretical considerations. This is not to say that intuitive judgement is not a valid and desirable ingredient in the decision-making process. It does mean that there is a dearth of relevant organization theory for the practitioner to use in his organizing function.

It is evident from the widespread interest in the subject (9, p.xv), that a healthy thrust for organization theory has been in the making over the past two or three decades. A survey of the literature in this growing field reveals that a

great amount of interest in organization theory is evident in several disciplines such as economics, political science, psychology, sociology, anthropology, management science, mathematics, biology, etc. Possibly, the present effort will make a worthwhile contribution to this thrust for theory.

The Organizational Plan

Chapter I introduces the problem. Chapter II is devoted to a comprehensive review of organization theory from the early beginnings of the classical writers to the neoclassical and modern organizational theorists. It was considered desirable to include such a survey in a separate chapter not only to indicate the importance of the solid theoretical foundation upon which the present investigation should be made but also to recognize the many contributions which others have made to this field of study. The classical writers, beginning with Fredrick W. Taylor, laid the theoretical basis which has been built upon by later contributors. A survey of the classical literature therefore is given in Chapter II.

The neoclassical school is commonly identified with the human relations movement which was sparked by the Hawthorne studies in the 1920's and 1930's. Writers from this school have made important contributions to the development of organization theory by pointing to the importance of human factors. A review of the writings of this group is included in Chapter II.

The modern school views organizations as systems and therefore emphasizes the need to look at organizations as total integrated systems. Therefore, in order to give a proper treatment of modern organization theory, a review of systems theory is given which should further enhance the clarity of the theoretical basis for the present research. A brief review of cybernetics, the science of feedback and control, is also included since feedback and control are important considerations in systems theory. A review of information theory is also included in Chapter II.

Modern organization theory seeks to apply systems theory to organizations. Organizations are considered as "open systems" and are therefore affected by their environment as well as the internal forces acting between subsystems in the total system. Herein lies the main contribution of modern organization theory, that is, the extension and integration of the classical and neoclassical systems of thought to include internal and environmental forces acting within and upon the organization considered as a total system.

An important and concluding section of Chapter II is a review of trends and forecasts in the field of organization theory. An attempt is made in this section to synthesize the thinking of contemporary organization theorists in a brief prognostication with regard to the direction that organization theory seems to be heading.

Chapter III is devoted to a review of trends in organization research techniques. The main impetus of this chapter is to review the methodologies used by organization theorists and to attempt to deduce from current activities in this growing field of research some expectations which might be looked for in future methods and procedures for studying and developing new facts about organizations. In other words, Chapter III deals with the thrust for technique in organization thought in a somewhat similar manner that Chapter II deals with the thrust for theory. The thrust for technique must develop parallel with the thrust for theory if productive advances are to be made in the understanding of organization. Therefore, a chapter devoted to the thrust for technique seems justified.

Chapter IV describes the research strategy of the investigation including a statement of the problem, the working hypothesis, and the research design. Chapter V describes the existing organization and model organizations with which the existing organization was compared. Chapter VI is an evaluation of the existing and model organizations with respect to the economic efficiency in accomplishing the given output of the existing organization. Chapter VII is a statement of conclusions and recommendations for further research. Finally, the appendices included in the report contain organization charts and tables which display the data used in the study.

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CHAPTER II

ORGANIZATION THEORY

> The organism is inexplicable without environment. Every characteristic of it has some relation to environmental factors. And particularly the organism as a whole, i. e., the unity and order, the physiological differences, relations and harmonies between its parts, are entirely meaningless except in relation to an external world (26, p. 99).

Introduction

Chapter II reviews organization theory as it has developed from the classical period to the present time. This introduction to the subject is for the purpose of establishing a background for the remainder of the chapter and to suggest a basis for the importance that theorists are placing on the need for developing relevant organization theory. The review is limited to the extent necessary to serve the special purpose of supplying the basic background information needed for the present investigation.

Factors of Importance

Organization theory as a field of interest. --Organization theory, as a separate field of interest dates from the works of Barnard (5), Roethlisberger and Dickson (46), and Simon (49) whose writings of the late 1930's and early 1940's are cited by March (33) as the foundation of organization

theory as a separate field of study. From this early beginning, embedded in a number of social sciences, the field has broadened to include

> . . . groups with traditions extending beyond this primary trinity (most conspicuously the Weberians in sociology and the natural heirs of the Common tradition in economics). As the field has grown, the ratio of 'organization' to 'general social' treatises with which it deals has increased, but the field continues to feed extensively on other disciplines (33, p. xiii).

In fact, as Learned and Sproat (28, p. v) have stated, the range of contributors to organization theory has broadened to such an extent that viewpoints are so different, the contributors seem hardly to speak the same language.

March (33) has indicated, however, that there is another side to the theoretical development of organization. While theorists have cited one another, organizations have continued to develop and prosper, wither, and die. Parallel with the development of theory there has been the necessity for administration, and since most of the earlier as well as some modern writers in the field were practicing managers as well as organization theorists,

> . . . with few exceptions, they were neither experimentally nor theoretically oriented; they tended to report the wisdom they had gained from experience with a casual bow to evidence. The men of experience spoke to the novices of what they had found successful in the course of their careers. Frequently, the advice was embellished with general principles and basic truths, but the burden of the argument was pragmatic, and

> the burden of the evidence was buried irretrievably beneath the trials and errors of day-to-day management (33, p. xiii).

Size of organization as a factor of importance. -- Organization theory is becoming more important as modern organizations increase in size and complexity. Berle and Means (7), in support of this statement, regard the modern corporation as potentially, if not yet actually, the dominant institution of the modern world. Thus, the recency of interest in organization theory can be linked directly to the importance of the impact that organizations have had and are having on man's everyday existence.

Early "unspecialized" man, for example, was organized in family groups which served all his needs quite well. This statement, made by Thompson (51), indicates the simplicity of primitive organizations and their relatively minor place in man's thought. However, as he continues in the same vane as Berle and Means (7): " . . . In the highly specialized industrial society of today, the predominant form of organization is a highly rationalized and impersonal integration of a large number of specialists co-operating to achieve some announced specific objective." (51, p. 3).

Concentration of power as a factor of importance. -- In Berle and Means' analysis (7), the relatively recent emphasis in organization theory can be traced to the way power has been historically concentrated in the dominant interest of every age. For example, the strong man in his time strove to

be pope, prince, or bank president. Spiritual power was exercised by the medieval church in dominating man's existence and supplied a unifying force at a time when political and economic power were diffused. With the development of the modern nation state, a means was provided to successfully challenge the spiritual interest as the strongest bond of human society. "Out of the long struggle between church and state which followed, the state emerged victorious; nationalist politics superseded religion as the basis of the major unifying organization of the western world. Economic power still remained diffused." (7, p. 313).

Litterer (31, p. 2) also sees large-scale organizations as one of the dominant characteristics of the present world. And, as he points out, this fact is not always viewed as an unmixed blessing but is rather looked upon by some with concern for the impact that large powerful organizations have on individuals as organization members as well as their social life.

Classical Theory

A Rational Model

Twofold classification of organization theory. -- Waldo (53, pp. 9, 10) has suggested a twofold classification in which organization theory may be viewed, that is, (1) as a rational model, and (2) as an organic or natural-system model. In the rational model, organization is viewed as "mechanistic"

or as machine. In this model "it is presumed that man can consciously construct and manipulate organizations, that he can thus use rational processes to achieve consciously posited goals." The organic model, on the other hand, has life of its own which attempts to maintain equilibrium with its environment as well as internally between sub-organizational entities. From the viewpoint of the organic model, organization is much more complicated, subtle, and mysterious than from the viewpoint of the rational model. "Classical theory is rationalist in general tendency."

Origin of the rational model. --Classical organization theory as viewed by the rational model has its roots in early social and scientific thought. The impact of scientific thought on organization theory is cited by many writers. For example, von Bertalanffy (8, p. 30) discusses the aim of classical physics as one of resolving natural phenomena into elementary units governed by "blind" laws of nature. This atomistic mechanical model of science was carried over into the social realm by classical economic theorists. Roots even go far back into antiquity as reported by Marshall (36, pp. 440, 441) in the nineteenth century. In discussing the concept of "division of labor," Marshall cites Plato's Republic as an early source for this idea. Since Darwin, he reports, economists have owed much to the many analogies drawn between social and industrial organization. The development of the organism involves an increasing subdivision of functions between its

separate parts on the one hand, and on the other a more intimate connection between them. "Each part gets to be less and less self-sufficient, to depend for its wellbeing more and more on other parts, so that any disorder in any part of a highly developed organism will effect other parts also."

Johnson, Kast, and Rosenzweig (23, p. 5) recognizing the influence of science and economics on organization theory cite the writings of Darwin and Keynes as examples of well known works from which organization theory has developed. "Both men had a major impact on man's thinking because they were able to conceptualize interrelationships among complex phenomena and integrate them into a systematic whole. The word system connotes plan, method, order, and arrangement. Hence it is no wonder that scientists and researchers have made the term so pervasive."

Classical Theory Assumptions

Factors influencing classical assumptions. --Early classical writers on the subject of organization such as Fayol (17), Gulick (19), Mooney (39 & 40), Urwick (52), and Brown (9) were concerned about differentiation and integration, that is the division of labor in the organization and how to coordinate or integrate these separate divisions of activities. From the viewpoint of Lawrence and Lorsch (27, p. 9), however, they did not recognize the systemic properties of organizations and thereby failed to see the full impact of differentiation on

the behavior of organizational members. They did not foresee, for example, that members of individual organizational entities would develop specialized working styles and mental attitudes because of their background, experience, and training.

Roethlisberger (46, p. 405) writing in the late 1930's recognized this weakness in the classical doctrine and attributed it to the fact that most classical writers had not made their assumptions explicit. He attributes this, however, to the institutional and environmental setting of the 1910 to 1940 period in which the classical theory was developed. In this early setting the classical propositions were probably valid but require some modification or elimination in the institutional setting of the present.

Implied classical assumptions. --Although classical writers did not make their assumptions explicit, there are several assumptions that are implied in the theory as described in the works of the classical theorists. Some of the more important assumptions of classical organization theory given by Roethlisberger (46, p. 405) will be reviewed here to show the rationalistic nature of the theory.

Classical organization theory according to Roethlisberger assumed that the efficiency of an organization is based solely on productivity without regard for human factors. Since production was considered to be mechanistic in nature and the economic utilization of resources was the means by which productivity was achieved, it was logical to assume that good

organization could be achieved without regard to human factors. Classical theory further assumed that human beings act rationally and would logically proceed toward management goals. It was also assumed that members of an organization could not work out the relationships of their position without detailed guidance. Unless clearly stated job descriptions were enforced, members would become confused and tend to encroach upon the domains of others. Classical theory further assumed that human beings prefer to be told definitely what to do rather than have the freedom of determining their own approaches to problems. The activities of a group should be viewed objectively and impersonally without consideration for personal problems. Workers are motivated by economic needs which call for monetary incentives. People do not like to work and must therefore be closely supervised and lead by management in ways that are not compatible with their inherent nature. Finally, coordination will not be achieved unless it is planned and directed from above.

Classical Theory Principles

General nature of the principles. --Classical theorists, according to Massie (37, p. 390), for the most part stated simple and concise principles more or less as guides for managerial action. Neither Fayol's (17), nor Gulick's (19) principles were intended to be rigid since there is nothing rigid or absolute in the affairs of management. However, there

developed general agreement among a number of authorities who arrived at essentially the same foundational principles which then tended to take on a little more status than mere hypotheses. There followed a tendency toward acceptance of them as universal principles valid in all situations.

Principles relevant to present study. --Four of Fayol's and five of Gulick's principles (two of which are common) have to do with the structure of organization and are therefore pertinent to the present research effort. The first principle is "division of labor" which permits a reduction in the number of things for which any one individual must direct his attention. The second principle bearing on organization structure is "unity of command" which precludes the head of an organizational entity's reporting to or receiving orders from more than one higher level authority. The third principle, "unity of direction," denotes a single head and a single plan of operation toward achieving a common objective of the organization. Unity of command, and unity of direction, tend to force a pyramidal structure rising from a broad base to a single point of overall command and direction at the pinnacle of the pyramid.

The fourth principle bearing on organization structure is the scalar principle. The scalar principle is the chain of individuals ranging from the highest authority to the lowest ranks and has somewhat the same bearing on organization structure as the unity of command and unity of direction principles.

"Departmentalization on the basis of purpose, process, clientele, or place," the fifth classical principle that is significant with regard to organizational structure, has been the subject of much debate by later writers. The sixth classical principle significantly affecting organizational structure is "coordination by hierarchy." This principle stems from the classical theory assumption that coordination will not be achieved unless it is planned and directed from above.

Finally, "coordination by committee," the seventh "universal" principle is mentioned with some reservation by Gulick (19, p. 36) who would limit its use to abnormal situations and matters of policy.

Neoclassical Theory

Scott (47) sees the neoclassical approach to organization theory as one in which some of the deficiencies of classical doctrine are compensated. This school, which is commonly identified with the human relations movement, takes the postulates and assumptions of the classical school as given and then proceeds to regard them as modified by people acting within the context of the formal organization.

Roethlisberger's thesis (44, p. 9) was that a human problem requires a human solution. The main difficulty as he saw it was in the failure of classical theorists to recognize the human problem in organization. After recognizing the human

problem as such we must learn to approach it as such and not as if it were something else. "Too often at the verbal level we talk glibly about the importance of the human factor; and too seldom at the concrete level of behavior do we recognize a human problem for what it is and deal with it as such. A human problem to be brought to a human solution requires human data and human tools."

George (18) sees the behavioral school as tending to lift the individual from his insignificant traditional role to one of centrality in any cooperative effort: " . . . in as much as managers get things done through people, the study of management must be centered around the workers and their interpersonal relations."

Identification of Human Problems

Labor-management conflict. --The approach taken by the human relations theorists, in Mayo's words, was to call attention to "the seamy side of progress." This statement by Lawrence and Lorsch (32) prefaces their analysis of the neoclassical school of organization theory as it developed in the 1930's. The early writers during this period were concerned that industrial organizations were, in addition to producing a vast quantity of goods and services, generating undesirable human problems in the process of production. They saw signs of such problems in labor-management conflict, in worker unrest, and in the many struggles among managers

for power. Such unproductive activity was seen by and large as a waste of human resources. "From this beginning the research of the human relations school has grown over the years to encompass an interest in individual and small-group behavior, intergroup behavior, and total organization phenomena."

Teamwork and motivation. --Introducing Roethlisberger's Management and Morale (44), Mayo finds that the study of the problem must begin with an investigation of human happiness rather than as an anthropological study of ceremonial participation. He says that every social group must secure for its individual and group membership the satisfaction of economic needs and the maintenance of cooperation. Traditional methods are all geared toward increasing efficiency, none toward the maintenance of cooperation. With Mayo the issue is how to insure spontaneity of cooperation or teamwork which is a far greater problem in our modern society than in a simple or primitive community.

> In a simple society the extent of change from year to year, or even from century to century, may be relatively small. Traditional methods are therefore brought to a high degree of perfection; almost from birth disciplined collaboration is drilled into the individual but in these days of rapid and continuous change the whole conception of social discipline must probably be altered.

In agreement with Roethlisberger, Lorsch and Lawrence (32) see the main impetus behind the human relations movement as resulting from the inadequate treatment which the classicists gave the whole issue of motivation. They attribute

this lack of adequate treatment of the human problem in organization theory to the concerns and biases of the classical writers.

Resistance to change. --Resistance to change on the part of employees was also identified by Roethlisberger (45, pp. 15, 16) as a major factor in the human relations movement. The informal organization, for example, performed the function of precluding rapid changes in the work environment. "This opposition to change not only was reflected in all their tactics to keep output constant but also was implied in all the reasons they gave in justification of their actions." Explicitly stated, employee behavior might be stated to have been guided by the rule: "let us behave in such a way as to give management the least opportunity of interfering with us--our ways of work and personal relations with each other."

Formal vs. informal organizations. --Some writers argue that the basic shortcoming of the classical school lead by Taylor (50) was their failure to distinguish between the formal and informal organizations. Roethlisberger (45, p. 13), for example, attributes the lack of understanding of the worker's actual behavior to the failure to distinguish between the "technical" and "social" organization. The technical organization which was the chief concern of the classical school "is an incomplete representation of the actual situation."

Criticism of neoclassical theory. --Classical theory's rational model suffered from its failure to include the human problem as an element in organization theory. This does not invalidate the model but rather suggests a need to modify it, at least to the extent necessary for theory to have maximum utility for the manager. The neoclassical school set out to rectify this deficiency of the classical school but in the process failed to integrate the many facets of human behavior introduced by it. It also failed to see that human behavior was just another facet, albeit an important one, of the overall framework in which a relevant theory of organization should be built. Scott (47) points to the fact that the fundamental insight which the Hawthorne studies provided did not result in much extension in subsequent work in the neoclassical vein. "Indeed, the neoclassical school after the Hawthorne studies generally seemed content to engage in descriptive generalizations, or particularized empirical research studies which did not have much meaning outside their own context. Modern theory has made a move to cover the shortcomings of the current body of theoretical knowledge."

Modern Theory

An Organic Model

Internal and environmental relationships. --Modern organization theory brings into focus the interrelationships within organization as well as recognizing the environment in which

it is embedded. Classical theory, having been built on the basis of the rational model did not call attention to the impact each part of the organization may have on other parts nor the effects of the organization as a whole interacting with its environment. The goal of modern theory is to account for these important factors, not to the exclusion of earlier theoretical considerations, but rather to round out the picture and present a theory of organization which will be an effective tool for designing and managing organizations.

In agreement with the systems approach, Dill (15) suggests that " . . . in expanding our understanding of organizational behavior and in elaborating theories of organization and administration, we need to incorporate 'environmental' variables more explicitly into our work." Dill also agrees with Lawrence and Lorsch (27, p. 94) that the idea of a "best" way to organize does not appear to hold true empirically. In trying to develop simple and general theories there has been a tendency to assume that what is found to be true in one organizational setting would also be true for others. "Too often, though, when we do take the trouble to repeat a study in a new environment, we find that the old relationships disappear and new ones become prominent."

Modern organization theory relies heavily on systems theory and therefore borrows from a wide variety of fields such as biology, psychology, economics, political theory and others since it is these fields that have contributed most to

the "open system" model upon which modern organization theory depends. A brief discussion on the subject of systems theory, cybernetics, and information theory will now be undertaken which should lay the foundation for considering the organization as a total system.

Organic model and system theory. --Scott (47) sees modern organization theory as having the distinctive quality of a conceptual--analytical base, embedded in a philosophical framework in which the only meaningful way to study organization is to study it as a system. Notwithstanding the fact that human organizations have large numbers of variables to contend with, modern organization theory accepts system analysis and thereby "shifts the conceptual level of organization study above the classical and neoclassical theories."

Waldo (53, p. 13) also sees organizations as systems and suggests that since the term "system" connotes the essence of organization, they can best be studied as such. He further amplifies his argument by defining systems as "entities that are more or less independent and consist of parts that constitute mutually dependent variables." The main point Waldo makes is that systems qua systems have generic qualities, and that all fields can find a common ground in the concept of system.

Bertalanffy (8, p. 149), the father of general systems theory, sees it as a unity of science movement which seeks a common set of principles which will apply to all kinds of

systems, regardless of their nature. "Open system" theory is a part of a general system theory the principles of which may be applied successfully to wider fields, "from ecology, the competition and equilibrium among species, to human economy and other sociological fields."

Organic model vs. closed systems. --By way of illustration of the meaning of general system theory, Bertalanffy (8, p. 30) contrasts closed and open systems. For example, conventional physics deals only with closed systems, that is, systems which are considered to be isolated from their environment.

> However, we find systems which by their very nature and definition are not closed systems. Every living organism is essentially an open system. It maintains itself in a continuous inflow and outflow, a building up and breaking down of components, never being, so long as it is alive, in a state of chemical and thermodynamic equilibrium but maintained in a so-called steady state which is distinct from the latter.

The main contrast between the classical theory model and the modern theory model is that the former is essentially a closed system and the latter an open system. Organizations then, as open systems, must have at least some characteristics of organisms and therefore we would expect to find some useful analogies from social and biological fields of knowledge. Rapoport and Horvath (42, pp. 87-93) see the value of considering a real organization as an organism and suggest that the comparison need not be a sterile metaphorical analogy such as the scholastic speculation about the body politic.

Quasi-organismic functions can be seen in organizations such as self-maintenance, response to stresses, aging, and dying.

Cybernetics

Historical Origin. --Cybernetics, the science of communications and control, is a concept historically derived from Plato's Republic where he used the Greek word "kybernetike" which means the art of steersmanship. Plato's use of the term was in analogizing between the art of steering a ship and the art of guiding or steering the ship of state. Until recently, control systems have been limited largely in their application to the field of engineering. Applications to social fields including political, economics, and management have recently been advanced by men such as Wiener (54), Ashby (3) and others.

Dechert (13, pp. 261-269) gives a historical sketch of cybernetics from its early beginnings to the present time. He includes a discussion on the scope of cybernetics which indicates that in the United States the term "cybernetics" has tended to be limited to a rather narrow range of disciplines such as computer engineering, bionics, and control systems engineering. However, in the Soviet Union the term is used in a much broader array of disciplines including the social sciences and is defined as "the new science of purposeful and optimal control over complicated processes and operations which take place in living nature, in human society, and in industry."

Elements of a cybernetic system. --Cybernetic systems have three basic elements as described by Dechert (13) which form an "open loop" in which the control information is used to direct an interaction between the self-regulating system and its environment. The effector elements manipulate the environment to achieve certain objectives. Receptor elements detect environmental changes which are transmitted to the decision-making or selector element. The selector element compares the percept with the objective and transmits new directions to the effector elements in terms of the differential between objective and achievement.

Cybernetics is the science of feedback and control in all kinds of systems and as such is a key element in the study of modern organization theory. Feedback--or as Deutsch (14, p. 88) calls it, a servomechanism--is a communications network which stimulates action in response to an input of information. This input has included in it the results of the system's action and generates a new input from which subsequent behavior is modified still further. Wiener (54) explains the servomechanism or feedback network as an arrangement by which the self-regulating system reacts to an outside event, such as a target at which a gun is directed. The feedback and control mechanism operates to redirect the system in such a manner that the results will be a series of decreasing mistakes of over and under corrections until the goal is reached. In organization, a feedback and control mechanism

is necessary in order to guide or direct the system toward its predetermined goal.

Viewpoint of cybernetics. --For Deutsch (14, pp. 75-97), cybernetics represents a shift of interest from driving to steering, from instincts of decisions, regulation, and control.

> In other words, the viewpoint of cybernetics suggests that all organizations are alike in certain fundamental characteristics and that every organization is held together by communications. . . . Finally, cybernetics suggests that steering or governing is one of the most interesting and significant processes in the world, and that a study of steering in self-steering machines, in biological organisms, in human minds, and in societies will increase our understanding of problems in all these fields.

Information Theory

Theoretical concepts. --Shannon and Weaver (48, pp. 115, 116) discuss the theory of communication in terms of the system's fundamental components. To be effective a communication system must transmit information through the various components of the system with sufficient fidelity to serve the purpose of the user. Information must be encoded at the transmitter into signals which then pass through the system to the receiver where the signals are decoded and delivered to the destination. In the information flow process there are three major sources of "noise" which impair communications. First, there is a source of semantic noise at the point where the message to be transmitted is encoded. This source of noise stems from the inability of the message encoder to

retain the exact meaning of the information as it is processed into the message signal. The second source of noise in the system is at the point in the system where the message is decoded. This point also gives rise to semantic noise in the same manner as at the encoding point except in this case the semantic noise arises from the inability to retain the exact information contained in the received signal as it is processed back into message form in which it is to be used. A third source of noise, "engineering noise," arises from imperfections in the system itself which preclude an exact replica at the receiving point of the signal as transmitted.

Dubin (16, p. 228) attributes instability in organization to the phenomenon dealt with in communication theory of "channel overload." This problem stems from the effects of increasing the volume of transmission in a channel beyond the point that the system is capable of receiving what is transmitted. Dubin reasons by analogy that the channel-overload problem may be generalized to multiple-simultaneous stimuli. In other words, it is to be expected that characteristic falling-off of reception will take place when the volume of simultaneous stimuli exceeds the receiver's capability to assimulate them. "In organization terms, there may be too many linkages between one unit and others, so that if all linkages are simultaneously activated, little or none of what is transmitted along the linkage channels will be effectively received. The consequences for the receiving unit may be confused action, evasive

action, or general inefficiency." Dubin concludes that minimizing the number of links between organization units promotes stability in the organization.

Importance of information theory. --In order to achieve the goals of an organization with reasonable efficiency, information supplied must be sufficiently accurate and timely for each sub-organizational element to make rational decisions with regard to its particular function. Thus, modern organization is concerned with communication systems within the organization. Barnard (5, p. 91) views communication as a central concept in organization theory and "in an exhaustive theory of organization, communication would occupy a central place, because the structure, extensiveness, and scope of the organization are almost entirely determined by communication techniques."

Simon (49, p. 108) discusses the importance of communications with regard to the way the administrative process influences the decisions of organizational members. He concludes that without effective communications the administrative process does not affect the individual members at all. We may conclude from these statements that for an organization to function effectively there must be a system of communication within that organization which will distribute timely and accurate relevant information to each element in the organization.

Behavioral Theory

Importance of behavioral theory to organization. --Bennis (6, p. 184) sees the growing interest in behavioral sciences as being due, in part at least, to the same reason any science gathers momentum. That is, because conventional wisdom and practice failed to work. As modern human organizations have increased in size and complexity, other significant changes have also taken place. Technological growth, unionism, growth of human sciences, separation of property and power, influx of professionals into large-scale organizations, increase of educational level and aspirations of the worker, shifts in the value-systems of the world community toward humanitarianism, science and democracy are listed by Bennis as contributing factors to the increasing momentum of the social sciences.

Bennis goes on to say that these changes were not reflected in the traditional or bureaucratic form of organization although they

> . . . were reflected nevertheless in the palpable inadequacy of leadership styles and managerial assumptions about human behavior. In short, the man conducting the enterprise, the managers were basing their predictions on incomplete and skewed data, a mechanistic and depersonalized view of man, and late Victorian cum Darwinian ideal of Empire.

The behavioral approach to organization theory according to Koontz (25) is based on the thesis that since management is the art of getting things done through people, the study of management must be centered on interpersonal relations.

As he puts it " . . . this school concentrates on the 'people' part of management and rests on the principle that since people work together in groups to accomplish objectives, 'people should understand people,' and has as its primary focus the motivation of the individual as a sociopsychological being."

Behavioral problems in organizations. --Haire (21, p. 273), after reviewing the wide variety of approaches of organization theory, concludes that none of them focused on the important fact that a chief characteristic of social organization is simply that it is a special kind of aggregation of individuals. Many organizational problems stem from two facets of this fact. The first facet is that organization is made up of individuals, and, second that it is an aggregation of them.

> From the first comes the problem of conflict between individual and organization, and the organizational necessity of resisting the centrifugal force associated with individuals - each with his own goal and each tending to fly off from the path of the whole. From the second comes the pressure, as the size of the aggregation increases, to provide communication among the parts, integration of the parts into the whole, and the possibility of specialization of function.

Jasinski (22, p. 758) finds that the major problem with organization is one of adaptation. For example, changes brought about as a result of new techniques of production and technological changes are cited as factors that affect organizational relationships. Organization members may find themselves, for example, in new groups and reporting to different supervisors as a result of such changes. "When management

overlooks these social changes, it generally fails to realize the full potential of a change in technology, however well thought out the innovation was from an engineering standpoint."

March and Simon (34, p. 4) conclude that since organizations are "assemblages of interacting human beings" with central coordinative systems, they behave in many respects as organisms, and the individual organization as a sociological unit is comparable to the individual organism in biology. The study of behavioral problems in social organization will therefore in many respects parallel biological research. Argyris (1, p. 2) believes this similarity between biological and social organization should lead social scientists to find useful research methods from the works of biologists.

Behavioral approach to organization theory. --Likert (29) advances a modified theory of organization based on major motivational forces of (1) economics, (2) ego (including the desire for growth and significant achievement in terms of one's values and goals as well as the desire for status and recognition.), (3) security, and (4) the desire for new experiences, i. e., creativity. There is also the need for "an efficient interaction or mutual influence system which provides the mechanism through which the activities of the organization are integrated and coordinated." This theory is further amplified and empirically validated in The Human Organization: Its Management and Value by Likert (30).

The behavioral approach to organization theory is gaining momentum and current research in the field is rapidly throwing additional light on organization. Some writers see major changes in the making as a result of such research. Bennis (6) and Read (43), for example, see a decline in the basic bureaucratic model of organization and the emergence of one more compatible with the creative side of human nature and the human side of enterprise (38).

Behavioral theory is a major adjunct to modern organization theory and as the writings cited above show, people acting and interacting as individuals and as aggregrates of individuals must be dealt with effectively in any theoretical development in this field of study. Modern organization theory seeks to integrate all relevant factors into a unified theory of management (24) and organization theory that will lift the practice of management to a level of rationality based on knowledge and facts of reality. In other words, the goals of modern theory is to incorporate empirically derived facts into a theoretical model which will have a high degree of correspondence with the real world. Such an accomplishment will have far reaching effects on social organization and will lift man to new levels of coordinated and integrated activity and yet allow him to maintain his individuality. Since organizations are an important aspect of our lives as Litterer (31, p. 3) states it: " . . . Anything that looms

so large in the lives of so many people in today's world is a matter of great importance."

Organization as a Total System

Organization considered as a system provides a very useful framework for discussing modern organization theory and also provides a basis for considering organization in its totality. The following discussion of organization as a system will be made in terms of the parts, the interrelations between the parts, the processes, and system concepts.

Parts of the System

Individual members. --According to Argyris (2) a key part of organization considered as system is the individual member of the organization. The individual brings to the system his talents, expectancies, motives, and attitudes. The individual, in becoming a member of the system, must expect to gain in some way since it is assumed that he becomes a member voluntarily. In order to maintain a viable relationship between the system and the individual, the system must provide the individual with the minimum level of expected returns demanded. On the other hand, the system makes certain demands on the individual and the way he is to perform his job. The interaction that takes place between the individual and the organization as a result of these demands has been the object of considerable attention particularly the incongruencies existing as a result of the fundamental conflict between the mature personality and the demands made by the system.

Formal organization. --The second part of the system usually referred to by modern organization theorists is the formal organization. The formal organization includes the formal arrangement of functions into the various departments (subsystems) of the organization. Standard operating procedures and job descriptions would also be included as an integral part of the formal organization. Classical organization doctrine centered its attention around the formal organization.

Informal organization. --Consideration for the informal organization, the third part of the system, was the main contribution of the neoclassical school of organization theory. The informal organization consists of the natural groupings of organization members in the work situation. Social needs may explain, in a general way, why informal organizations come into being; however, for analytical purposes Scott (47) gives several more satisfying determinants which underly the appearance of informal organizations. An interactional pattern, for example, exists between the individual and the informal group and is viewed as the mutual modification of expectancies. The informal organization demands certain behavior patterns from its members and its members require certain satisfactions from the informal organization. These mutual expectancies between the individual and the informal organization result in the individual's modifying his behavior to be more in line with the demands of the group and,

conversely, the group's modifying its behavior to conform more closely with the expectation of the individual.

Fusion Process. --Bakke (4, pp. 60, 61) sees the Fusion Process as a strategic part of the organization considered as a system. The Fusion Process functions to reconcile or fuse the divergent expectancies of the formal organization, informal organization, and members as individuals. In the process the organization, groups, and individuals are changed, and their behavior is changed.

> In other words, the function of the Fusion Process is to maintain the integrity of the organization in the face of divergent interests of individuals, groups, other organizations, and the organization itself, which each hopes to realize through its contact with the other. Its aim is to establish and maintain for the organization an internal and external integration which will at least leave its capacity to perform its function unimpaired, and at best will improve that capacity.

The Fusion Process may also be viewed as a means by which conflict is managed in order to bring about the best overall solution to the divergent viewpoints in the decision making process. Pondy (41, pp. 246-256) sees conflict as a concept with many meanings and should not necessarily be considered in a negative sense. "It is quite legitimate to think of conflict as interpersonal hostility; but it is equally legitimate to think of it as disagreement or preception of disagreement between two persons on some choice or preference. Or merely as incompatibilities among several formally defined jobs." The reconciliation of conflicting goals and expectancies of

individuals, groups, and the organization, the essence of Bakke's Fusion Process, "is a force which acts to weld divergent elements together for the preservation of organizational integrity."

System concepts as parts of the system. --Chin (11, pp. 16-26) discusses organization in terms of concepts that are a part of the system model. These concepts are (1) boundary, (2) stress or tension, (3) equilibrium, and (4) feedback. These concepts are applicable to open and closed system models and provide a useful framework for discussing modern organization theory. These concepts form the basis for the development of the working hypothesis of the present study given in Chapter IV. The concept of boundary is necessary in order to specify what is inside or outside the system. The concept of stress or tension is necessary because of the fact that the different parts of the system are not perfectly integrated or they are interacting with each other and with outside agents giving rise to stress or tension in the system.

The concept of equilibrium is necessary to describe the process by which a system reacts with its environment and within its subsystem network in order to maintain the status quo. Feedback is a concept denoting the way information flows in the system which enables it to make rational decisions with regard to changes that are necessary in order to maintain equilibrium.

Early views of organization as system. --Organization considered as system is not a new scheme for studying organization. For example, Marshall (36, p. 241), writing in the nineteenth century, viewed industrial organization as an "open system." The classical theorists viewed organization as a system but mistakenly disregarded important features of the system and in the process of abstraction wound up with what amounted to a "closed system" model.

Perhaps, as Koontz (24, p. 11) has said, the truth of the matter is in the semantic confusion which lies in the word "organization." Classical writers, for example, use it to define the activity-authority structure of an enterprise in which case organization represents the formal framework within the organization that furnishes the environment in which members perform. A large number of theorists, however, view organization as the "sum total of human relationships in any group activity."

The modern view then of organization considered as a system is merely an extension of what has gone before. That is, old theories are not discarded but rather recast in light of new information relevant to empirically observed phenomenon. Thus modern theory seeks to integrate all relevant parts of the organization as system and to determine the interrelationships that exist between the parts. Modern theory recognizes the environment in which the organization is embedded as a

powerful influence which must be reckoned with in any relevant theory.

In conclusion, modern organization theory seeks a more realistic model in which reality may be studied and practical solutions to operational problems may be realized. Even then, as Marschak (35, p. 320) puts it, about the only benefit one can derive from an organization model is to clarify the general logic of approach to practical problems that cannot be formalized and must therefore be resolved largely by intuitive judgement. "Even the best biochemist will not replace a good restaurant chef. Yet biochemical analysis has, in fact, improved our food."

Trends in Organization Theory

Massie (37) views the present state of organization and management theory as being characterized by a slow but persistent evolution resulting from ideas that have developed outside the traditional school. He feels that, notwithstanding the absence of a full general theory at the present time, there are clear trends into the future. For example, the impact of recent mathematical and behavioral contributions have not been fully realized. He cites three basic factors contributing to the changes in classical thinking. First, the managerial environment is changing, calling for revision of old concepts which worked well in past environments. Secondly, the methodology for studying management must be refined to

meet the demands of better support for a proposition than the mere statement by an "authority" that it is true. Third, the classical framework of thought is being challenged by new frameworks which are integrating the micro tools of Taylor (50) with research techniques of the behavioral sciences. The new frameworks will require a more rigorous analysis and will at the same time aim toward a better synthesis.

> In the next decade, many of the promising new ideas that have been advanced in the last few years will be tested, and it is reasonable to predict that some will be valid. At that time, classical theorists must be able to provide clear support for their propositions or admit that their framework must be adjusted to accommodate those propositions which have conflicted with their previous assertions. For the traditional theory to remain viable, it must be made capable of new growth within itself (37, pp. 420-21).

Haire (20, pp. 1-15) asserts that organization theory has developed at a very rapid rate in recent years. He cites a whole group of conceptual developments of recent origin such as game theory, decision theory, information theory, communication theory, group theory, and developments in motivational theory which can be focused on the central topic.

Cartwright (10) discusses the growing importance of graph theory especially with regard to its potential use in dealing with structural properties of organization. "The few attempts made to date have produced gratifying results. And, most important, as further experience is acquired it should not be at all difficult for mathematicians to advance the theory of graphs

in those directions of greatest promise for organization theory."

Cleland and King (12, p. 8) see the increased recognition of the human subsystem portending more complexity in the manager's job. This, coupled with the new information systems which do not coincide with standard organization charts and the increasing interdependence between social and economic factors, are bringing about major changes to the situation which the manager must face. "The pace of technology has made many of our 'tried and tested' management and organization theories obsolete. In order to survive, the business must prepare to adapt to these changes."

For Bennis (6) the behavioral sciences have grown out of a response to the need for "revitalizing" organization theory and practice. He cites five main substantive areas where the behavioral sciences have contributed. These are (1) personality theory, (2) interpersonal dynamics, (3) group behavior, (4) intergroup behavior, and (5) organizational behavior. He contends "that the behavioral sciences are becoming more attached to various spheres of action, to a variety of institutional realities. Management education and practice has proved to be particularly receptive to the behavioral sciences." Bennis sees a basic change in philosophy underlying the changes which seems to be in the making even though the transformations are not fully accepted, to say nothing of their being implemented in the affairs of organization. These three basic philosophical changes are:

> 1. A new concept of man, based on increased knowledge of his complex and shifting needs, which replaces the over-simplified, innocent push-button or inert idea of man.
>
> 2. A new concept of power, based on collaboration and reason, which replaces a model of power based on coercion and fear.
>
> 3. A new concept of organizational values, based on an humanistic existential orientation, which replaces the depersonalized, mechanistic value system (pp. 187, 188).

Lorsch and Lawrence (32, pp. 1, 2) recognize a new trend in the study of organization phenomenon. Underlying this trend is the notion that the internal functioning of effective organizations " . . . must be consistent with the demands of the organization task, technology, or external environment, and the needs of its members." This general trend is accompanied by two important methodological approaches to the study of organization. First, is the growing interest in studying organization as systems interacting with their environment. Second, is the increasing interest in applied research for the purpose of throwing light on the practical problems of administrators as well as increasing knowledge and understanding of organization.

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CHAPTER III

ORGANIZATION TECHNIQUES

> Experiments constitute a search for relations and structure in the empirical world. Theories produce languages of some structure. If the two structures are similar, the 'theories work'; otherwise, they do not, and suggest further search and structural adjustments (26, p. 110).

Introduction

Chapter III reviews some of the important techniques currently being used in the process of obtaining data for the theoretical study of organization. The first section is devoted to experimental methods organization theorists employ in their research activities both in the laboratory and in field investigations. Although simulation, strictly speaking, is an experimental method and therefore could have been included in the first section as such, it was felt that the relative newness, scope, and potential of this approach to the study of organization warranted a separate treatment of the subject; therefore, a section of the present chapter is devoted to "simulation and organization research."

Systems analysis has many applications in various fields such as biology, political science, military weapon systems, economics, and engineering as well as organization. Systems

analysis is used in all other techniques of organization research and therefore is dealt with in a separate section.

As indicated in Chapter II, behavioral science has made significant contributions to organization theory and is moving in a direction of even greater contributions. The section on behavioral techniques is devoted to a review of this rapidly developing tool which is considered to be an important factor in the overall advance of organization techniques.

Recent intense interest in organization theory has generated a parallel interest in organization techniques without which theory could not advance very rapidly if at all. A concluding section is therefore devoted to a discussion of trends in organization techniques.

Experimental Methods

Scientific Methodology in Social Science

It is useful to begin a discussion of experimental methods with a brief discourse on the subject of science in general and social science in particular since it is the latter field of knowledge in which organization and management theory is located.

Categories of science. --Peterson (35, pp. 4, 5) and Seligman (39, p. 3) divide science into the two categories of natural, and mental or cultural sciences. Natural sciences are concerned with the physical universe and the mental or cultural sciences are concerned with what goes on in man himself, that is, in the realm of his mental life. Seligman further divides the latter

into those areas in which man is treated as a separate individual and those areas where he is treated as a member of a group. Group related phenomena " . . . are commonly called social phenomena, and the sciences which classify and interpret such activities are the social sciences. The social sciences may thus be defined as those mental or culture sciences which deal with the activities of the individual as the member of a group."

Scientific Methodology. --According to Farmer (13, pp. 25, 26), scientific methodology dates back to seventeenth-century England, particularly to the writings of Francis Bacon. The first step in methodological thinking is the development of a hypothesis, i. e., if X is accomplished then Y will be the resulting occurence. The implication of this statement is that X and Y are related, and the relationship is stated in mathematical terms. Next, one trys X to see if, in fact, Y occurs.

> If it does occur, one can go on from there to the next problem, perhaps involving factors Y and Z. If it does not occur, the hypothesis is discarded, and some new relationship is proposed: If X is tried, then C will occur. The experiments continue until some proper relationship is demonstrated.

Diversity of experimental methods. --Experimental methodologies whether in natural or social sciences perform basically the same functions that is to help the researcher test hypotheses as well as generate new hypotheses; however, as stated by McGrath (32, pp. 533-4), since the field of organization research is inherently and historically interdisciplinary in character, " . . . it is marked by great diversity in

concepts, terms, and methods of study. Since the men who do organization research come from a variety of backgrounds, they tend to bring with them different tools, different concepts, and different methodological approaches." Each of these methodologies have limitations that tend to preclude their being totally "interchangeable, and the choice of methodology in any given case should be made on the basis of the possibilities and limitations of that methodology vis a vis the research problem to which it is to be applied."

Criteria for analysis. --Many aspects of organization theory must be studied through comparative analysis between organizations and therefore precludes single case analysis. Blau (7, pp. 175-186) discusses the comparative analysis of organizations and distinguishes three foci of analysis in the study of organization life. These are (1) role analysis, (2) structural analysis, and (3) organizational analysis. "The differentiating criterion is whether the unit of analysis whose characteristics are being compared, and of which, therefore, a fairly large number must be examined, is the individual member, the work group, or the entire organization." Using this criterion would preclude making the organization the unit of analysis in a single case study. Such a study would have to restrict analysis only to subgroup structure or the roles of individuals. Similarly, the study of environmental influences on organizations would require a research design that includes a variety of organizational settings,

" . . . and since hardly any studies do so, the complaint often heard that we know virtually nothing about the impact of the social setting on organizations is quite justified."

Behavioral assumptions in organization. --March and Simon (31, pp. 6, 7) outline three basic classes of assumptions which are, to some extent, either implicitly or explicitly embedded in all propositions advanced about human behavior in organizations. The first class of assumptions consider employees as passive instruments, capable of accepting directions and performing work but not exerting any significant influence. The second class of assumptions postulate that members bring to their organization attitudes, goals and values, must be motivated, that there is incongruency between personal and organizational goals. The third class assumes that organization members, as decision-makers and problem-solvers, are involved in perception and thought processes which are central to organizational behavior.

Classes of research methods. --Although there is a wide diversity of methodologies in the field of organization, McGrath (32, p. 536) sees some common elements among them when they are each considered in terms of the characteristics of the setting in which the collection of data takes place. They should also be considered in terms of the extent that the investigator intrudes upon, or is responsible for, the nature of the setting. "Viewed in these terms, in fact, most of the types of methodology used in organization research seem to fit

within one of four major classes. We will label these four classes of research settings as field studies; experimental simulations; laboratory experiments; and computer simulations." Field studies and laboratory experiments are discussed in this section followed by a section in which simulation techniques are discussed.

Field Experimental Methods

Value of field experiments. --Some writers argue that the field experiment is the ideal vehicle for studying organization as compared to other methods. In support of this argument Barnes (2, p. 77) cites the advantages of having the possibility of controlled situations, and before-after measurements of change. The field experimental method can help trace causality which neither the single case study nor the comparative study can do. The implication of the field experimental method is " . . . that the sophistication of the laboratory experiment can be transferred to the field situation, thus furnishing the field worker with a rigorous methodological approach." He goes on to admit however, that in fact, " . . . the rigors of experimental design seldom reflect the realities of organization life. The experimental laboratory must always oversimplify the variables found within a complex organization. Likewise, the complex organization cannot easily provide laboratory conditions."

Scott (38, p. 261) believes that "most of what we know today about organizations and the behavior of their members is known on the basis of field studies." The meaning of the term "field methods" is clarified by Scott to include all of the various kinds of techniques that have been used by researchers in gathering their data which is employed in examining human behavior in natural groupings of human beings as contrasted to the laboratory techniques used in studying ad hoc groups.

One of the chief advantages of field experiments in organization research is that the investigations are carried out under conditions which are most like the normal operating situation of the real world. Hughes (21, p. v), recognizing this advantage of "field work," states that observing people in their normal work situation and living with them in some role acceptable to them allows the researcher to observe certain aspects of their behavior intimately and report the results in such a manner that the information is useful to social science and at the same time not harmful to the organization members.

Difficulties with field experiments. --Individual case studies and comparative organizational studies are important field methods of studying organization. However, some writers have criticized these methods on the basis that the experiment and the experimenter change the situation and therefore the outcome of the investigation. For example, Barnes (2, p. 87)

states that " . . . for many years, field researchers have lived with the stigma attached to the expression 'Hawthorne effect' when laboratory purists discussed the pitfalls of field researcher influence."

Some researchers such as Klintz et. al. (25, pp. 223-232) have studied this problem of experimenter-subject relationship and have concluded that experimental psychology can ill afford to neglect the experimenter as an independent variable and therefore should not accept any longer the notion that the experimenter is necessary but harmless.

In order to overcome the difficulties an outsider has in obtaining information without changing some aspect of the organization itself, Dalton (12, pp. 161-168) analyzed two organizations in which he was employed at the time of his study. Being a member of the organization under study, according to Grusky and Miller (16, p. 159), allowed him considerable "freedom to engage in detailed participant observation, to interview other organizational members, and provide him with some access to personnel files. Dalton also made extensive use of informants in the various organizations he studied and discussed the problems that resulted from their use."

Although recognizing the fact that problems do exist, not all investigators agree that this necessarily invalidates the method. Lipset, Trow, and Coleman (30, pp. 169-174) have studied the problems of generalizing from single case studies. A major difficult problem these researchers dealt with was

the problem of how to generalize from a single case. Studying a single organization as they indicate is somewhat analogous to a chemist developing a theory or set of laws from the analysis of the contents of a single test tube. Just as the chemist could draw some generalizations from the single system he has before him, so can the organization researcher draw generalizations from single case studies.

Conclusion

Field experimental techniques offer the advantage of having a situation in which the investigation is carried out under conditions which are in many respects like the real world. The main disadvantage is that the investigation itself including the investigator does have an impact on the organizational setting in which the study is made.

Laboratory Experimental Methods

Experimental vs. nonexperimental methods. --An excellent introduction to the experimental method is given by Mills (34, pp. 409-448). In his treatment of the subject he first of all defines an experiment as " . . . a study in which the investigator manipulates or varies one or more variables (called the independent variables) and measures other variables (called the dependent variables)." In contrast to an experiment, that is, a study in which the investigator has full control over at least one variable, a nonexperiment study is one in which the investigator simply measures the differences that occur.

Borrowing from Festinger (14, p. 360), Mills explains that the difference between an experiment and a nonexperimental study "is not, as is frequently assumed, in the amount of control over other variables which the research worker has. It is quite possible to have a good deal of control over variables and a good deal of precision of measurements in nonexperimental situations."

The experiment in the laboratory, according to Zelditch and Hopkins (43, p. 465), is a special kind of inquiry and is quite different from the field experiment and laboratory observation. "To experiment is so to manipulate the conditions under which some event is made to occur that the effects produced by different sets of initial conditions can be contrasted . . . . By laboratory is meant any setting that allows the investigator to control rigorously the conditions under which he makes his observations."

The major value of experiments cited by many writers, including Mills (34, p. 412), is that experiments are more capable in testing hypotheses about causal relationships than nonexperimental studies. "The great power that the experimental method has in testing causal hypotheses is the reason that the distinction between experimental and nonexperimental studies is so important. If the term experiment is not defined in terms of the manipulation of variables, then another term will be needed to make this crucial distinction."

One of the major disadvantages of field studies cited by Grusky and Churchill (15) is the impossibility of verifying propositions systematically. They claim that since most of the research data on the effects of succession and organizational effectiveness has been obtained by field studies, its methodological weaknesses should be kept in mind. For example, the case study researcher must become thoroughly familiar with the organization, its member, its operation, and many other aspects of the system. This takes a great amount of time plus the fact that sufficiently large samples of reasonably comparable organizations to permit statistical analysis of organizational relationships present researchers with almost insurrmountable problems. In order to overcome these difficulties, Grusky and Churchill designed an experimental method which was used in a laboratory experiment to study the effects of succession and organizational effectiveness under carefully controlled conditions.

Function of laboratory experimentation. --One of the main functions of laboratory experimentation is to isolate features which are common to all organizations and to study the particular feature isolated under controlled conditions. A good illustration of this function of experimentation is in the study of communication networks as reported by McGrath (32, p. 538). In these studies the fundamental feature of communication linkages between suborganizational entities was studied under controlled laboratory conditions.

> Neither the specific nets studied (four and five node nets, of various patterns ranging from highly centralized to highly decentralized) nor the tasks being performed (symbol-identification problems, simple arithmetic problems, etc.) were meant to "simulate" real organizational structures or real organizational tasks. Rather, the purpose of the communication net studies was to determine how variations in highly abstract and basic patterns of communication influenced certain basic kinds of human activities . . . which presumably operate in all human organizations.

Controversial issues over laboratory experimentation. -- Laboratory techniques are superior in many respects to field experimental techniques but not without some accompanying disadvantages. Many theorists reject organization experiments on the basis of several controversial issues associated with experimentation. Weick (41, pp. 1-56) cites several of these issues from folklore which notwithstanding their being "rich, colorful, varied, at times popular, and often accurate, it also serves to perpetuate certain fictions about experiments." He quotes Lewin (28, p. 155) as an example of the controversial issue of what is and is not meaningful in experimentation. Lewin states that "what can be observed reliably is socially meaningless and what is socially meaningful cannot be observed reliably." Weick cites other selections, one in particular worth mentioning being from Homans (20, p. 259) who asserts that "some social scientists will do any mad thing rather than study men at first hand in their natural settings." Weick discusses four specific issues which he claims are often overrated and are therefore not the deterrents to experimentation

that some believe them to be. These issues are: (1) experiments demonstrate the obvious, (2) experiments are artificial, (3) laboratory contexts are oversimplified, and (4) hypotheses induce myopia.

Admitting that laboratory events differ from everyday events in many ways, Weick concludes, however, that observed differences do not necessarily mean that the laboratory event is any less real or any less valuable as a means to learn about people. Relationships between variables are verifiable in the laboratory just as they are in the field.

> Laboratory controls do not restrict the richness of data; they frequently make it easier to detect the unexpected when it occurs. There are considerable problems in conducting laboratory studies. But the problems of incomplete knowledge of variables, artificiality, simplicity of events, and focused observation are not among the major drawbacks even though they are often represented as such.

Commenting on the problems of organization research, Sells (40, pp. 521-22) gives both field and laboratory methods a "high risk" rating due to the frustrating problems of criteria, control, data collection without disturbing organizational interactions, and numerous other restraints to effective research. Such problems have led researchers to simpler laboratory and simulation approaches although these approaches are not without methodological problems such as the interdependence of individual differences and environmental variables.

Simulation and Organization Research

Two types of simulation methodologies researchers use in studying organizations have several advantages over field and laboratory experimental methods. However, they also have limitations and disadvantages which dictate to some extent their usefulness in any particular situation. Data handling capability of digital computers increases the potential of simulation techniques significantly. Experimental simulation will be discussed first followed by a discussion on computer simulation and its use in studying organization.

Experimental Simulations

The term "experimental simulations" as used by McGrath (32) and others refers to empirical studies which try to faithfully represent an organization under quasi-laboratory conditions. The simulated organization is set "in motion," and studied in terms of the expressed behavior of subjects who are assigned roles within it. In experimental simulation studies, many features of the organization are simulated sometimes using computers to study structure and processes and to make behavioral determinations of subjects who function in the system.

Contrasting features of experimental simulations. -- McGrath distinguishes these studies from laboratory experiments in several respects. For example, the stimulus situation within which the individual is operating is a continuous function

in an experimental simulation, as contrasted with laboratory experiments which normally consist of a series of discrete trials. Another contrasting feature of experimental simulations is their continuous nature as opposed to the discrete nature of laboratory experiments. Thus, participants' responses at any particular point in time partly determine the stimulus situation in which they will be operating at subsequent time points. "Finally, experimental simulations differ from laboratory studies in that they attempt to simulate or model properties of 'real-life' organizations, which is the key defining property of this class of methods in the present schema."

Application of experimental simulation. --Experimental simulation has its chief application in studying situations that are too complex for laboratory experiments or other methods which are too restrictive or lack sufficient control such as those usually found in most field studies. Experimental simulations are "property-rich" experiments which lend themselves to the study of highly complex organizational situations as opposed to testing individual cognitive processes, one by one. In discussing this feature of experimental simulation, Bass (3) says that typically experimental simulation is not the tool with which to test specific processes, one by one, any more than a pilot plant is necessary to test the tensile strength of a particular alloy. It is when the test-tube findings of several interrelated processes, are not trusted

or the simple stress tests of the alloy is not considered valid that we build the pilot plant or employ the alloy in a specific wing structure to try a "property-rich" simulation.

> Thus the complex game becomes the recommended experimental procedure when we want to examine questions about the organizational mix, particularly of real men, process, and materials as they interact. When no simple experiment with all-but-one variable held constant will provide the answers we seek, it will be profitable to simulate the organization (3, p. 99).

Computer Simulation

Distinctive features of computer simulation. --Experimental simulation may make use of computers in which case they are sometimes referred to as "man-computer simulations" as discussed by Guetzbow (17), but the methodology is quite different from "computer simulations." In experimental simulation "real-life" organizational properties are simulated in which human subjects participate. In contrast, computer simulation employs abstract mathematical models which are programmed into a computer. Variables are then manipulated according to some scheme appropriate to the research problem under investigation. The computer in turn operates on the model in accordance with the changed conditions represented by variable manipulation and computes an answer based on the construct of the model.

One of the distinguishing features of computer simulation models as compared to more conventional techniques of organizational research lies in the role of the researcher. In

conventional research methodology the experimenter is clearly part of the process under investigation and therefore must be accounted for in the research problem. He may, as Roby (36) points out, change the organization in some particular way, however, parts of the organization are always inaccessible to manipulation. "In simulation studies, however, the experimenter pulls all the strings even if they are so tangled that he does not know in advance what they will do. From this standpoint the variation in a simulation model is wholly exogenous to the system under investigation."

The distinctive feature of the class of research commonly referred to as computer simulations, according to McGrath (32) "is that all structures and processes which are to be dealt with in the investigation are represented in the simulation model itself either as parameters, as operating rules, or as stochastic processes."

Computer model difficulties. --An excellent treatment of computer simulation is given by Cohen and Cyert (11, pp. 305-334) in which several organizational behavior studies are reported. Several problems encountered in the use of computer models are discussed, the main one of which will be touched on here. A major problem with computer models concerns the amount of explanatory power gained. The tendency is for researchers to "embed as much of the real world as is possible in the models." As models are made more complex, it becomes more difficult to interpret the model's behavior. These

writers advise users of computer models to try to find "the middle ground where the model is complicated enough to deal with reality but not so complicated that it impedes comprehension of this reality."

Systems Analysis and Organization Design

Role of Systems Analysis in Organization

A conceptual framework. --One of the main contributions of modern organization theory stems from the conceptual framework of systems theory in which organization is considered. Many writers agree that systems theory has given modern organization theory an inspirational boost and in general are optimistic with regard to present trends. The techniques of systems analysis, according to Haberstroh (18), have assumed an important role in organization as well as many other fields of endeavor.

Scott (37) says that "the distinctive qualities of modern organization theory are its conceptual-analytical base, its reliance on empirical research data, and, above all, its synthesizing, integrating nature. These qualities are framed in a philosophy which accepts the premise that the only meaningful way to study organization is as a system."

Systems analysis as a research tool. --Systems analysis as a research technique is a powerful tool in studying organization. Systems analysis, for example, provides an analytical framework in which organization is viewed as a total system

with a whole range of interrelated questions brought into focus which as Scott (37) asserts are not seriously considered by the classical and neoclassical schools. The major questions asked by system analysis are: "(1) What are the strategic parts of the system? (2) What is the nature of their mutual inter-dependency? (3) What are the main processes in the system which link the parts and facilitate their adjustment to each other? (4) What are the goals sought by the system?"

A rational approach to the study of organization. --In considering the design and management of complex organizations from an "engineering systems approach," Briggs (9) equates "organization" and "system" and defines a system "as an assemblage of components, each of which carries out assigned functions and all of which are intercoupled in such a way as to obtain a particular goal." For Briggs, systems analysis is a "rational approach" to the study of organization in terms of the organization or system itself and its environment. Considering the organization as a system results in a specification of the goals of the organization, identification of the various suborganizational entities or system components, identification of the functions performed by these components, information flow, interaction among components, and details of the environmental factors influencing the operation of the system. "It may be seen this effort is primarily descriptive. Indeed, system analysis is nothing more than a careful and complete description, since, like in any research area, an

understanding of systems must be based on a sound description of phenomena."

Systems analysis forces one to take a more thoughtful view of the subject being analyzed than the view invoked by the atomistic mechanical model of early scientific thought. Yinger (42) makes this point very clear in discussing the levels of analysis in which the science of human behavior must be made. For example, he states that it is one thing for a psychologist to give some deference to the concepts of culture role and to try to include them into his system. It is quite another thing, however, for him to assert that only an individual can "behave" and therefore conclude that the science of behavior is the science of the individual. "Such a statement disregards the influence of the organization of parts into new wholes and the effects of interaction, which by definition cannot reside in individuals viewed separately."

Future of systems analysis in organization theory. -- Systems analysis has reached a stage of maturity and respect from many different disciplines as a research technique and will no doubt continue to be a major tool in the development of organization theory. As analyses become more complex and dynamic in nature, as Indik (23, p. 262) asserts, " . . . it seems clear that future work must accept and account for a more complex model of how behavior variance may be explained." A more complex model will no doubt require even a more rigorous analysis than before if relevant theory is to evolve and

therefore we may conclude that systems analysis will retain its rightful place in the organization theorist's repertoire of organization techniques.

Behavioral Techniques

Introduction

Techniques are tools which aid the researcher in collecting data about which he wishes to theorize. Techniques discussed thus far may be used to some degree in collecting behavioral facts about organizational life. The subject of the present section therefore will be directed toward those techniques uniquely related to the collection of behavioral facts about organization. Thus the discussion will center around techniques for determining individual behavior, group behavior, organizational behavior vis a vis its environment, and interrelational factors internal to the organization itself.

Behavioral influences. --Since the Hawthorne studies of the 1920's and 1930's, the view of organization theory has broadened to include behavioral factors such as motivation, personal vs. organizational goals, and group processes, etc. McGregor (33) has contrasted this new or "human" side of organization within his theoretical dichotomy of theory X and theory Y. As the field is broadened, Haire (19, p. 3, 4) also sees more facets appearing on the scene. He sees a continuum of variables extending from the relatively pure

structure of organization at one extreme and behavioral factors of organization at the opposite extreme with various interrelational aspects between the two extremes.

The behavioral side of organization has been given much attention over the past few years by theorists from many different disciplines. Likert (29) and Argyris (1) have made important empirical contributions to the subject of organizational behavior. Bennis (4) has devoted considerable effort toward reporting what he sees as a rather recent phenomenon in our society, that is, "organizational revitalization," a term he uses "to encompass those complex organizations which scrutinize carefully their operations and processes and then improve and develop them with the aid of the behavioral sciences." Yinger (42) writes on the subject of a "field theory" of behavior in which "the unit of analysis is neither the individual nor the social structure, but the field within which they meet."

Individual and Group Behavior Techniques

Unit of analysis. --The unit of analysis for individual behavior in organization is the work group and the entire organization if we use Blau's (7, pp. 175-186) criteria for analysis which requires a fairly large number to be examined. Blau's criteria would preclude making the individual the unit of analysis for individual behavior analyses; it would also restrict analysis of subgroups in a similar manner to the

entire organization as the unit of analysis. The question then arises: What techniques are available for determining individual behavior and group behavior in organizations? The answer to this question will be the subject for discussion in this section.

Attitudes and interpersonal perceptions. --Writing on the subject of "interpersonal attraction, hostility, and perception," Bramel (8, p. 3) focuses on attitudes and interpersonal perceptions. "Precise operational definitions of attitudinal concepts such as liking, hostility, avoidance, and aggression are hard to come by in the literature of social psychology." Accordingly, most of the experiments discussed by Bramel utilized pencil marks on a verbal scale in operationalizing attitudinal dispositions of subjects who were usually led to believe that the marks they made would have no further consequences and were confidential. One possible way to measure liking and disliking is the anonymous reward-or-punishment technique. The assumption underlying this technique is that a person should be motivated to make a friend happy and an enemy unhappy. However, this technique has its shortcomings mainly stemming from the difficulty in psychology of finding "a measure that taps a single dimension and only that dimension. Any indicator inevitably is influenced by a number of factors."

Social psychologists have studied attitude and attitude change from an empirical and theoretical standpoint and have found some interesting and useful information which can be transferred to the organizational setting. Along these lines, Berscheid and Walster (5) discuss attitude in terms of three components in which it has been conceptualized. These are (1) an affective, (2) a behavioral, and (3) a cognitive component. The fact that most people usually desire that their beliefs be consistent with each other gives us one technique for changing attitudes. "Specifically, if we can irrevocably change one element of an attitude, often the other elements of the attitude will also change to achieve consistency." Experiments reported by Berscheid and Walster confirm this to be the case.

Use of confederates. --A technique used by many behavioral scientists including Bramel is to employ stooges to interact with subjects in a programmed manner and observe the subjects response to the interaction. Bramel reported on an experiment designed in such a manner that required each subject to participate in a series of brief interactions with a stooge after which the subject was allowed to overhear the stooge and experimenter carrying on a programmed conversation which the subject thought was quite natural. The subject was then asked to evaluate his liking for the confederate under various conditions of positive and negative programmed conversations which the subject was allowed to overhear.

Creating a situation. --The technique of creating a situation from which behavioral measurements are made is used quite extensively to measure such things as "shared" threat, prejudice, within-group attitudes resulting from inter-group competition, etc. These techniques, used in many experimental research efforts reported by Bramel (8) and others, are indicative of the techniques theorists use in studying individual and group behavior. Studies of group pressure and conformity as reported by Kiesler (24) use the same basic techniques of creating a controlled situation in which subjects and confederates are programmed to interact under specified conditions.

Sociometric techniques. --Interdependence in groups, a key analytical factor in organizational analysis, has been studied using sociometric techniques, as reported by Burnstein (10), in which relationships between individuals were determined by their "sociometric choices." "On the basis of this analysis, predictions could be made about, among other things, the "path" a rumor would follow."

The interview. --The key research technique for studying organizational behavior, according to many authorities, is still the interview. Argyris (1), for example, says that for the particular types of problems and the models reported, "the semistructured interview seems to provide the maximum return on research investment." He feels that the semistructured interview is especially suited for lower-level employees.

The managerial grid. --One of the more ambitious methodologies for organizational development is the "managerial grid" technique developed by Blake and Mouton (6). The managerial grid approach is based on the premise that the single greatest variable to organization effectiveness is the management team. Used as an analytical and training tool, the managerial grid, so claim Blake and Mouton, can increase managerial competence to a significant degree.

Organization Behavioral Techniques

Unit of analysis. --The unit of analysis for studying entire organizations using Blau's (7) criteria would be groups of organizations and their common environment. Lawrence and Lorsch (27) have made such studies of groups of business firms in different industries and therefore different environments. The main thrust of these investigations was to determine the relationship between organization structure and the environment. Using comparative analysis as a research technique, it was found that organizations tend toward structures that are best suited to the environment in which they are embedded.

Organizational development techniques. --Although organizational development techniques are primarily used for training purposes, they are inherently useful for obtaining organizational behavior information. T-group training and the managerial grid methodologies are examples of techniques which are being used by many organizations to help develop better

organizational behavioral patterns. These techniques are far from being universally acceptable; however, they do give some promise and will no doubt gain much more acceptance as techniques are improved to the extent that they can be unquestionably validated.

Trends in Organization Techniques

Total system view. --Recent interest in viewing organization as total systems demands that techniques be developed which will enhance the researcher's capability for studying total systems. Argyris (1, p. 155) repeatedly stresses the fact that many important questions are still unanswered or at best only partially discussed. In stressing the need for more knowledge Argyris poses questions concerning criteria for relevant variables and operational definitions.

> . . . What are the precise criteria that one may use to know when he has discovered (or conceptually reconstructed by the use of the model) the pattern of the relevant variables that is assumed to be the organization in the empirical world? What operational definitions are there available to the researcher to show him when the model adequately represents the organization as a whole?

New patterns of management. --Techniques for comparing the different styles or patterns of management in organizations will continue to improve to include operationally verifiable results with regard to which style of management or which organizational design is best for a particular situation. Bennis (4) believes that bureaucracy is obsolete as a viable approach

to administration. This view is either explicity or implicitly held by many theorists and will therefore require techniques that will permit an operationally verifiable determination to be made. This would require a massive undertaking of research in all types of organizations.

Conclusion. --Blake and Mouton (6) have concluded that there is a "trend leading to maturity and relationships among men toward which production organizations seem to be evolving." The achievement of such a goal as this trend implies will ultimately rest on sound theoretical considerations which must depend to a large extent on the tools of research techniques, tools which will furnish the theoretician with indisputable facts upon which a sound theory of organization can be built.

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CHAPTER IV

RESEARCH STRATEGY

Introduction

The strategy for carrying out a research effort must be carefully planned and executed in order to assure that the objective of the investigation is achieved with reasonable effectiveness. Strategy for research logically follows from recognition of some problem or question that the researcher desires to pursue. In the present study the question of rationality in organization design was uppermost in the researcher's mind.

Following recognition of a problem, the researcher normally develops a hypothesis about the problem which he desires to test. He then develops a method which he thinks will fulfill the requirements of answering his original question. These three steps then are discussed in that order, that is, (1) a statement of the problem, (2) the working hypothesis, and (3) the research design.

Statement of the Problem

The problem of this study was to investigate the relationships between managerial functions and organization structure. A search of the literature did not reveal any work, past or present, along the specific lines of the strategy of

this effort. Most work in the general area of organization design has been centered around comparative field studies, laboratory experiments, and experimental simulation studies. Each of these three methodologies had deficiencies which the present research was designed to at least partially overcome. In addition to providing a practical tool for organization design, it was also desired to test the theoretical soundness of the working hypothesis and thereby make some contribution to the development of organization theory.

A rapidly changing environment such as is found in modern society places tremendous demands on organizations in all areas of society. The bureaucratic model of organization which worked quite well in a more stable and less demanding environment does not fulfill the requirements of rapid change and technological advances.

The present study has attempted to answer the question: What is the best approach to organizational design in the present day environment of modern society?

The Working Hypothesis

The working hypothesis evolved through the process of considering the problem of organization design within the framework of systems theory. One outstanding feature of modern organization theory, as discussed in Chapter II, is its consideration for interrelatedness within the organization itself. All areas of science (including social science) seem

to be concerned with the relationships between entities in any group setting. The realization of this importance of relations led the researcher to consider this aspect with regard to systems in general and to social organization in particular, with special interest in the relationships inside a system and that system's structure.

A cursory review of systems found in the physical world revealed what seemed to be a common feature in all such systems and that is simplicity of structure. This does not mean that there are no complex systems found in nature. It does mean, however, that the systems one finds in nature have structures which are uniquely fitted for the functions of that particular system, and it is interesting to note that in such systems there are no useless relations in the system. In other words, the systems found in nature seem to have a minimum amount of interrelatedness between subsystems within the total system necessary for producing its output. These statements are not intended to be construed as an indication that the researcher has made an exhaustive study of systems found in the physical world. The statements are made merely to indicate the thinking process by which the hypothesis of the present study evolved.

Equating interrelatedness with coordination and applying deductive reasoning, the obvious question then was: If in the physical world then why not in the social world? In other words, why not design social organizations in such a manner

that there would be a minimum amount of required interrelatedness (or coordination) between suborganizational elements in accomplishing the functions of the organization?

In the systems approach, one studies the interrelationships found in the organization between the various elements or parts that make up the organization considered as a system. Chin's systems concepts of (1) boundary, (2) stress or tension, (3) equilibrium, and (4) feedback, as discussed in Chapter II, were useful in deriving the hypothesis upon which the present research effort is based.

In thinking of organization in terms of the systems concepts mentioned above, the following questions were posed: How do managerial functions relate to the concepts which are a part of the system? Can organizational structure be optimized by manipulating the relationships between managerial functions and the systems concepts?

The managerial function which is directly related to the systems concepts and through which all other managerial functions are related is the function of coordination or in system terms "interrelatedness." Therefore, the specific objective of the study was reduced to determining whether or not organization structure may be optimized by adjusting the structure in such a manner as to require a minimum amount of coordination between suborganizational elements in accomplishing the functions and goals of the organization.

The reason for choosing the singular managerial function of coordination is that it seemed to be the connecting link between the systems concepts and the managerial functions of planning, organizing, directing, and controlling. This relationship between the functions of management and organization structure may be demonstrated by considering each of Chin's systems concepts and its relation to coordination.

System boundary. --The concept of boundary of the system or sub-system is a major factor which determines the amount of coordination that must take place in a given structural design. This being the case, one could vary the required coordination in an organization necessary to accomplish organizational goals and perform organizational functions simply by varying the boundary of one or more sub-organizational units.

In the present study sub-organizational boundary was varied and thereby different amounts of required coordination achieved by varying the structural design while holding the output of the organization constant. Five structural designs were included in the investigation each design being utilized to simulate operations of the existing organization for a test period of one year.

The concept of boundary is also useful in studying effects of the environment on the organization as a whole. Many studies have recently been made in which environmental factors were considered from the viewpoint of structural design. In these research efforts comparative analyses were made in which

different environments and organizations were studied. However, in the present investigation the boundary and environment of the total organization were held constant with only internal factors varied and resulting effects measured.

Stress or tension. --The implication of the working hypothesis is that stress or tension is directly related to the quantity of required coordination that must take place in a given organizational structure in order to effectively achieve the goals of the organization and to effectively perform the functions of the organization. The hypothesis also implies that organizational stress results from a lack of coordination when the situation requires it to effectively perform organizational functions. If it is true that the quantity of stress or tension in a given organization at any point in time is directly related to the coordination that is taking place or that should be taking place at that time, in order to minimize stress or tension in an organization, the structure should be designed in such a manner that required coordination for accomplishing organizational goals and performing organizational functions will be a minimum. It logically follows that the management functions of planning, organizing, directing, and controlling would also be affected, hopefully in a similar manner, since they are directly related to coordination.

In the present study a comparative analysis was made of the managerial functions of planning, organizing, directing, and controlling. Each of the five structures was evaluated

and compared with the existing organization. The results of this analysis is included in Chapter VI.

Equilibrium. --Equilibrium, according to Chin's article discussed in Chapter II, page 46, is a concept in which the dynamic and static nature of organization may be considered. For example, dynamic equilibrium is maintained in a group if a new procedure or method is easily adopted and integrated into the functional processes for which the group is responsible. In other words, dynamic equilibrium in an organization allows that organization to progress to higher and higher levels of effectiveness much like a ratchet action. On the other hand, stationary equilibrium in an organization exists when initial conditions are always returned to after a disturbance. An organization in which stationary equilibrium predominates is unlikely to change and therefore is unlikely to improve itself since there is a strong tendency to always return to the initial conditions after any such attempt to change. An organization encrusted with tradition or with clearly articulated and entrenched rules exhibits stationary equilibrium. Such an organization is usually encumbered with an abundance of required coordination, characteristic of bureaucratic organizations.

Thus, the concept of equilibrium in an organization is directly related to the required coordination or interrelatedness within the organization. Stationary equilibrium in organizations is primarily caused by inferior structural design

which results in more required coordination or interrelatedness within the system than would be necessary if the structure were designed to minimize interrelatedness. Dynamic equilibrium on the other hand permits change and is a characteristic of organizations with structures arranged such that a minimum amount of coordination is required between sub-organizational entities in accomplishing the function and goals of the organization. Equilibrium is also affected by environmental factors although in the present study these factors were held constant and only internal factors allowed to vary.

Feedback and control. --Much of what has been said about equilibrium applies also to feedback in organizations. In considering feedback, however, we are dealing more with the flow of information from the environment back into the system or sub-system where it is used to make corrective decisions in the process of guiding the system toward its goal. Feedback between sub-organizational elements as well as between the environment and the organization as a whole is directly related to the amount of required coordination within the system. The simpler the organization structure is made the easier will be the feedback and control process and the better the chances will be for achieving the desired results and the more reliability will be realized from the system. In organizations this means the less coordination is required in achieving the desired results or goals the more likely there

will be a smoothly operating organization and the less chance there will be for a breakdown to occur.

Hypothesis. --If what has been said is true, then at least one important criterion for structural design of organization is minimum required coordination necessary to accomplish the goals and functions of the organization. A corollary to minimum required coordination is a maximum propensity to coordinate that which is required. The hypothesis with which this study is concerned then may be stated as follows:

> Optimum organization structure occurs under conditions of (1) minimum required coordination of actions and processes necessary to accomplish organizational goals and functions, and (2) maximum propensity to coordinate those actions and processes that require coordination.

Optimum organization structure is defined as that structure which permits the accomplishment of organizational goals and functions with the greatest economic efficiency.

Research Design

Design Criteria

The objective of the present investigation was to study organization structure which would normally require a comparative analysis of several organizations since the unit of analysis is the total organization. In order to maximize the utility of the methodology from a practical viewpoint, the design limitation of a single organization was imposed. Thus, the methodology would be practical from the viewpoint of

management of a single organization who desires to proceed on a rational basis to design or redesign organization structure without the necessity of acquiring outside information.

In order to achieve this objective, a scheme was developed whereby the structure of an existing organization could be analyzed on a comparative basis with the structures of several alternative organizations by simulating operation of the normal business of the existing organization in several model organizations each with a different structural design. It was felt that such a scheme would be superior to a comparative study of several actual organizations because of the necessity for having full control of the main variable of "coordination" which would be impossible in a comparative study of actual organizations.

Elements of the Design

The research project was carefully designed with elements appropriately chosen from several of the currently used methodologies in organization research discussed in Chapter III. The data base, for example, was generated from an organization's normal operation for a time period of one year. The data base was the outgoing correspondence of the organization for a prior year than the time of analysis of the data which precluded the problem of experimenter-subject or "Hawthorne effect" occurring.

Although the study included only one actual organization, the benefits of comparative analyses were realized through the process of simulation with four model organization structures. The same data used for analyzing the existing organization was also used to simulate the operation for one year in each of the four model structures.

An element of experimental methodology was realized since the researcher had control over the basic independent variable of "coordination." Coordination was changed through variations in the structural design of the four model organizations. Thus it was felt that the greatest advantage the experimental method has in testing causal hypotheses was retained.

Key factors. --Key factors which influenced the design of the research methodology was (1) size of organization to be studied, (2) availability of data, (3) method of obtaining data, (4) time frame of the study, and (5) choice of managerial functions to be included in the research model.

Size of organization. --The size of the organization to be studied was carefully chosen with two objectives in mind: (1) to permit validation of the hypothesis and (2) to permit the simulation of a practical managerial situation. The organization chosen for study consisted of a field division of a relatively complex governmental agency. The number of employees in the organization was approximately 1500 of which approximately 200 were employed at the headquarters location and the remaining 1300 dispersed throughout a region encompassing several states.

Availability of data. --The data required for the study had to be of such nature that it would give some indication of the output of the organization under study. The data universe consisted of the outgoing correspondence of the various suborganizational elements. A 6 percent random sample totaling 508 items was taken from the outgoing correspondence covering a period of one year. The data universe consisted of an estimated 8,000 to 10,000 items.

Method of obtaining data. --The data used in the research was extracted from the random sample of the outgoing correspondence of the organization studied. Each item of correspondence in the sample was analyzed to determine the amount of coordination between suborganizational elements (branches) that was required in producing it. An average manhour figure was determined for each act of coordination. The total coordination required for each suborganizational element was calculated for the existing organization.

The sample of outgoing correspondence was then used to simulate operation in each of four different model organization structures. The amount of coordination required for each suborganizational element in each model organization structure was determined in the same manner as was determined for the existing organization.

Time frame of the study. --The time frame for the study was carefully chosen to assure that a good representative sample of the normal operating situation would be included in

the study. A time frame of one year of operation was chosen which seemed to be adequate for the purpose of the project. A one year time frame is very likely to take in most variations in the business carried on by the organization. It was also felt that a small sample of a full year's operation would be more realistic than a study of the entire universe of data for a correspondingly shorter time frame.

Managerial function included in the research model. -- The purpose of the study was to determine the relationships between organization structure and managerial functions with the objective to utilize this relationship in some way to measure the effectiveness of the organizational structure. Interrelatedness is the key factor in modern organization theory. Organization researchers are concentrating on studies which take into account the effects of the external environmental relationships as well as the internal relationships between suborganization units.

The concept of "interrelatedness" which is used by most researchers in studying organization is equivalent to the concept of "coordination" in terms of managerial functions. Coordination therefore was considered to be the logical managerial element to include in the research model. The other managerial functions and organizational elements were evaluated as part of the overall analysis of the results of the study.

Conceptual Scheme

This sub-section discusses the overall strategy for the investigation and considers the hypothetical model of Figure 1 which diagramatically depicts the overall scheme of the research design.

The general aim of the research was to test the hypothesis that optimum organization structure may be obtained by designing the organization such that minimum coordination between sub-organizational elements would be required to accomplish the functions and goals of the organization. Such a design of organization structure should increase managerial efficiency within the organization by (1) reducing the effort involved in the coordinating function, (2) reducing stress or tension in the organization, (3) reducing stationary equilibrium while increasing dynamic equilibrium and thereby enhancing the organization's capability to adapt itself to a changing environment, and (4) enhancing feedback and control within the organization which should increase the organization's capability to achieve its objectives.

The research strategy attempted to develop a practical model for organizational change which could be utilized effectively by management in designing organization structure. To be most useful from a practical viewpoint the scheme should provide for a procedure that would require only information that is readily available to management within the organization. This would enhance its usefulness as a managerial tool in this important area of decision-making.

Conceptual model. --Figure 1 depicts the conceptual model of the research design. The following symbols will be used in describing the operation of the model:

O_E - The existing organization studied

E_I - The input to the existing organization

E_O - The output of the existing organization

E_{OS} - Sample of the output of the existing organization

T - Translator

M_I - The input to the model organizations

O_A - Model organization A

O_B - Model organization B

O_C - Model organization C

O_D - Model organization D

A_{OS} - Output of model organization A

B_{OS} - Output of model organization B

C_{OS} - Output of model organization C

D_{OS} - Output of model organization D

C_E - Required coordination in existing organization

C_A - Required coordination in model A organization

C_B - Required coordination in model B organization

C_C - Required coordination in model C organization

C_D - Required coordination in model D organization

CC - Coordination comparator

F_A - Figure of merit for model A organization

F_B - Figure of merit for model B organization

F_C - Figure of merit for model C organization

F_D - Figure of merit for model D organization

A sample of the output, E_{OS}, from the existing organization, O_E, is translated into an input, M_I, to the existing organization and the model organizations O_A, O_B, O_C, and O_D. This input, M_I, to the existing and model organizations is arrived at through a process of analyzing the output sample, E_{OS}, of the existing organization. The analysis consisted of answering the question--What internal processes were necessary in the existing organization in order to accomplish the output? Specifically, for each item in the sample, the originator of the item was identified and a determination made of the required coordination in producing the output represented by the sample item. The model input, M_I, is the input for the existing organization, O_E, and the model organizations O_A, O_B, O_C, and O_D.

To arrive at the amount of required coordination in each of the existing and model organizations an analysis was made of each item in the sample of the output of the existing organization, E_{OS}. The amount of coordination required in the model organizations O_A, O_B, O_C, and O_D to accomplish the output as represented by the sample of the output of the existing organization was determined by a similar analysis as was accomplished for the existing organization, O_E. An average man-hour figure for each coordination activity was determined

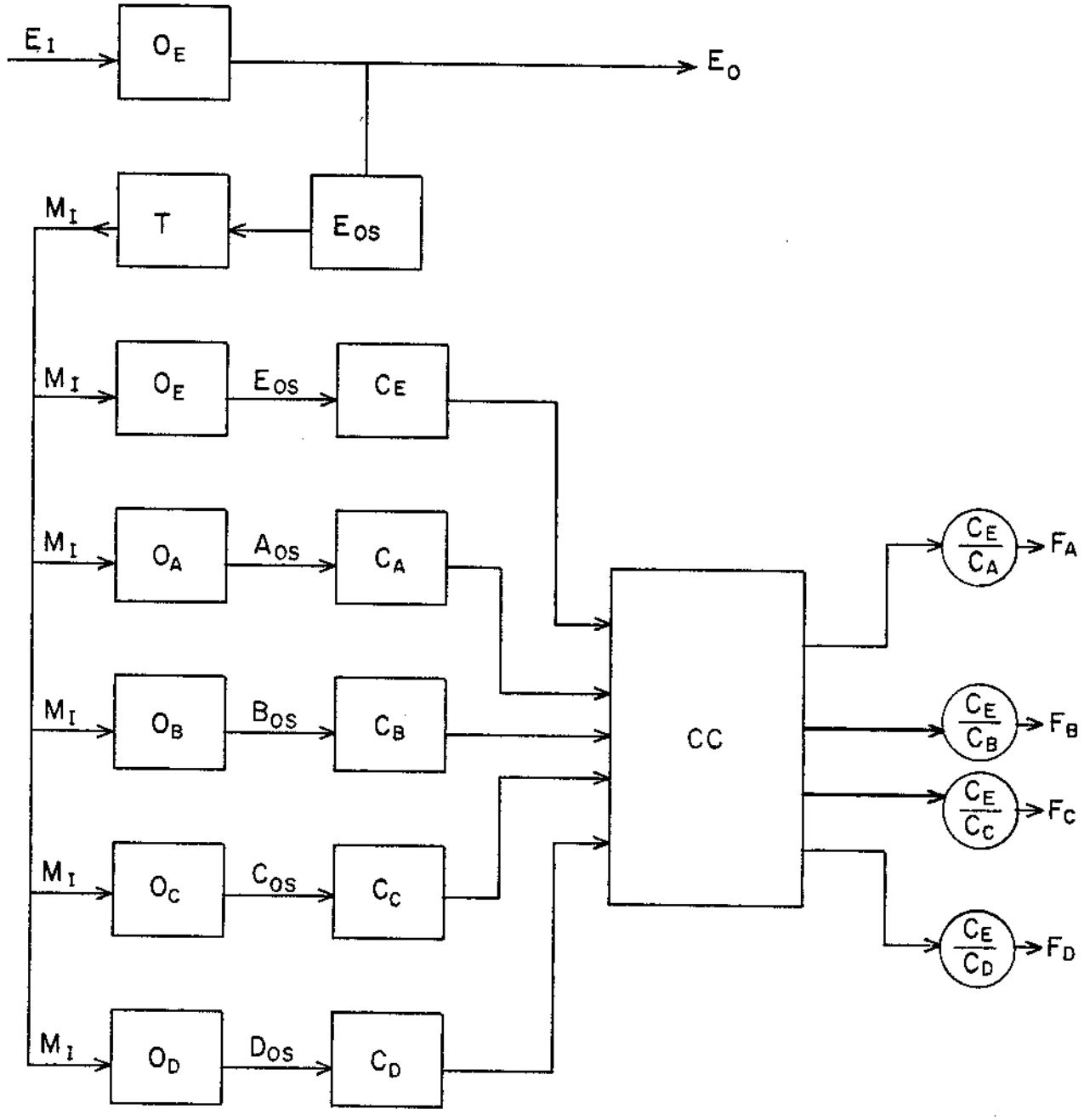


Figure 1. Conceptual Model of Research Design.

and the total required coordination for accomplishing the sample output was calculated for the existing organization, O_E, and the model organizations O_A, O_B, O_C, and O_D. The required coordination for each of these organizations are labeled in the model respectively as C_E, C_A, C_B, C_C, and C_D.

The comparator, CC, in the conceptual model determines the relative merit of each model organization as compared to the existing organization based on the relative amounts of required coordination in accomplishing the given output as represented by the output sample of the existing organization. The comparison is expressed as a ratio of the amount of required coordination in the existing organization to the amount of required coordination in a model organization. This ratio is the figure of merit for the model organization in the conceptual model and is labeled F_A, F_B, F_C, and F_D respectively for models A, B, C, and D.

CHAPTER V

EXISTING AND MODEL ORGANIZATIONS

The Existing Organization

The existing or actual organization chosen for the purpose of the research effort was a field division of a relatively complex governmental agency. The division is situated in a geographical area encompassing five states with approximately twenty-five field offices located in key cities throughout the five-state area. The total number of employees in the organization was approximately 1500 with approximately 200 located at the division headquarters and the remaining 1300 dispersed throughout the geographical area in operational field offices.

Structural Design of Existing Organization

Figure 2 is an organization chart of the existing organization. The organizational structure of the existing organization is basically along functional lines with each of the five branches assigned a major functional responsibility. The five major functional branches are: (1) Logistics, (2) Operations, (3) Engineering, (4) Leased Communications and Frequency Utilization, and (5) Systems Planning and Establishment. Functional statements for each branch and staff are

given under the sub-section of the present chapter which describes the sub-organizational unit. The overall mission of the existing organization and its functions are given in the following sub-section.

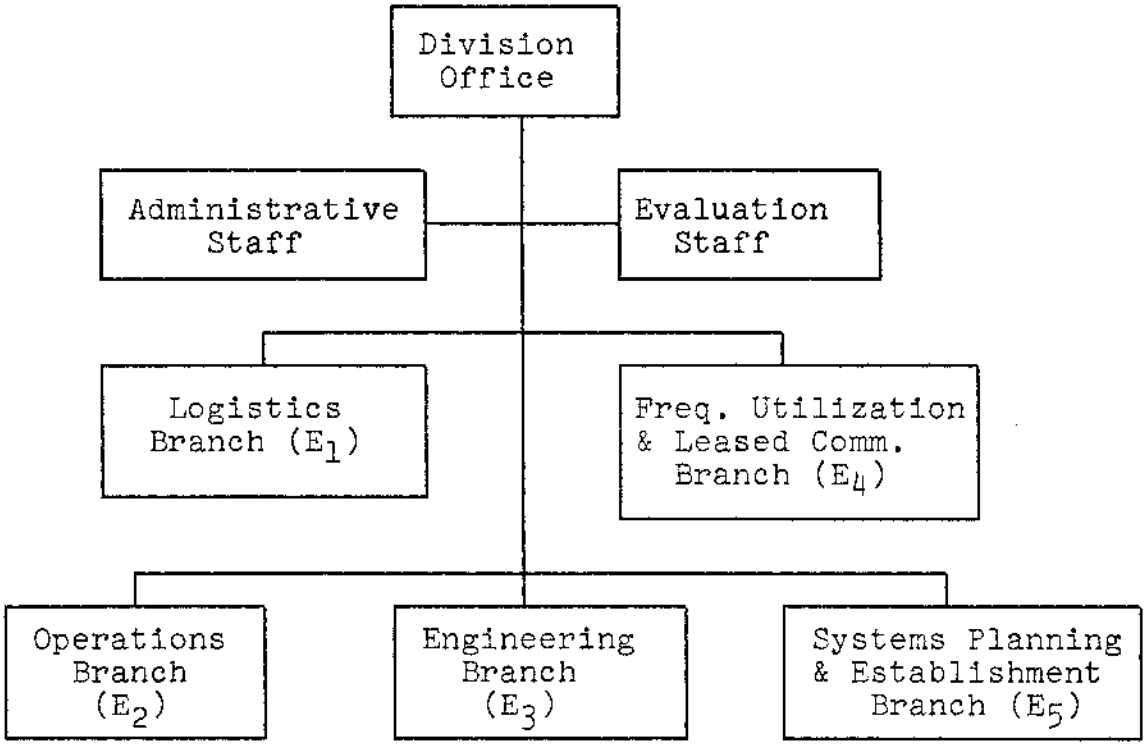


Figure 2. The Existing Organization

Mission, Functions, and Goals

The mission, functions, and goals statements given in this sub-section were derived from official documents, modified where necessary to eliminate references to the specific organization in which the study was made.

These statements indicate the scope of business conducted by the existing organization and the output of the organization. The model organizations described in the next section of Chapter V are assumed to have the same mission, functions, and goals.

Mission of the existing organization. --Accomplishes a program for establishment, maintenance, logistics support and related defense readiness of hardware systems and equipment utilized in accomplishing the agency's programs including planning, evaluating, controlling, and providing engineering services and technical support; and assuring the responsiveness of programs to the requirements of service to the public.

Sub-organization Functions

Administrative staff functions. --Administrative staff functions are:

(a) Provides for an administrative management program for the division encompassing such broad areas as personnel, training, recognition and awards, security, travel, budget, management information, management analysis, directives systems, and paperwork management.

(b) Provides staff assistance and coordination for division emergency readiness activities, ensuring the development and maintenance of current plans in this program area.

(c) Provides safety officer for divisional office functions.

(d) Provides the custodian and maintains the classified document files for the division.

Evaluation staff functions. --Evaluation staff functions are:

(a) Develops appropriate guidelines which will result in a systematic and periodic evaluation of agency field hardware systems.

(b) Provides team leadership and conducts evaluations of field maintenance, logistics and systems establishment activities.

(c) Conducts appropriate followup activities to ensure that corrective action is taken on deficiencies disclosed in the evaluation process.

(d) Recommends appropriate action to correct deficiencies or institute change for improvement.

(e) Conducts special studies seeking the resolution of problem areas which are of executive concern.

Logistics branch functions. --Specific functions for the Logistics Branch are:

(a) Accomplishes or controls all agency acquisition and procurement of personal and real property, public utilities,

construction, transportation, and other services required to effectively support approved programs.

(b) Develops, administers, and executes agency programs and establishes implementing policy, standards, and procedures to accomplish the efficient management, utilization, conservation, and protection of agency property holdings and the prompt identification and disposition of excess holdings in accordance with applicable law, regulations, and directives.

(c) Formulates agency logistics program objectives and goals and develops policies, schedules, priorities, systems standards and procedures required to effect their attainment.

(d) Monitors and reports on execution of the logistics program.

(e) Monitors for the division chief, the overall program for logistics support by maintaining overall surveillance of agency supply support activities with respect to responsiveness to program needs and economy and recommending or taking corrective action as required.

(f) Participates in the development of standards and procedures for negotiating with other organizations in preparing agreements for the establishment of privately owned hardware systems.

(g) Provides representation for negotiation and coordination of logistics matters with other governmental agencies and local communities.

(h) Provides technical guidance and specialized staff assistance to field logistics activities.

Operations branch functions. --Specific functions for the Operations Branch are:

(a) Formulates appropriate agency program objectives and goals. Provides the engineering expertise to adapt national operational standards, policies, and procedures for use in the field; develops agency policy and definitive guidelines where elaboration of national guidance is required.

(b) Assures adequate and efficient planning, programming, implementation, use and control of resources required for the field maintenance program including special projects. Monitors and reports on program performance and cost.

(c) Develops and coordinates program guidelines related to fiscal programs and budget estimates for all program requirements. Reviews field submissions, makes necessary adjustments and coordinates with appropriate offices. Provides appropriate followup coordination with the field offices.

(d) Develops operational standards and procedures relating to maintenance and modification of hardware systems and equipment.

(e) Monitors the agency field program by analyzing management information data with respect to safety, availability, reliability, maintainability, and economy. Conducts indepth staff studies and recommends action to be taken as required.

(f) Serves as the principal contact point for other division branches concerning operational aspects of the field maintenance program. Provides managerial and operational guidance and assistance to the field offices.

(g) Through various sources monitors the performance of the agency hardware systems and makes engineering analyses to identify significant problems or adverse trends in system availability and/or reliability and initiates positive remedial action as appropriate.

(h) Represents the agency in coordinating with other organizations including military, other governmental agencies, states, and local governments.

(i) Reviews the effectiveness of position management and manpower planning through staff studies and visits to counterpart field activities.

Engineering branch functions. --Specific functions for the Engineering Branch are:

(a) Performs engineering services within nationally provided guidelines for the siting, construction, installation, flight inspection, and commissioning of hardware systems.

(b) Provides technical and engineering effort to solve problems and recommends changes for improvement to R & D on technical problems identified with construction and/or installation phases of system establishment.

(c) Participates in joint acceptance and inspection of systems as appropriate.

(d) Provides engineering input to R & D for procurement and contractual specifications and criteria to be used in the development and procurement of new systems or modification of current systems or components.

(e) Develops timely and adequate system and equipment installation and adjustment guidelines and installation and maintenance specifications, procedures, and techniques.

(f) Provides technical guidance and specialized engineering assistance to field operations.

(g) On request, monitors agency programs by maintaining overall surveillance of hardware systems, conducting engineering analyses with respect to their availability, reliability, maintainability, safety and economy, and recommending corrective action as required. Provides technical feedback to field activities.

(h) Recommends modifications and improvements of systems and equipment and monitors approved modifications and, as required, special projects.

(i) Performs engineering analyses to provide engineering feedback to appropriate offices at the bureau level.

(j) Conducts on-site engineering studies to resolve system deficiencies. Initiates corrective action or makes recommendations to the bureau level as appropriate.

(k) Conducts engineering analyses of employee suggestions concerning installation, maintenance, modification, or improvement of hardware systems or equipment. Recommends adoption

or nonadoption to the appropriate bureau level. Coordinates field testing of selected suggestions.

(l) Coordinates and monitors the flow of technical issuances relating to hardware systems and equipment to insure accuracy and complete distribution to field operations.

(m) Reviews and develops recommendations to agency headquarters for test and working equipment.

(n) Participates in value engineering programs as required.

(o) Participates in the development of standards and procedures for negotiating with representatives of other organizations in preparing agreements for the establishment of privately owned hardware systems and for the negotiation of reimbursable agreements for performance of work by agency personnel.

(p) Participates with other organizational segments on technical boards and committees as required in the accomplishment of assigned objectives.

(q) Participates in evaluations of field maintenance activities and recommends or takes appropriate action to correct deficiencies or institute change for improvement.

Frequency Utilization and leased communications branch functions: --Specific functions for the Frequency Utilization and Leased Communications Branch are:

(a) Plans, coordinates, conducts, and directs the agency's field program concerned with radio frequency requirements,

assignments, interference problems, and use of frequencies and initiates corrective action when necessary.

(b) Develops standards and procedures for effective and proper utilization of the radio frequency spectrum.

(c) Engineers specific frequency assignments for operational use. Coordinates assignments with other organizations both public and private. Recommends frequency selections to the national office for further coordination and authorization.

(d) Provides specialized assistance and advice to non-public applicants on radio frequency matters.

(e) Operates and controls a frequency monitoring and analyzing unit.

(f) Conducts a program for the continued review of all radio frequency assignments within an assigned area to ensure compliance with the terms of the authorization initiating corrective action as appropriate.

(g) Conducts liaison with other government agencies and private industry on matters related to frequency utilization, assignments, and interference.

(h) Plans, coordinates, programs, and budgets for leased control circuitry and telephone company equipment.

(i) Provides engineering and technical planning for leased remote control interphone, teletypewriter circuits, and common carrier equipment to meet operational requirements.

(j) Monitors both programmed and unprogrammed requirements and provides engineering consultation on leased communications services.

Systems Planning and Establishment Branch functions: -- Specific functions for the Systems Planning and Establishment Branch are:

(a) Within national and local policies, standards and procedures, recommends, and implements immediate and long-range plans and approved programs for accomplishment of responsibilities for the establishment, modernization, relocation or decomissioning of hardware systems to meet validated requirements expressed in terms of locations of facilities, costs, schedules for construction and installation leading to commissioning.

(b) Reviews and analyzes proposals for new or additional systems based upon planning standards or other applicable criteria, including other program plans to ensure an appropriate integrated planning base, and prepares recommendations for higher managerial review.

(c) Formulates compatible systems establishment program objectives and goals and develops schedules, priorities, procedures, and resources requirements to effect their attainment. Reviews policies and standards to assure inclusion in program objectives and goals.

(d) Converts increments of above systems establishment plan into requests for inclusion in annual appropriation requests, including the preparation of systems establishment projects and the subsequent preparation and processing of reprogramming actions, if any.

(e) Manages and reports on the execution of the overall regional program for construction, equipment installation, and commissioning and modifications and improvements of hardware systems by maintaining overall surveillance of systems establishment activities and recommending corrective action as required.

(f) Schedules, monitors and conducts the systematic integration of approved fiscal and manpower resources, real property acquisition, contractual actions, construction, requisitioning of materiel, equipment installation and inspection.

(g) Schedules, monitors and conducts a program for the dismantling of hardware systems at the time of decommissioning.

(h) Directs and manages a force of field personnel engaged in the accomplishment of systems establishment programs.

(i) Participates in acceptance and inspection of hardware systems.

(j) Participates in site testing for new hardware systems.

(k) Identifies technical problems in connection with construction and installation phases of facility establishment and participates in technical and engineering effort to solve the problems and recommends changes for improvement.

(l) Programs modifications and improvements of systems and equipment, and schedules and accomplishes implementation of approved projects for modifications and improvements of equipment and systems.

(m) Recommends awards of contracts after review and coordination.

(n) Identifies systems or equipment deficiencies discovered during system establishment and furnishes feedback for correction.

(o) Programs, schedules and provides technical supervision of construction and installation activities performed under contract.

(p) Directs the functioning of the shutdown and commissioning committee.

(q) Certifies quality of control lines associated with establishment projects and initiates action to reach performance levels when required.

(r) Identifies frequency interference problems caused by establishment projects and makes recommendations for correction of problems.

Goals of the existing organization. --The goals of the existing organization are, with minor exceptions, those stated in an official document and used by all levels of management for general guidance in the decision-making process. The goals are stated followed by one or more specific "means" statements developed by the lower levels of management in the organization and either approved or modified and then approved by top management.

GOAL: To improve the economy and effectiveness of logistics support through better management of our physical resources.

MEANS: 1. Obtain better services from contract operations by: (a) Monitoring performance of janitorial and service type contracts more closely through on-site visits with contractors and/or contracting officers' representatives at 15 locations each quarter; (b) updating and clarifying instructions to the contracting officer's representatives of the Realty Officer by the end of the first quarter.

2. Improve utilization of real and personal property holdings by: (a) Verifying all real property holdings by the end of the fourth quarter; (b) verifying all records of personal property holdings in "Administrative and other" categories by the end of the fourth quarter; (c) capitalizing all current projects within 60 days after notification of project completion; (d) initiating utilization and disposal processes on all excess property within 10 days after receipt of declaration of excess; (e) conducting on-site lease vs purchase studies of 25 facility sites by the end of the fourth quarter.

GOAL: To improve the availability and reliability of hardware systems.

MEANS: 1. During the first quarter, develop an improved method to screen the 328 communication frequencies to identify low performers.

2. By the end of the fourth quarter, reduce number of leased communications circuits failures by five percent by: (a) Identifying low performers; monitoring circuit

performance reports and alert bulletins; (b) personally visiting local telephone company offices; (c) attending agency/telephone company meetings.

3. During each quarter, review the training program of three field offices to ensure that every technician receives that programmed training required to perform his work satisfactorily.

GOAL: To improve the effectiveness and economy of systems planning and establishment programs.

MEANS: 1. Improve the quality of program planning by: (a) Initiating a planning information system by the fourth quarter; (b) developing appropriate issuances for the orderly submittal of project requests by the end of the fourth quarter; (c) conducting a planning survey at a major location each quarter; (d) developing guidelines and making one program study during FY 1971.

2. Improve the ratio of overhead hours to direct hours to a level of ten percent or less by the fourth quarter.

3. By the end of the second quarter, reduce engineering effort spent on cost estimates by developing typical project costs based on historical data for major projects and applying known job variances.

4. Complete standard design to adapt present transmitting and receiving equipment to new solid-state control equipment by the end of the fourth quarter.

Model Organizations

Four model organizations were designed by the research with the objective of varying the required coordination while holding the input and output constant. Each model organization design is described in the following subsections.

Structural design, Model-A. --Figure 3 depicts Model-A organization. The structural design of model-A has four basic changes from the existing organization structure. In the existing organization structure, for example, maintenance planning is performed in the Operations Branch, E_2. This function is in the Planning Branch, A_5, in model-A organization. Secondly, the establishment function is performed

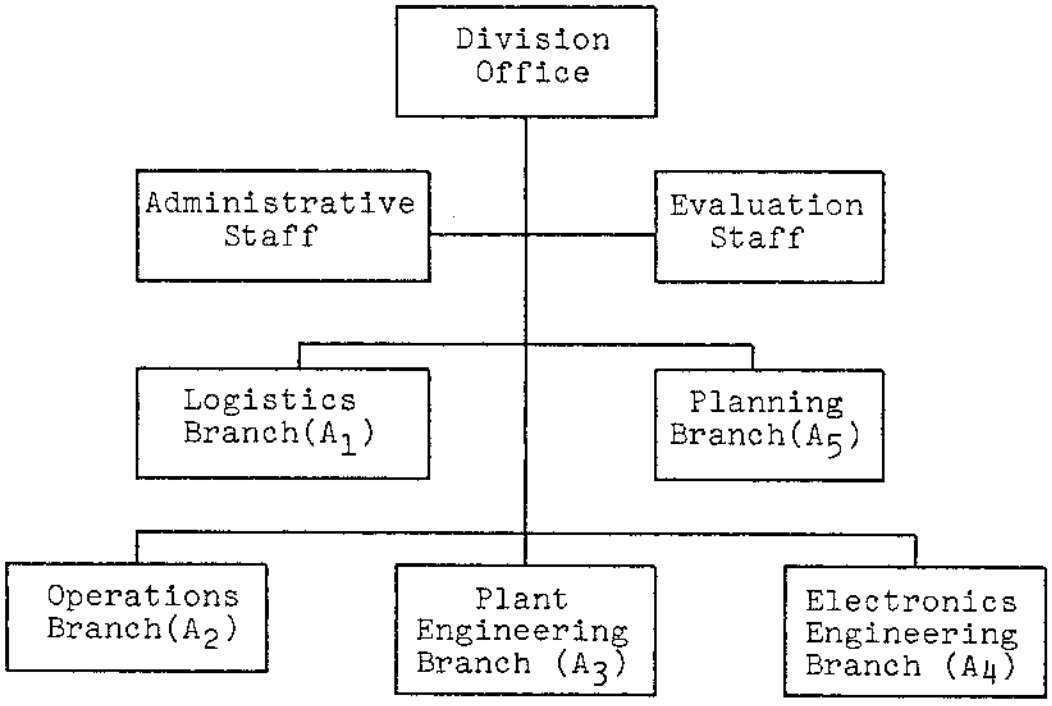


Figure 3. Model-A Organization.

by the systems planning and establishment branch, E_5, in the existing organization. This function is divided in model-A organization with the plant construction portion located in the plant engineering branch, A_3, and the electronics installation portion located in the electronics engineering branch, A_4.

A third change is the division of the total engineering function as assigned to the engineering branch E_3, in the existing organization. This function is divided into plant engineering and electronics engineering in model-A organization with plant engineering assigned to A_3, the plant engineering branch, and electronics engineering assigned to the electronics engineering branch, A_4. Finally, the frequency utilization and leased communications function is relocated from a separate entity, E_4, in the existing organization to the electronics engineering branch, A_4, in model-A organization.

Structural design, Model-B. --Figure 4 is an organization chart of model-B organization. In model-B, the establishment function, both plant construction and electronics installation, have been relocated from the systems planning and establishment branch, E_5, in the existing organization to a separate establishment branch, B_1, in model-B organization. The engineering function in model-B has been divided into the two functions of plant and electronics and located respectively in the corresponding engineering branches, B_3, and B_4.

A major change in model-B is the relocation of the logistics function outside the existing organization and is therefore not shown on the organization chart for model-B organization. The planning function in model-B includes both the maintenance and systems establishment planning functions. The Frequency Utilization and Leased Communication function is located in the Electronics Engineering Branch, B_4, in Model-B Organization.

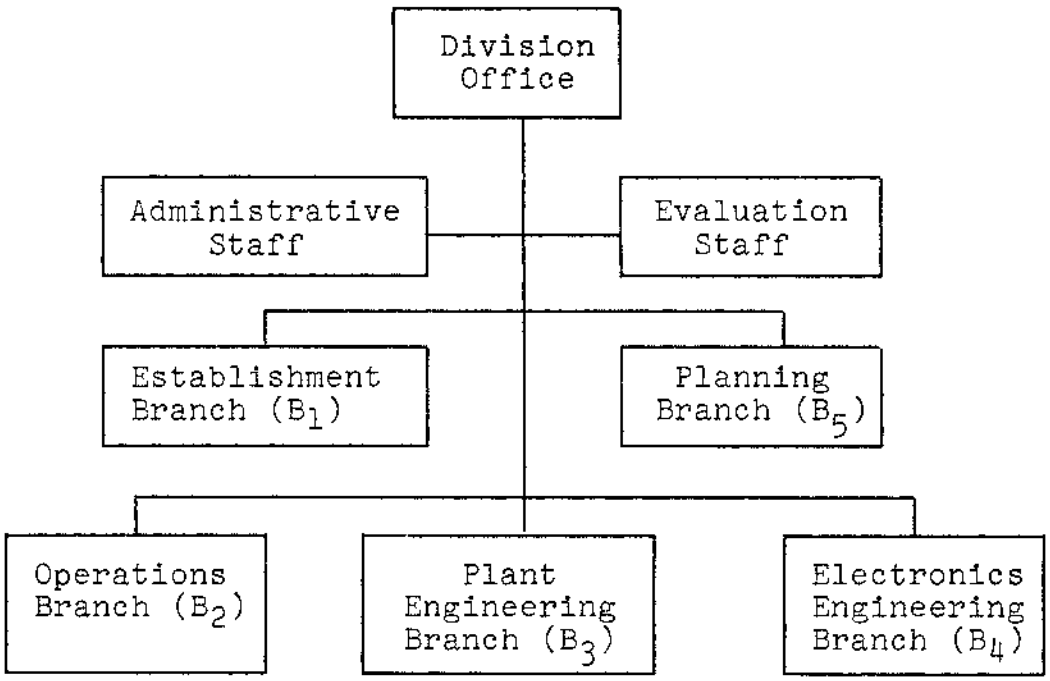


Figure 4. Model-B Organization.

Structural design, Model-C. --Figure 5 depicts the structural design of Model-C organization. Model-C organization is basically a project management or product oriented structure with divisions along the lines of major system types which

the organization establishes and maintains. For the purposes of this study these systems are categorized as Type-A systems, Type-B systems, and Type-C systems. Each major type system is assigned to a branch in which the functions of logistics, engineering, planning, maintenance, installation, construction, etc. are assigned as required for the branch to function with total responsibility for a major type system.

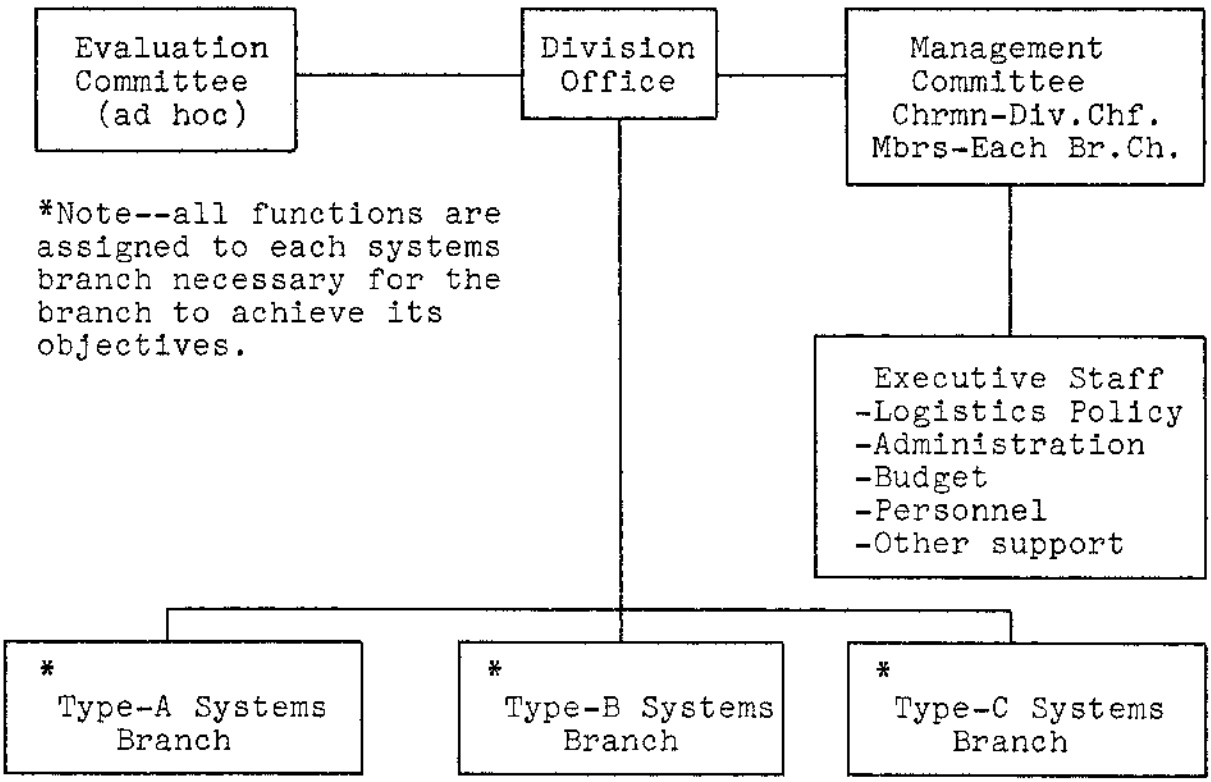


Figure 5. Model-C Organization.

The executive staff in Model-C organization is responsible for policy matters and all across-the-board functions such as budget, personnel and training, and administrative support

functions. The chief of the executive staff reports to the management committee which is chaired by the division chief with membership consisting of the chiefs of each system branch. The concept of operation would be similar to a board of directors with the chief of the executive staff being related to the board and the executive staff in a manner similar to the relationship of a corporate president to the board of directors of the corporation and the corporation.

The evaluation function is performed in Model-C organization by an ad hoc committee which would function under the direction of the division chief. The chairman and membership of the committee would be appointed by the division chief and given a specific assignment. Upon completion of the assignment the committee would be dissolved.

Structural design, Model-D. --The structural design of Model-D organization is depicted in Figure 6. Model-D is basically a matrix organization structure.

In this organization model the basic functions of logistics, operations, engineering, and planning are each assigned to branches D_1, D_2, D_3, and D_4 respectively. Each branch provides support to each program manager as required and provides administrative supervision only of it's resources. Technical supervision is provided by the program manager to which the support is committed.

In Model-D organization the functional branches are concerned primarily with policy and overall program matters rather

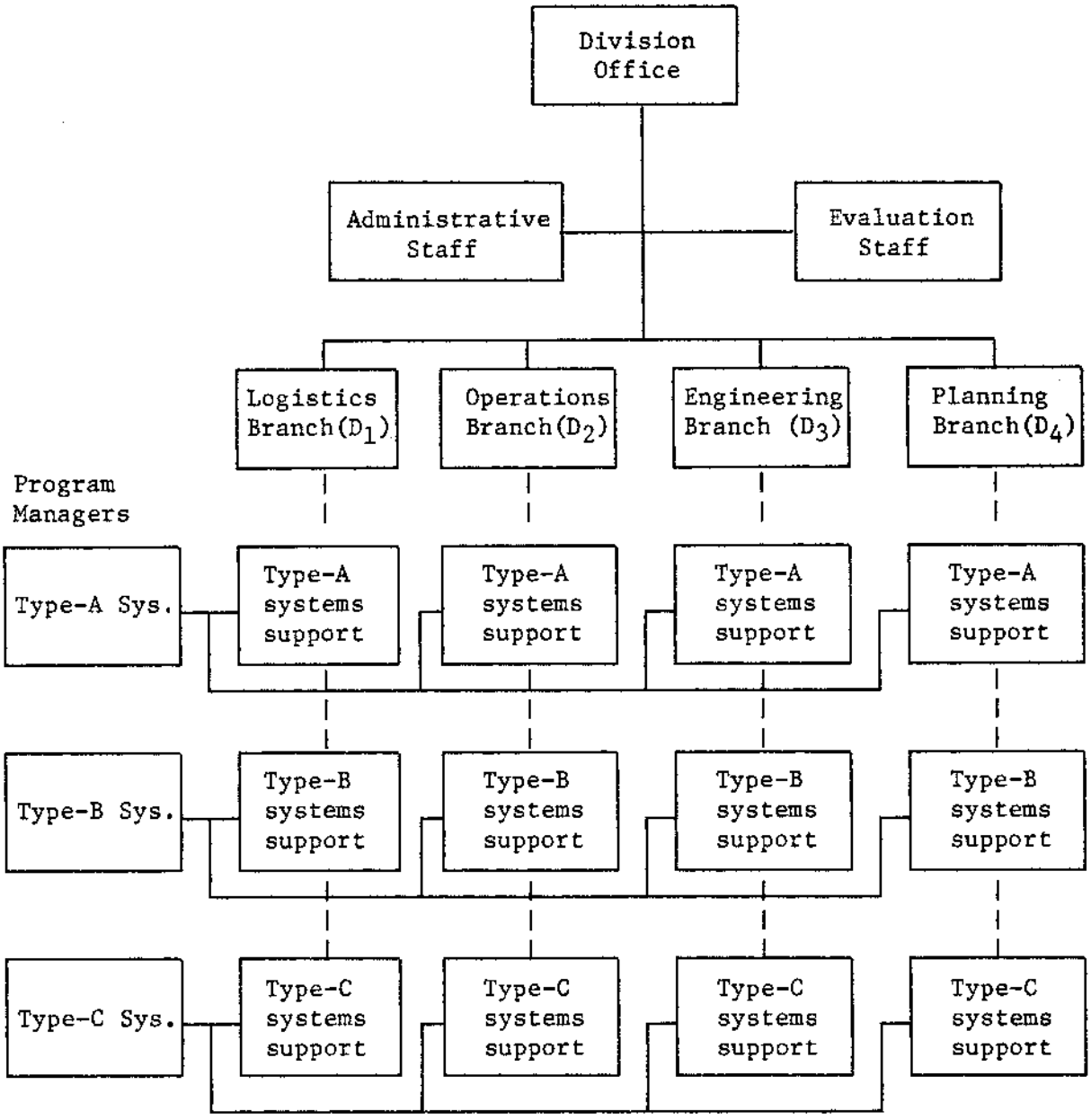


Figure 6. Model-D Organization.

than the details of individual projects and/or problems. The program managers on the other hand are concerned with the day-to-day activities in their particular area of responsibility.

The program managers report directly to the division chief and are reponsible for program accomplishment.

Simulation of Existing Organization

A simulation study was conducted of the operation of the existing organization for a period of one year. A random sample of the output of the existing organization as indicated by outgoing correspondence was extracted from the files of each branch. The sample size was approximately six percent of the data universe of an estimated 8 to 10 thousand items representing a period of operation of one year.

The sample was used to simulate operation in the existing and model organizations. The simulation procedure consisted of first determining the originator of each item in the sample. Second, a determination was made of the required coordination necessary to accomplish the output as indicated by the item of outgoing correspondence.

Simulation with each model organization was then made in turn for each item in the sample. In each model organization a determination was made of where in the organization would the item have been originated and what suborganizational entities (branches) would have been coordinated with in accomplishing the output.

The data produced by the simulation study is included in Appendices B through F and is used in Chapters VI and VII where

analyses are made of the existing and model organization structures and overall results summarized and evaluated respectively.

CHAPTER VI

ANALYSIS OF RESULTS

This chapter analyzes the data generated by the investigation in simulating the operation of the existing organization for a test period of one year. The existing and model organizations are compared with regard to the required coordination as found in the simulation study. Managerial functions of planning, organizing, directing, and controlling are evaluated for each structural design and compared with each other design with the objective of verifying or modifying the working hypothesis.

The first section is devoted to an analysis of required coordination in the existing and each of the model organizations as found in the simulation study described in Chapter V. Data derived from the responses of managers in the existing organization are also used in analyzing the existing organization.

The second section of the present chapter analyzes the data from responses of managers and journeyman-level employees in the existing organization. A sample of the questionnaire developed by the research is included in Appendix G.

The third section of the present chapter presents a comparative analysis of the existing organization and the model

organizations based on required coordination found in each through the simulation study. This analysis compares each model organization with the existing organization using the Coordination Index described in the first section. An evaluation of the managerial functions is included based on the research findings including responses from managers in the existing organization.

Finally, a concluding section gives an overall analysis of the results of the study and evaluates the methodology used in the investigation.

Analysis of Required Coordination

Coordination Index

An index figure for indicating the quantity of required coordination in a given organization was developed by the research and is called the "Coordination Index." The Coordination Index was developed from a well known mathematical model used in many fields of science and engineering. The particular model chosen for describing the quantity of coordination is one based on natural growth phenomena and is defined by the following formula:

$$C_i = 1 - \epsilon^{-\frac{C_r}{n}} \qquad (1)$$

Where C_i = Coordination Index

n = A constant representing a given output of the organization

ϵ = Base of natural logarithms

C_r = Number of times coordination is required in producing the output, n.

Formula (1) describes a function, C_i, which varies exponentially from "0" to "1" as the independent variable, C_r, varies from "0" to "∞" while the parameter, n, is held constant. This type of function fulfills the requirements of the research design since it was desirable to have a finite range of numbers to describe all possible values of required coordination, C, in any situation. From formula (1) it can be seen that the Coordination Index may take on values from "0" when no coordination is required to "1" when an infinite amount of coordination is required in producing the output, n, of the organization or suborganization. Thus, the Coordination Index, C_i, is a function which varies exponentially from "0" to "1" as illustrated in Figure 7.

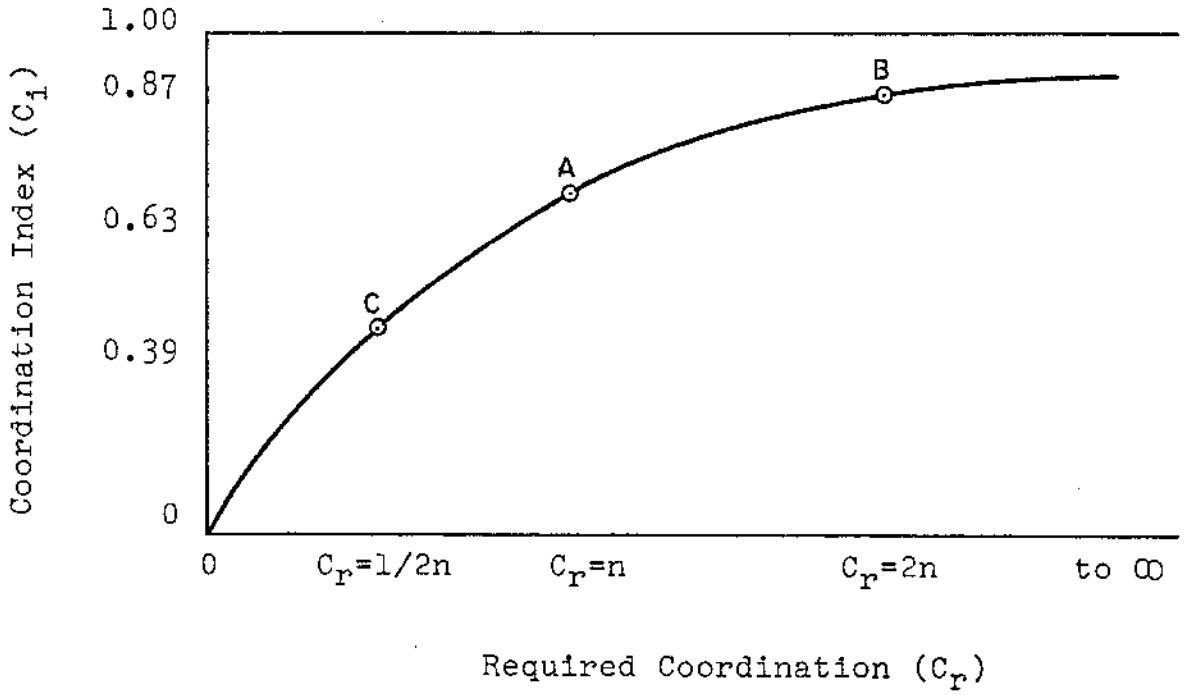


Figure 7. Coordination Index.

Theoretically, the values "0" and "∞" are limiting values between which the value of C_r may vary and correspond to the limiting values of "0" and "1" for C_i. A point of interest on the C_i function curve is point A where $C_r = n$. This occurs when the average required coordination is once for each unit of output of the organization and corresponds to a Coordination Index value of 0.63. A second point of interest is point B where the average required coordination is twice per unit of output, that is, $C_r = 2n$. This point corresponds to a Coordination Index of 0.87 and represents a relatively high level of required coordination. A final key point of interest is point C where the average required coordination is 0.5n. This point corresponds to a Coordination Index of 0.39 and represents a relatively low level of required coordination.

The Coordination Index proved to be a very useful tool in analyzing the existing and model organizations with regard to relative amounts of required coordination in producing the output of the organization or suborganization. For example, the value of n in formula (1) for comparing the total existing and model organizations was 508, the total number of items in the sample of the output of the existing organization. This sample was used in simulating the operation of the existing organization in the existing structure and the four model structures. In comparing the overall operation of the existing and model organization structures using formula (1), the value

of n was held constant at a value of 508. The required coordination, C_r, was determined in the simulation process and the value of the Coordination Index, C_i, calculated for each organization using the value of C_r determined for each structure.

The Coordination Index was also used to analyze the required coordination within each of the existing and model structures. The total sample of 508 items was analyzed to determine which suborganization entity in each structure would have been the originating office for each item in the sample. Thus, the 508 items were divided among the suborganizations in each structure and a corresponding value of n assigned for each suborganization according to the number of items each would have originated. The corresponding value of required coordination, C_r, was determined in the simulation process for each case and the value of the Coordination Index calculated.

A value of C_i was calculated for each total organization and for each suborganization considered first as a total system relating to the rest of the organization as a whole and then as a subsystem relating to each other suborganization individually. The indices calculated in this manner proved to be very useful indicators of interrelationship patterns existing internally in each structure and suggest areas where the structural design should be examined closer for possible improvements.

Existing Organization

The required coordination in producing the sample output of the existing organization is shown in Table I. The total sample size for the one year test period was 508 items. This represents approximately six percent of the data universe which was estimated to be between 8 and 10 thousand items. The total number of items originated by each suborganization is shown in column 2 and in the row corresponding to the sub-organization which originated the items. These rows are labeled respectively E_1, E_2, E_3, E_4, and E_5. The numbers in the columns headed E_1, E_2, E_3, E_4, and E_5 indicate the number of times coordination was required for those items shown in column 2 opposite the corresponding originating suborganization. The total sample of 508 items had to be coordinated 923 times or an average of 1.8 time per item in the sample.

TABLE I

REQUIRED COORDINATION-
EXISTING ORGANIZATION

Organization	Sample Size (N)	Required Coordination					
		E_1	E_2	E_3	E_4	E_5	Total
E_1	132	-	95	79	2	82	258
E_2	77	17	-	33	4	38	92
E_3	177	26	92	-	15	80	213
E_4	90	3	77	45	-	27	152
E_5	92	32	73	88	15	-	208
Total	508	78	337	245	36	227	923

Of the total 923 times the sample output had to be coordinated, 78 times, or 8.4 percent of the total required coordination, was with the Logistics Branch, E_1; 337 times, or 36.5 percent, was with the Operations Branch, E_2; 245 times, or 26.6 percent, was with the Engineering Branch, E_3; 36 times, or 3.9 percent, was with the Leased Communications and Frequency Utilization Branch, E_4; and 227 times, or 24.6 percent, was with the Systems Planning and Establishment Branch, E_5.

Logistics Branch, (E_1). --The Logistics Branch, E_1, originated 132 of the 508 items in the sample output of the existing organization. This amounted to 26 percent of the total sample having been originated in the Logistics Branch. The 132 items originating in the Logistics Branch required 258 coordination actions with other branches as shown by the first item in the total column and last item in row E_1. Thus, an average of 1.96 coordination actions were required for each item originating in the Logistics Branch. Of the 132 items originated in E_1, 95 items, or 72 percent, had to be coordinated with E_2, the Operations Branch; 79 items, or 60 percent, with E_3, the Engineering Branch; 2 items, or 1.5 percent, with E_4, the Leased Communications and Frequency Utilization Branch; and 82 items, or 62 percent, with E_5, the Systems Planning and Establishment Branch.

TABLE II

INTERRELATIONSHIP PATTERN - LOGISTICS BRANCH, E_1
SAMPLE SIZE (N) = 132

Suborganization Interface	E_2	E_3	E_4	E_5
Required Coordination (C_r)	95	79	2	82
Coordination Index (C_i)	0.51	0.45	0.02	0.46

Table II depicts the interrelationship pattern between the Logistics Branch, E_1, and each of the other branches in the existing organization, as viewed from the Logistics Branch activities. The Coordination Index values for E_1 with regard to each of the other branches in descending order of required coordination is E_2, E_5, E_3, and E_4 with corresponding coordination indices of 0.51, 0.46, 0.45, and 0.02. The pattern is one of relatively close relationship between the Logistics Branch and Operations, Systems Planning and Establishment, and Engineering branches but of very little relationship with Frequency Utilization and Leased Communications Branch, E_4.

Operations Branch, (E_2). --The Operations Branch, E_2, originated 77 of the 508 items sampled from the output of the existing organization. This represents 15.2 percent of the total sample. The 77 items originating in the Operations Branch required 92 coordination actions with other branches as shown in row E_2 of Table I. Thus, the average number of coordination actions per item was approximately 1.2. Of the

77 items originating in the Operations Branch, 17 items, or 22 percent, was coordinated with E_1, the Logistics Branch; 33 items, or 42.9 percent, was coordinated with E_3, the Engineering Branch; 4 items, or 5.2 percent, was coordinated with E_4, the Frequency Utilization and Leased Communications Branch; and 38 items, or 49.9 percent, was coordinated with E_5, the Systems Planning and Establishment Branch.

Table III shows the interrelationship pattern between the Operations Branch, E_2, and each of the other branches in the existing organization as viewed from the activities originating in the Operations Branch.

TABLE III

INTERRELATIONSHIP PATTERN - OPERATIONS BRANCH, E_2
SAMPLE SIZE (N) = 77

Suborganization Interface	E_1	E_3	E_4	E_5
Required Coordination (C_r)	17	33	4	38
Coordination Index (C_i)	0.20	0.35	0.05	0.39

The Coordination Index for E_2 with regard to each of the other branches in descending order of required coordination is E_5, E_3, E_1, and E_4 with corresponding coordination indices of 0.39, 0.35, 0.20, and 0.05. This pattern indicates a fair degree of interrelationship between the Operations Branch and the Systems Planning and Establishment, and Engineering Branches; a relatively low degree of interrelationship with the

Logistics Branch; and very low degree of interrelationship with the Frequency Utilization and Leased Communications Branch.

It is interesting to note that the degree of interrelationship between two branches is not necessarily mutual. That is, one branch may have a high degree of dependence on another branch, but the second branch may have a low dependence on the first. Such is the case with the Logistics and Operations branches, E_1 and E_2, as indicated by their corresponding coordination indices given in Table II and Table III respectively. E_1 has a Coordination Index value of 0.50 and E_2 has a Coordination Index value of 0.20 representing a difference of 85.7 percent.

Engineering Branch, (E_3). --The Engineering Branch, E_3, originated 117 of the 508 items in the sample, representing 23 percent of the total. The 117 items originating in the Engineering Branch required a total of 213 coordination actions with other branches as depicted in row E_3 of Table I. This is equivalent to an average of 1.83 coordination actions per item sampled. The required coordination of the 117 items originating in the Engineering Branch resulted in 26 actions, or 22.2 percent, with E_1, the Logistics Branch; 92 or 78.6 percent with E_2, the Operations Branch; 15 items, or 12.8 percent, with E_4, the Frequency Utilization and Leased Communications Branch; and 80 items, or 68.5 percent, with the Systems Planning and Establishment Branch, E_5.

The interrelationship pattern between the Engineering Branch, E_3, and each of the other branches in the existing organization may be derived from the data given in Table IV.

TABLE IV

INTERRELATIONSHIP PATTERN - ENGINEERING BRANCH, E_3
SAMPLE SIZE (n) = 117

Suborganization Interface	E_1	E_2	E_4	E_5
Required Coordination (C_r)	26	92	15	80
Coordination Index (C_i)	0.20	0.54	0.12	0.50

The data show Coordination Index values for the Engineering Branch with regard to each of the other branches in descending order of required coordination of 0.54 for E_2, 0.50 for E_5, 0.20 for E_1, and 0.12 for E_4. This pattern indicates a relatively high degree of interrelationship between the Engineering Branch, and the Systems Planning and Establishment, and Operations Branches with a fairly low degree between Engineering and Logistics, and a very low degree between Engineering and Frequency Utilization and Leased Communications.

Frequency Utilization and Leased Communication Branch, (E_4). --As shown in row E_4 of Table I, the Frequency Utilization and Leased Communications Branch, E_4, originated 90 of the 508 items sampled in the existing organization. These 90 items required 152 coordination actions or an average of 1.69 action per item originating in this branch. Of the 90 items

originating in E_4, 3 items, or 3.33 percent, were coordinated with the Logistics Branch; 77, or 85.7 percent, with the Operations Branch; 45, or 50 percent, with the Engineering Branch; and 27, or 30 percent, with the Systems Planning and Establishment Branch.

Table V depicts the interrelationship pattern between the Frequency Utilization and Leased Communications Branch, and each of the other branches.

TABLE V

INTERRELATIONSHIP PATTERN - FREQUENCY UTILIZATION AND LEASED COMMUNICATIONS BRANCH, E_4
SAMPLE SIZE (N) = 90

Suborganization Interface	E_1	E_2	E_3	E_5
Required Coordination (C_r)	3	77	45	27
Coordination Index (C_i)	0.02	0.48	0.32	0.21

The data show in descending order of required coordination 0.48 for E_2, 0.32 for E_3, 0.21 for E_5, and 0.02 for E_1. Thus the interrelationship pattern as viewed from the Frequency Utilization and Leased Communications Branch activities is one of moderately high degree with Operations, moderately low degree with Engineering, low degree with Systems Planning and Establishment, and very low degree with Logistics.

Systems Planning and Establishment Branch, (E_5). --The Systems Planning and Establishment Branch, E_5, originated 92

items or 18.1 percent of the total sample of the output. These 92 items required 208 coordination actions, an average of 2.6 actions per item of those originating in the Systems Planning and Establishment Branch. Thirty-two, or 34.8 percent, of the 92 items were coordinated with E_1, the Logistics Branch; 73, or 79.3 percent, were coordinated with E_2, the Operations Branch; 88, or 95.6 percent, were coordinated with E_3, the Engineering Branch; and 15, or 16.3 percent, were coordinated with E_4, the Frequency Utilization and Leased Communications Branch.

Table VI shows the interrelationship pattern existing between the Systems Planning and Establishment Branch, E_5, and each of the other branches as viewed from the activities originating in the Systems Planning and Establishment Branch.

TABLE VI

INTERRELATIONSHIP PATTERN - SYSTEMS PLANNING AND ESTABLISHMENT BRANCH, E_5
SAMPLE SIZE = 92

Suborganization Interface	E_1	E_2	E_3	E_4
Required Coordination (C_r)	32	73	88	15
Coordination Index (C_i)	0.29	0.55	0.62	0.15

The coordination indices for E_5, the Systems Planning and Establishment Branch, with regard to each of the other branches, are in descending order: 0.62 for E_3, 0.55 for E_2, 0.29 for E_1, and 0.15 for E_4. This pattern is one of very high degree

of interrelationship between Systems Planning and Establishment, and Engineering; a fairly high degree between Systems Planning and Establishment, and Operations; a low degree between Systems Planning and Establishment, and Logistics; and a very low degree of interrelationship between Systems Planning and Establishment, and Frequency Utilization and Leased Communications.

Summary-interrelationship pattern--existing organization. --The analysis of the existing organization presented in Tables II through VI was for the purpose of demonstrating the detailed procedure one should follow in studying a particular organization. Table VII below is a summary of the coordination indices for the existing organization as given in Tables II through VI.

TABLE VII

COORDINATION INDICES - EXISTING ORGANIZATION

Organization	Sample Size(n)	Coordination Indices					
		E_1	E_2	E_3	E_4	E_5	O_E
E_1	132	--	0.51	0.45	0.02	0.46	0.86
E_2	77	0.20	--	0.35	0.05	0.39	0.70
E_3	177	0.20	0.54	--	0.12	0.50	0.84
E_4	90	0.02	0.48	0.32	--	0.21	0.82
E_5	92	0.29	0.55	0.62	0.15	--	0.90
Total	508						0.84

The numbers in columns E_1 through E_5 are the values of indices for the suborganizations in column one relating to the suborganizations E_1 through E_5. For example, the Coordination Index for E_1 relating to E_2 is 0.51 as indicated by the first entry in column E_2.

The advantage of a summary presentation such as that depicted in Table VII is that interrelationship patterns existing in the total organization can be readily identified. For example, the values of indices in column E_1 indicate that all suborganizations are relatively independent with respect to E_1, the Logistics Branch. On the other hand, the values of indices in row E_1 indicate that the Logistics Branch is highly dependent on E_2 (Operations), E_3 (Engineering), and E_5 (Systems Establishment and Planning).

Column O_E contains the values of coordination indices for suborganizations listed in column one relating to the rest of the organization as a whole. The overall Coordination Index for the existing organization is 0.84 as shown in the last entry of column O_E.

The analyses for the model organizations in the following sections of Chapter VI include presentations of data similar to the data in Tables I and VII. Presentation of data similar to that depicted in Tables II through VI, although useful, was omitted in order to conserve space.

Model-A Organization

The required coordination for producing the sample of 508 items with Model-A organization structure substituted for the existing organization is depicted in Table VIII. Model-A has two engineering branches as compared to only one in the existing organization. The establishment function is divided between the two engineering branches with construction in plant engineering and electronics installation in electronics engineering. Planning in Model-A is a separate branch as compared to being only part of a branch in the existing organization.

TABLE VIII

REQUIRED COORDINATION-
MODEL-A ORGANIZATION

Organization	Sample Size (N)	Required Coordination					
		A_1	A_2	A_3	A_4	A_5	Total
A_1	134	--	96	84	41	23	244
A_2	78	18	--	24	27	34	103
A_3	65	22	48	--	30	29	129
A_4	152	17	128	16	--	28	189
A_5	79	22	64	62	61	--	209
Total	508	79	336	186	159	114	874

The originating suborganization is shown in the first column. The second column shows the sample size for each suborganization A_1, A_2, A_3, A_4, and A_5. In other words, column

two shows where the sample of 508 items from the existing organization would have been originated had the existing organization been structured as Model-A.

Logistics Branch, (A_1). --Table VIII shows that Logistics originated 134 of the 508 items in the total sample. These 134 items required 96 coordination actions with A_2, the Operations Branch; 84 actions with A_3, the Plant Engineering Branch; 41 actions with A_4, the Electronics Engineering Branch; and 23 actions with A_5, the Systems Planning Branch. Thus, the 134 items originating in A_1, required a total of 244 coordination actions with other branches in Model-A organization. This is equivalent to 1.82 coordination action per item originated by A_1.

Operations Branch, (A_2). --The Operations Branch, A_2, originated 78 of the 508 items in the total sample requiring 18 coordination actions with A_1, the Logistics Branch; 24 actions with A_3, the Plant Engineering Branch; 27 actions with A_4, the Electronics Engineering Branch; and 34 actions with A_5, the Planning Branch. Thus, the 78 items originating in A_2 required a total of 103 coordination actions with other branches in Model-A organization or an average of 1.32 action per item originated.

Plant Engineering Branch, (A_3). --The Plant Engineering Branch, A_3, originated 65 of the 508 items in the total sample. These 65 items required a total of 129 actions with other sub-organizational elements or an average of 1.98 action per item;

22 actions with Logistics, A_1; 48 actions with Operations, A_2; 30 actions with Electronics, A_4; and 29 actions with Planning, A_5.

Electronics Engineering Branch, (A_4). --The Electronics Engineering Branch, A_4, originated 152 of the 508 items in the total sample and coordinated 17 times with Logistics, 128 times with Operations, 16 times with Plant Engineering, and 28 times with Planning for a total of 189 coordination actions. Thus, the average number of actions per item originated was 1.24.

Planning Branch, (A_5). --The Planning Branch, A_5, originated 79 of the 508 items in the total sample. For these 79 items, 22 coordination actions were required with Logistics, 64 actions with Operations, 62 actions with Plant Engineering, and 61 actions with Electronics Engineering. Thus, a total of 209 coordination actions were required for the 79 items originating in the Planning Branch of Model-A averaging 2.65 actions per item.

Coordination Indices, Model-A Organization. --Table IX shows the coordination indices for each suborganization in Model-A structure. The Coordination Index is shown for each suborganization's interrelations with each of the other suborganizations in Model-A. Column one depicts the suborganizational entities (branches). These are A_1, Logistics Branch; A_2, Operations Branch; A_3, Plant Engineering Branch; A_4, Electronics Engineering Branch; and A_5, Planning Branch. The sample size, n, for each suborganization is shown in column

two opposite the suborganization in column one. Columns A_1 through A_5 are values of indices as calculated by Formula (1) for each suborganization relating to each other suborganization in the total organization. The numbers in these columns are the values of the indices for the suborganization listed in column one relating to each suborganization in columns A_1 through A_5. Column O_A depicts the Coordination Index for each suborganization in column one relating to the rest of the organization considered as a total system.

TABLE IX

COORDINATION INDICES - MODEL-A ORGANIZATION

Sub-organization	Sample Size (N)	Coordination Indices					
		A_1	A_2	A_3	A_4	A_5	O_A
A_1	134	--	0.51	0.47	0.26	0.16	0.84
A_2	78	0.21	--	0.26	0.29	0.35	0.73
A_3	65	0.29	0.52	--	0.37	0.36	0.86
A_4	152	0.11	0.57	0.10	--	0.17	0.71
A_5	79	0.24	0.56	0.54	0.54	--	0.98
Total	508						0.82

The interrelationship patterns can be seen by examining the data in Table IX. A high degree of interrelations, for example, would be indicated by indices of values 0.40 to 0.63 indicating required coordination actions of 50 to 100 percent

in producing the output of the organization. Coordination indices above 0.63 means that for each unit of output from the organization an average of more than one coordination action is required between two suborganization entities.

Using the above criteria a relatively high degree of interrelationship is indicated between each branch and A_2, the Operations Branch, since each Coordination Index in the A_2 column in Table IX is greater than 0.40. The criteria also indicates a relatively high degree of interrelationship between A_5, Planning, and A_3, and between A_5 and A_4. Studying the interrelationship patterns between suborganizations in an organization should give clues as to what adjustments in the structure might be advantageous.

The overall Coordination Index for Model-A is 0.82 as compared to 0.84 for the existing organization.

Model-B Organization

Table X depicts the required coordination data for Model-B Organization. This data, generated by the simulation study, indicate the required coordination with Model-B Organization structure substituted for the existing organization in producing the 508 item sample output.

TABLE X

REQUIRED COORDINATION-
MODEL-B ORGANIZATION

Organization	Sample Size (N)	Required Coordination					
		B_1	B_2	B_3	B_4	B_5	Total
B_1	14	--	19	11	14	7	51
B_2	75	16	--	23	25	38	102
B_3	63	32	46	--	32	31	141
B_4	147	33	127	13	--	32	205
B_5	209	113	148	123	88	--	472
Total	508	194	340	170	159	108	971

Establishment Branch, (B_1). --Table X shows that the Establishment Branch, B_1, would have originated 14 of the 508 items in the total sample had the existing organization been structured as Model-B. These 14 items would have required 51 coordination actions with the other suborganizational entities (branches); 19 such actions with B_2, the Operations Branch; 11 actions with B_3, the Plant Engineering Branch; 14 actions with B_4, the Electronics Engineering Branch; and 7 actions with B_5, the Planning Branch. The 51 total coordination actions amounts to an average of 3.64 actions for each of the 14 items originating in B_1.

Operations Branch, (B_2). --The data in Table X indicate that the Operations Branch, B_2, would have originated 75 of the 508 items in the sample. These 75 items would have been

coordinated a total of 102 times, 16 of which would have been with B_1, the Establishment Branch; 23 with B_3, the Plant Engineering Branch; 25 with B_4, the Electronics Engineering Branch; and 38 times with B_5, the Planning Branch. Thus, the 75 items originating in B_1 would have averaged 1.36 coordination action per item originated.

Plant Engineering Branch, (B_3). --The Plant Engineering Branch, B_3, would have been the originating suborganization for 63 of the 508 items in the sample as shown in column 2 opposite B_3 in the third row of Table X. These 63 items would have required 32 coordination actions with B_1, the Establishment Branch; 46 actions with B_2, the Operations Branch; 32 actions with B_4, the Electronics Engineering Branch; and 31 actions with B_5, the Planning Branch. The total number of coordination actions for the 63 items originating in B_3 is 141 or an average of 2.24 actions per item originated.

Electronics Engineering Branch, (B_4). --The Electronics Engineering Branch, B_4, would have originated 147 of the 508 items in the sample as presented in Table X. These 147 items would have been coordinated 205 times with other suborganizations in Model-B. Thirty-three coordination actions would have been with B_1, Establishment; 127 actions with B_2, Operations; 13 actions with B_3, Plant Engineering; and 32 actions with B_5, Planning. Thus, the 147 items would have required an average of 1.40 coordination action for each item.

Planning Branch, (B_5). --The Planning Branch in Model-B organization would have originated 209 of the 508 items in the output sample of the existing organization. These 209 items would have required 472 coordination actions or an average of 2.26 actions per item originated. One hundred and thirteen coordination actions would have been required with B_1, the Establishment Branch; 148 actions with B_2, the Operations Branch; 123 actions with B_3, the Plant Engineering Branch; and 88 actions with B_4, the Electronics Engineering Branch.

Coordination Indices, Model-B Organization. --The data in Table XI present the coordination indices for each sub-organization in Model-B structure. The data show a relatively high degree of interrelationship between B_1, the Establishment Branch; and B_2, Operations; B_3, Plant Engineering; B_4, Electronics Engineering; and B_5, Planning, based on the criteria used in the previous section in analyzing Model-A.

TABLE XI

COORDINATION INDICES - MODEL-B ORGANIZATION

Organization	Sample Size (N)	Coordination Indices					
		B_1	B_2	B_3	B_4	B_5	O_A
B_1	14	--	0.74	0.54	0.63	0.39	0.97
B_2	75	0.19	--	0.26	0.28	0.40	0.74
B_3	63	0.40	0.52	--	0.40	0.39	0.89
B_4	147	0.20	0.58	0.08	--	0.20	0.75
B_5	209	0.42	0.51	0.44	0.34	--	0.90
Total	508						0.85

The data also show a relatively high degree of interrelations between B_2, Operations, and B_5, Planning, as viewed from activities originating in B_2. Similarily, a high degree of interrelationship exists between B_3, Plant Engineering, and B_1, B_2, B_4, and B_5 with corresponding indices of 0.40, 0.52, 0.40, and 0.39.

B_4, the Electronics Engineering Branch in Model-B, has a high degree of interrelationship only with B_2, Operations, as indicated by the Coordination Index value of 0.58. B_5, the Planning Branch, has a relatively high degree of interrelationship with B_1, Establishment; B_2, Operations; and B_3, Plant Engineering. Coordination Indices for these cases are respectively 0.42, 0.51, and 0.44 as shown in Table XI.

The overall Coordination Index for Model-B is 0.85 as compared to 0.84 for the existing organization.

Model-C Organization

Model-C Organization structure simulation data is depicted in Table XII. The data present the required coordination for producing the output sample of 508 items had the existing organization been structured as Model-C.

TABLE XII

REQUIRED COORDINATION-
MODEL-C ORGANIZATION

Organization	Sample Size (N)	Required Coordination				
		C_1	C_2	C_3	C_4	Total
C_1	91	--	3	4	9	16
C_2	97	1	--	13	11	25
C_3	208	31	39	--	27	97
C_4	112	63	82	72	--	217
Total	508	95	124	89	47	355

Type-A Systems Branch, (C_1). --Data in row C_1 of Table XII show that Branch C_1, Type A systems, would have originated 91 of the 508 items in the total sample of the existing organization's output. These 91 items would have required a total of 16 coordination actions, 3 of which would have been with Branch C_2, Type-B Systems; 4 actions with Branch C_3, Type-C Systems; and 9 actions with the Executive Staff, C_4. Thus, the 91 items originating in C_1 would have been coordinated an average of 0.176 time per item originated.

Type-B Systems Branch, (C_2). --Type-B Systems Branch, C_2, according to the data presented in Table XII, would have been the originating office for 97 of the 508 items in the total sample. These 97 items would have been coordinated a total of 25 times or an average of 0.26 time per item in the sample. One of the items would have been coordinated with C_1, the

Type-A Systems Branch; 13 items would have been coordinated with C_3, the Type-C Systems Branch; and 11 items would have been coordinated with C_4, the Executive Staff.

Type-C Systems Branch, (C_3). --The data in Table XII show that Branch C_3 would have originated 208 of the 508 items in the output sample. These 208 items would have required 97 coordination actions, 31 of which would have been with Branch C_1, 39 with Branch C_2, and 27 with the Executive Staff. Thus, the average number of coordination actions per item originated by Branch C_3 is 0.47.

The Executive Staff, (C_4). --Table XII data indicate that 112 of the 508 items in the sample would have been originated by C_4, the Executive Staff, had the existing organization been structured as Model-C. These 112 items would have required a total of 217 coordination actions with the other branches in Model-C, 63 actions with Branch C_1, 82 actions with Branch C_2, and 72 actions with Branch C_3. Thus, the 112 items would have been coordinated an average of 1.93 time per item.

Coordination Indices, Model-C Organization. --Table XIII presents the coordination indices for the suborganizational entities in Model-C structure. These data indicate a very low degree of interrelations between any two of the systems branches. However, the degree of interrelations between the Executive Staff and each of the systems branches is relatively high as indicated by the values of the indices.

TABLE XIII

COORDINATION INDICES - MODEL-C ORGANIZATION

Organization	Sample Size (N)	Coordination Indices				
		C_1	C_2	C_3	C_4	O_C
C_1	91	--	0.03	0.04	0.09	0.16
C_2	97	0.01	--	0.13	0.11	0.23
C_3	208	0.14	0.17	--	0.12	0.37
C_4	112	0.43	0.52	0.47	--	0.86
Total	508					0.50

The overall Coordination Index for Model-C Organization structure is 0.50 as compared to 0.84 for the existing organization.

Model-D Organization

The required coordination for producing the sample of 508 items with Model-D Organization structure substituted for the existing organization is presented in Table XIV.

Logistics Branch, (D_1). --Data in row D_1 of Table XIV show that the Logistics Branch, D_1, of Model-D Organization would have originated 133 of the 508 items in the total sample. These 133 items would have been coordinated 211 times for an average of 1.59 time per item originated; 94 coordination actions would have been with D_2, the Operations Branch; 95 actions with D_3, the Engineering Branch; and 22 actions with D_4, the Planning Branch.

TABLE XIV

REQUIRED COORDINATION-
MODEL-D ORGANIZATION

Organization	Sample Size (N)	Required Coordination				
		D_1	D_2	D_3	D_4	Total
D_1	133	--	94	95	22	211
D_2	78	17	--	37	30	84
D_3	219	29	178	--	57	264
D_4	78	22	63	75	--	160
Total	508					719

Operations Branch, (D_2). --According to the data in row D_2 of Table XIV, 78 of the 508 items in the total sample would have been originated by the Operations Branch, D_2, had the existing organization been structured as Model-D. Of the 78 items originating in D_2, 17 would have required coordination with D_1, the Logistics Branch; 37 would have required coordination with D_3, the Engineering Branch; and 30 would have required coordination with D_4, the Planning Branch. Thus, the 78 items would have averaged 1.08 coordination action per item.

Engineering Branch, (D_3). --The Engineering Branch, D_3, would have originated 219 items of the total items in the sample. These 219 items would have been coordinated 264 times or an average of 1.2 time per item originated. Twenty-nine of

the 219 items originating in D_3 would have been coordinated with D_1, the Logistics Branch; 178 with D_2, and 57 with D_4.

Planning Branch, (D_4). --The Planning Branch would have originated 78 of the 508 items in the sample, requiring 160 coordination actions; 22 actions with D_1, 63 actions with D_2, and 75 actions with D_3. Thus, the 78 items originating in D_4 would require an average of 2.05 coordination actions per item.

Coordination Indices, Model-D Organization. --Coordination indices for the suborganizational elements of Model-D structure are depicted in Table XV.

TABLE XV

COORDINATION INDICES - MODEL-D ORGANIZATION

Organization	Sample Size (N)	Coordination Indices				
		D_1	D_2	D_3	D_4	O_D
D_1	133	--	0.51	0.51	0.15	0.80
D_2	78	0.20	--	0.38	0.32	0.66
D_3	219	0.12	0.56	--	0.23	0.70
D_4	78	0.25	0.55	0.62	--	0.87
Total	508					0.76

The data indicate a relatively high degree of interrelationship between D_1, the Logistics Branch, and all other branches in Model-D structure except D_4, Planning. A

relatively low degree of interrelationship exists between the Operations Branch, D_2, and each of the other branches in Model-D as viewed from activities originating in D_2.

The data show a relatively high degree of interrelations between D_3, the Engineering Branch, and D_2, the Operations Branch, and a low degree with the other branches. A low degree of interrelationship is indicated between the Planning Branch, D_4, and D_1 but a high degree with D_2 and D_3 as viewed from activities originating in D_4.

The overall Coordination Index for Model-D Organization structure is 0.76 as compared to 0.84 for the existing organization.

Managers Profiles and Responses

One objective of the research was to attempt to identify and explain relationships between managerial functions and organization structure. In the simulation study described earlier, the structure was varied and corresponding coordination determined for each structural variation.

A decision was made to obtain primary data from managers and employees in the existing organization by having each participating subject fill out a questionnaire. The questionnaire is included in Appendix G.

Procedure. --In most cases subjects were approached individually and briefed in private on the research being conducted and then asked to participate if they so desired.

Without exception managers and employees responded eagerly. Some subjects were assembled in small groups of 3 or 4 and briefed on the research effort and the questionnaire. Approximately 90 percent of the subjects interviewed actually participated by returning the questionnaire.

The questionnaire was designed to obtain impressions from managers and journeyman-level professional employees of the existing and model organizations. A set of organization charts accompanied the questionnaire, and the subject was asked to rate each organization with regard to his functional responsibilities on a scale of "0" to "5" indicating a range of "very poor" to "very good" opinion. The managerial functions of planning, organizing, directing, controlling, and coordinating were each rated by the subject. Other factors included in questions 6 through 10 were: Communications; Use of employees' talents; Decision-making; Achievement of goals; and Overall opinion.

The data supplied by the respondents varied considerably and is very difficult to relate as indicated by information contained in the profiles and responses. There are indications, however, from the data which suggest that employees in different suborganizations see organization differently according to their exposure to the day-to-day problems. There is also evidence from the responses that managers and employees see organization according to their level in the organization as well as their functional responsibility in the existing organization.

The profiles show a considerable range of background and experience of respondents as well as levels of management in the existing organization. Most respondents had been employed in the Agency more than 15 years and several more than 25 years.

The research evaluated each respondent's responses and gave an overall indication with regard to the verification or modification of the research hypothesis using the results of the simulation study as a standard. For example, the simulation study showed Model-C to be the best structure from the viewpoint of the hypothesis with Model-D next, followed by Model-A, Existing, and Model-B organizations. If a respondent's response was in general agreement with the results of the simulation study, the hypothesis was considered to be verified. If the respondent's response varied significantly from the results of the simulation study, then the hypothesis was considered to be modified by the response.

A summary of the results of the responses is given in Tables XVI and XVII. Each question is evaluated for each subject and indicates either a verification (V) or modification (M) of the hypothesis for that element. For example, subject number one's response to question one (Planning) indicates a verification of the hypothesis and is so indicated by a "V" under the column headed by "Planning."

The data in Table XVI show that the responses from the employees in the existing organization resulted in approximately

an equal number of verifications and modifications of the hypothesis for managerial functions. The total number of verifications is 55 versus a total of 50 modifications.

The data in Table XVII show 65 verifications versus 40 modifications of the hypothesis for other factors.

What is more significant than the number of verifications versus the number of modifications of the hypothesis is the reasons for the differences expressed by the subjects. An attempt was made to determine reasons for the differences in the responses by dividing the subjects into four groups as follows: (1) Verifiers for the managerial functions, (2) Verifiers for the other factors, (3) Modifiers for the managerial functions, and (4) Modifiers for the other factors. A study of the profiles and responses indicated to the researcher three possible causes for the differences in the responses: (1) The organizational level of the subject, (2) Background experience, and (3) The organizational function in which the subject was employed.

Tables XVIII through XXI display the data according to the four groups mentioned above. The data in these four tables suggest that verifiers of the hypothesis were at the section chief or journeyman level in the organization with background experience in electronics and presently employed in either engineering or planning. The data also suggest that modifiers of the hypothesis were at branch, section, or unit chief level in the organization. There was no modifier at a

TABLE XVI

RESPONSES BY MANAGERS

Managerial Functions

Subject	Planning		Organizing		Directing		Controlling		Coordination	
1	V		V		V		V			M
2	V			M	V			M	V	
3	V		V		V		V		V	
4		M		M		M		M		M
5	V			M		M		M	V	
6	V		V		V		V		V	
7		M		M		M		M		M
8		M		M		M		M		M
9	V		V		V		V		V	
10		M		M	V			M		M
11		M		M		M		M		M
12*										
13		M		M		M		M		M
14		M		M		M		M		M
15		M		M	V		V		V	
16	V		V		V		V		V	
17	V		V		V			M		M
18		M		M		M		M		M
19	V		V		V		V		V	
20	V		V			M	V		V	
21	V		V		V		V		V	
22	V		V		V		V		V	
Totals	12	9	10	11	12	9	10	11	11	10

*Subject No. 12's responses was invalidated and not used in this analysis.

V = Hypothesis verified for the particular element under which it is shown.

M = Hypothesis modified for the particular element under which it is shown.

TABLE XVII

RESPONSES BY MANAGERS

Other Factors

Subject	Communi-cations		Use of talents		Decision-making		Achievement of goals		Overall opinion	
1	V		V		V		V		V	
2	V		V		V		V		V	
3	V		V		V		V		V	
4		M		M		M		M		M
5		M		M		V		M		M
6		M	V		V		V		V	
7		M		M		M		M		M
8		M	V			M	V		V	
9	V		V		V		V		V	
10		M		M		M		M		M
11		M		M		M		M		M
12*										
13	V			M	V		V		V	
14		M		M		M		M		M
15	V			M	V		V		V	
16	V		V		V		V		V	
17	V		V		V		V		V	
18		M		M		M		M		M
19	V		V		V		V		V	
20	V		V			M	V		V	
21	V		V		V		V		V	
22	V		V		V		V		V	
Totals	12	9	12	9	13	8	14	7	14	7

*Subject No. 12's response was invalidated and not used in this analysis.

V = Hypothesis verified for the particular element under which it is shown.

M = Hypothesis modified for the particular element under which it is shown.

TABLE XVIII

VERIFICATION OF HYPOTHESIS
MANAGERIAL FUNCTIONS

Subject	Level in Organization*				Background Exp.**			Function in organization ***				
	BC	SC	UC	JL	EE	PE	Log.	E	P	Log.	Est.	Othr.
1		x			x						x	
2		x			x			x				
3		x			x				x			
6				x	x							x
9			x		x		x			x		
15		x			x				x			
16				x	x				x			
17				x		x			x			
19				x	x				x			
20				x	x			x				
21				x	x			x				
22				x	x			x				
Totals			1	7	11	1	1	4	5	1	1	1

*Level in organization - BC=Branch Chief; SC=Section Chief; UC=Unit Chief; JL=Journeyman-Level

**Background experience - EE=Electronics Engineering; PE=Civil, Electrical, Mechanical; Log.=Logistics

***Function in organization - E=Engineering; P=Planning; Log.=Logistics; Est.=Establishment; Othr.=Other

TABLE XIX

VERIFICATION OF HYPOTHESIS-
OTHER FACTORS

Subject	Level in organization*				Background Exp.**			Function in organization***				
	BC	SC	UC	JL	EE	PE	Log.	E	P	Log.	Est.	Othr.
1		x			x						x	
2		x			x			x				
3		x			x				x			
6				x	x							x
8			x		x						x	
9			x		x		x			x		
13		x				x		x				
15		x			x				x			
16				x	x				x			
17				x		x			x			
19				x	x				x			
20				x	x			x				
21				x	x			x				
22				x	x			x				
TOTALS		5	2	7	12	2	1	5	5	1	2	1

*Level in organization - BC=Branch Chief; SC=Section Chief; UC=Unit Chief; JL=Journeyman Level

**Background experience - EE=Electronics Engineering; PE=Civil, Electrical or Mechanical Engineering; Log.=Logistics

***Function in organization - E=Engineering; P=Planning; Log.=Logistics; Est.=Establishment; Othr.=Other

TABLE XX

MODIFICATION OF HYPOTHESIS-
MANAGERIAL FUNCTIONS

Subject	Level in organization*				Background Exp.**			Function in organization ***				
	BC	SC	UC	JL	EE	PE	Log.	E	P	Log.	Est.	Othr.
4	x						x			x		
5			x		x						x	
7		x				x		x				
8			x		x						x	
10			x		x						x	
11	x					x		x				
13		x				x		x				
14		x				x					x	
18		x					x			x		
Totals	2	4	3		3	4	2	3		2	4	

*Level in organization - BC=Branch Chief; SC=Section Chief; UC=Unit Chief; JL= Journeyman-Level

**Background experience - EE=Electronic Engineering; PE= Civil, Mechanical, or Electrical Engineering; Log.=Logistics

***Function in organization - E=Engineering; P=Planning; Log.=Logistics; Est.=Establishment; Othr.=Other

TABLE XXI

MODIFICATION OF HYPOTHESIS-
OTHER FACTORS

	Level in organization*				Background Exp.**			Function in organization ***				
	BC	SC	UC	JL	EE	PE	Log.	E	P	Log.	Est.	Othr.
4	x						x			x		
5			x		x						x	
7		x				x		x				
10			x		x						x	
11	x					x		x				
14		x				x					x	
18		x					x			x		
Totals	2	3	2		2	3	2	2		2	3	

*Level in organization - BC=Branch Chief; SC=Section Chief; UC=Unit Chief; JL= Journeyman-Level

**Background experience - EE=Electronics Engineering; PE= Civil, Mechanical, or Electrical Engineering; Log.=Logistics

***Function in organization - E=Engineering; P=Planning; Log.=Logistics; Est.=Establishment; Othr.=Other

lower level in the organization than unit chief. The modifiers had a predominance of background experience in Plant Engineering including civil, electrical, and mechanical.

Present employment of the modifiers in the existing organization was primarily in establishment, engineering, and logistics. None of the Modifiers were employed in Planning.

A Comparative Analysis

Existing Organization and Model-A

The existing organization had a Coordination Index value of 0.84 as derived from formula (1). The 508 items in the sample required a total of 923 coordination actions or an average of 1.82 action per item in the sample. This compares to a Coordination Index value of 0.82 for Model-A organization. Model-A required 874 coordination actions for the 508 items in the sample. This data indicate that Model-A is a better structure than the existing organization structure if the hypothesis is valid.

The numerical value of all responses to the first five questions on the questionnaire for Model-A averages 16.3. The corresponding responses for the existing organization averages 14.2. This represents a difference of 13.8 percent as compared to a 5.5 percent difference in the number of coordination actions required for Model-A and existing organizations in the simulation study. In other words, the simulation study indicated that Model-A was 5.5 percent more efficient

than the existing organization in producing the 508 item sample output. The responses from all managers indicate that Model-A is 13.8 percent better than the existing organization from the viewpoint of managerial functions.

Existing Organization and Model-B

Model-B Organization had a Coordination Index value of 0.85 resulting from 971 required coordination actions in producing the 508 item sample output. The percentage difference between Model-B and the existing organization with respect to the number of coordination actions required is 5.07 percent. Thus, the simulation study results show the existing organization to be 5.07 percent better than Model-B with respect to required coordination in producing the sample of 508 items.

The numerical average of all responses to the first five questions on the questionnaire for Model-B is 15.1. This represents a difference of 6.2 percent from the existing organization. Thus, Model-B organization, in the opinion of all the respondents, is 6.2 percent better than the existing organization with respect to the managerial functions.

Existing Organization and Model-C

Model-C Organization had a Coordination Index value of 0.50 resulting from 355 coordination actions in producing the 508 item sample output. This represents a difference of 89.0 percent between Model-C and the existing organization. Thus, the simulation study shows that Model-C is 89.0 percent more

efficient than the existing organization with respect to required coordination in producing the sample output.

The numerical average of all responses to the first five questions on the questionnaire for Model-C is 18.4. This represents a difference of 25.8 percent from the existing organization. Thus, the aggregate opinion of the respondents is that Model-C is 25.8 percent better than the existing organization with respect to managerial functions.

Existing Organization and Model-D. --The Coordination Index for Model-D was 0.76 with 719 coordination actions required to produce the 508 sample items. The difference between Model-D and the existing organization with respect to the number of coordination actions required to produce the output sample of 508 items is 22.2 percent. Thus, the results of the simulation study indicate that Model-D is 22.2 percent more efficient with respect to required coordination in producing a given output.

The numerical average of all responses to the first five questions on the questionnaire for Model-D is 17.3. This represents a difference of 15.8 percent from the existing organization. In this case, the aggregate of opinions of all respondents confirmed the results of the simulation study, the respondents' opinion being in favor of Model-D organization by a margin of 15.8 percent and the simulation study favoring Model-D by a margin of 22.2 percent.

Summary of Analysis

Chapter VI has attempted to analyze the internal relationships in an existing organization and four model organizations, two of which were designed on a conventional functional basis. These two models are designated Model-A and Model-B in the study and have the same design characteristics as the existing organization. Model-C Organization was designed along the lines of the "project management" concept. Model-D Organization had a matrix structural design.

The analysis of the coordination required in each of the five structures in producing the 508 item sample of the output of the existing organization showed that the project management structure of Model-C is superior from the viewpoint of the working hypothesis. This finding was supported by a subjective evaluation by 22 managers and journeyman-level professional employees in the existing organization. This subjective evaluation utilized a questionnaire which was designed to obtain employee impressions of the five organizational structures with regard to their particular function in the existing organization.

The matrix organization was found to be the second best structure according to the results of the simulation study. This finding was also validated by the subjective evaluation of the managers and employees of the existing organization.

The simulation study indicated only a slight difference between the existing organization and Models A and B. This

should be expected since these three structures are of the same basic "functional" design with variations in functional assignments being the only difference between the structures.

Although the responses from the managers and employees indicated an overall agreement with the results of the simulation study, there were obvious biases as shown by the analysis of the responses. Biases seemed to be the result of the background experience of the respondent as well as his level and function in the existing organization.

The methodology developed by the research proved to be a useful tool in evaluating different organizational structures based on simulation techniques. The Coordination Index and Figure of Merit developed by the research proved to be useful in analyzing different organizational structures by permitting a quantitative comparison to be made between the structures.

CHAPTER VII

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The research conducted an inquiry into the interrelations between suborganizational entities of several organization structures. It sought to determine if there are definite patterns of relationships between the structural aspects of organization and managerial functions. The managerial function of coordination was chosen as the independent variable because of its unique relation with the internal structure of organization and the managerial functions of planning, organizing, directing, and controlling.

Summary

Research results indicate that required coordination is a valid parameter in considering the structural design of organization. The data indicate a predictable pattern between the amount of coordination required in an organization in performing its functions and managerial functions themselves. In other words, managerial performance increases as required coordination decreases in an organization. The proposition that optimum structural design of organization coincides with minimum required coordination was verified in the simulation study as well as in the subjective evaluation of members of the existing organization.

Summary of Results

The results of the simulation study correlate very closely with the responses from the managers. Only two differences were noted between the two approaches. The simulation study produced a different order of merit for the existing organization and Model-B than did the responses from the managers for managerial functions. For example, the simulation study indicated a higher merit for the existing as compared to Model-B and responses from the managers indicated a higher merit for Model-B than the existing organization. The simulation study also indicated a different order of merit for Model-D and Model-A than did the managerial responses for "other factors." The simulation study, for example, showed Model-D superior to Model-A, and the responses from the managers to the last five questions (other factors) on the questionnaire indicate Model-A to be superior to Model-D.

The most significant overall result of the investigation was the fact that Model-C Organization employing a project management concept proved to be superior in both the simulation study as well as in the responses from the employees in the existing organization. With the one exception indicated by the responses to the "other factors" on the questionnaire, Model-D, employing a matrix structure, was recognized as the second best structure.

In summary, model structures A, B, and E, all employing functional structures, were rated low as compared to Model-C

with a project management structural concept. Model-D, with a matrix structure, was rated slightly higher than model structures A, B, and E.

Simulation study. --The simulation study was designed to measure the relative amounts of coordination required in different organizations with similar functions and producing a given output. Thus, the input and output of an existing organization was held constant and the internal structure varied while measuring the resulting required coordination to produce the given output.

The overall results of the simulation study is shown in Table XVII.

TABLE XXII

OVERALL RESULTS OF SIMULATION STUDY

Organization	Coordination Index (C_i)	Figure of Merit (F)*
Model-A	0.82	1.06
Model-B	0.85	0.95
Model-C	0.50	2.60
Model-D	0.76	1.28
Existing-E	0.84	1.00

*Figure of Merit, $F = \frac{C_E}{C_X}$

Where C_E = Required Coordination in Existing Organization

C_X = Required Coordination in A Model Organization

Thus, with the existing organization used as a standard for comparison, three of the four model structures proved to

be superior, and one model proved to be inferior on the basis of the relative amounts of required coordination in producing a given output. The existing and model organizations in descending order of merit are: Model-C, Model-D, Model-A, Existing-E, and Model-B, with respective figures of merit of 2.60, 1.28, 1.06, 1.00, and 0.95.

The Coordination Index. --The Coordination Index developed by the research proved to be useful in analyzing the various organizational structures. The Coordination Indices for the existing and model organizations considered as total systems are shown in the second column of Table XXII. A coordination index was calculated for each suborganization relating to each other suborganization in all organization structures studied. A coordination index was also calculated for each suborganization relating to the rest of the organization, considered as a total system, in each of the structures in the study.

Coordination indices are useful in studying interrelationship patterns in organization structures. They suggest possible areas for improvement in structural design. For example, coordination indices with values above 0.65 in the present investigation indicate that each item in the sample of the output of the organization had to be coordinated on the average more than once with some other suborganization. Coordination indices with high values indicate points in the organization that should be studied for possible improvements.

Responses of managers. --The questionnaire was designed to obtain subjective data from members of the existing organization that could be used to validate the simulation study and the working hypothesis. An important question posed by the research was: How do managerial functions relate to organization? The overall results of the responses from members of the existing organization are shown in Table XXIII.

TABLE XXIII

OVERALL RESULTS OF MANAGERS RESPONSES

Organization	Management Functions	Other Factors
Model-A	16.3	16.0
Model-B	15.1	11.8
Model-C	18.4	18.1
Model-D	17.3	14.7
Existing-E	14.2	13.4

The second column in Table XXIII shows the numerical averages of all responses to the first five questions on the questionnaire relating to management functions for the existing and for each model organization. Column three shows the numerical averages of all responses to questions 6 through 10 on the questionnaire relating to other factors of organization and management. The existing and model organizations in descending order of value as expressed by the respondents are, for managerial functions: Model-C, Model-D, Model-A, Model-B, and the Existing-E. In descending order of value as expressed

by the respondents are, for other factors (questions 6 through 10): Model-C, Model-A, Model-D, the Existing-E, and Model-B.

Research methodology. --The research results indicate that the general methodology of the study should prove useful as a practical tool in designing organizations. In other words, the management of an organization could, with information readily available, design a structure that could be easily tested by simulating the operation of the existing organization to determine if the proposed structure would result in improved performance prior to making the final decision to reorganize.

Conclusions

Conclusions with regard to the structural design of organization are as follows and contain the working hypothesis that was validated by the research:

1. Patterns of internal relations exist in organizations which are useful in designing or redesigning the structure for optimum organizational performance.

2. Minimum required coordination is a valid parameter for the structural design of organization.

3. Members of the existing organization agreed in general with the results of the simulation study as reflected in responses to the questionnaire included in Appendix G.

4. Patterns exist in the viewpoints of organizational members that relate to their position in the organization and to their functional responsibilities.

Recommendations

The research does not conclude that there is one best way to organize in a particular type of business or other activity. It does imply that in a particular situation, environment, etc. . . there is a best way to organize. If the situation or environment changes such that internal relationship patterns are changed, then the implication of the research is that a different structural design for the organization may be in order.

The following recommendations are made after carefully considering all the implications of the research effort:

1. Additional research is needed along the lines of this effort but with different types of business and activities to test the general validity of the hypothesis in all kinds of organizational settings.

2. Organizational development efforts should consider the integration of organization design into the overall development program. Input from each member of an organization should be an integral part of the decision-making process leading to organizational design.

3. Additional research is needed using computer simulation techniques which would permit extending the methodology to more and larger organizations.

4. Additional research is recommended into the possibilities for using the methodology of the research in

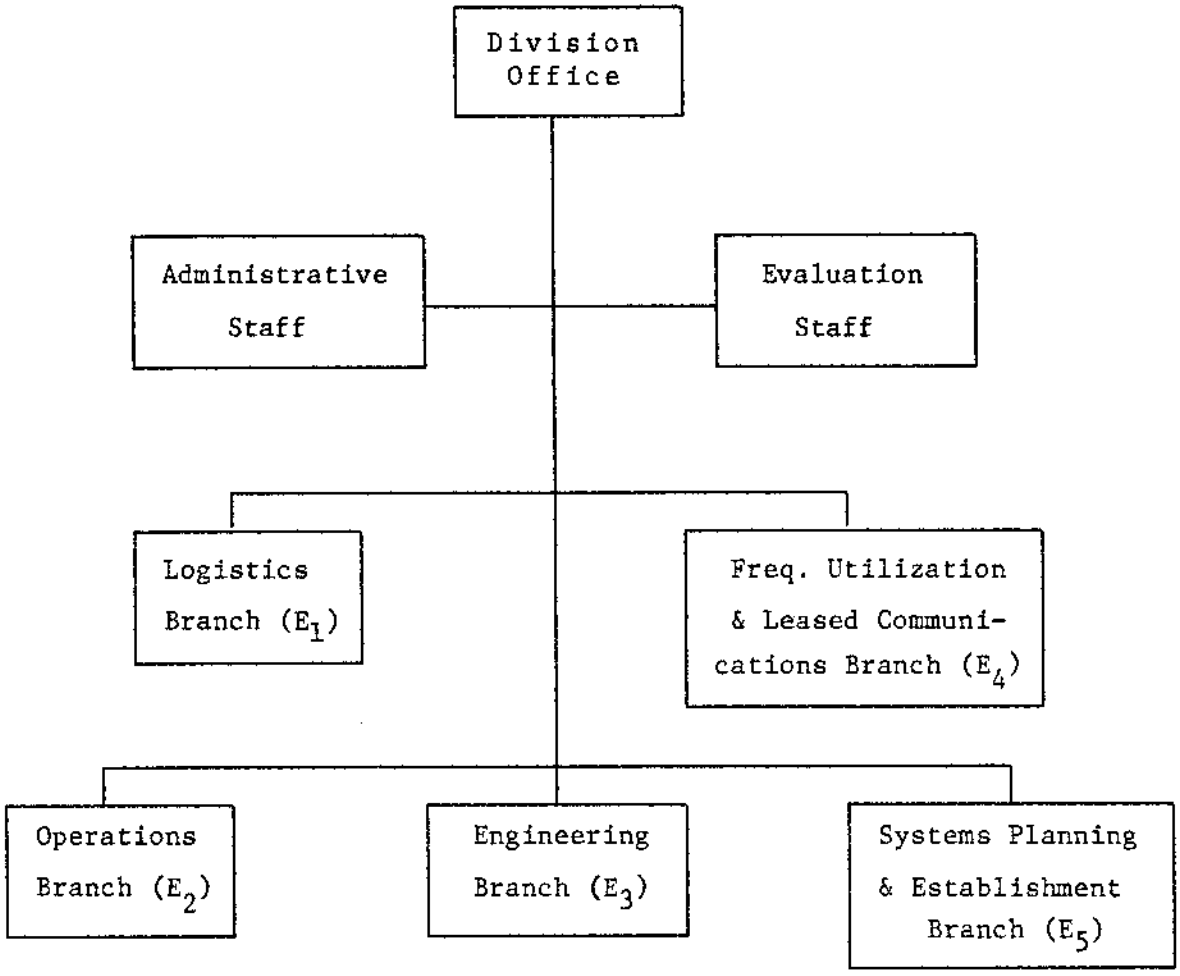
developing new organizations from functional statements where there is no existing organization.

5. The research clearly indicates that the systems approach to organization design is superior to the functional approach. Further research is recommended directed toward the validation of the systems approach versus the functional approach to organization design.

APPENDIX A

ORGANIZATION CHARTS

EXISTING ORGANIZATION - E



STRUCTURE TYPE: FUNCTIONAL

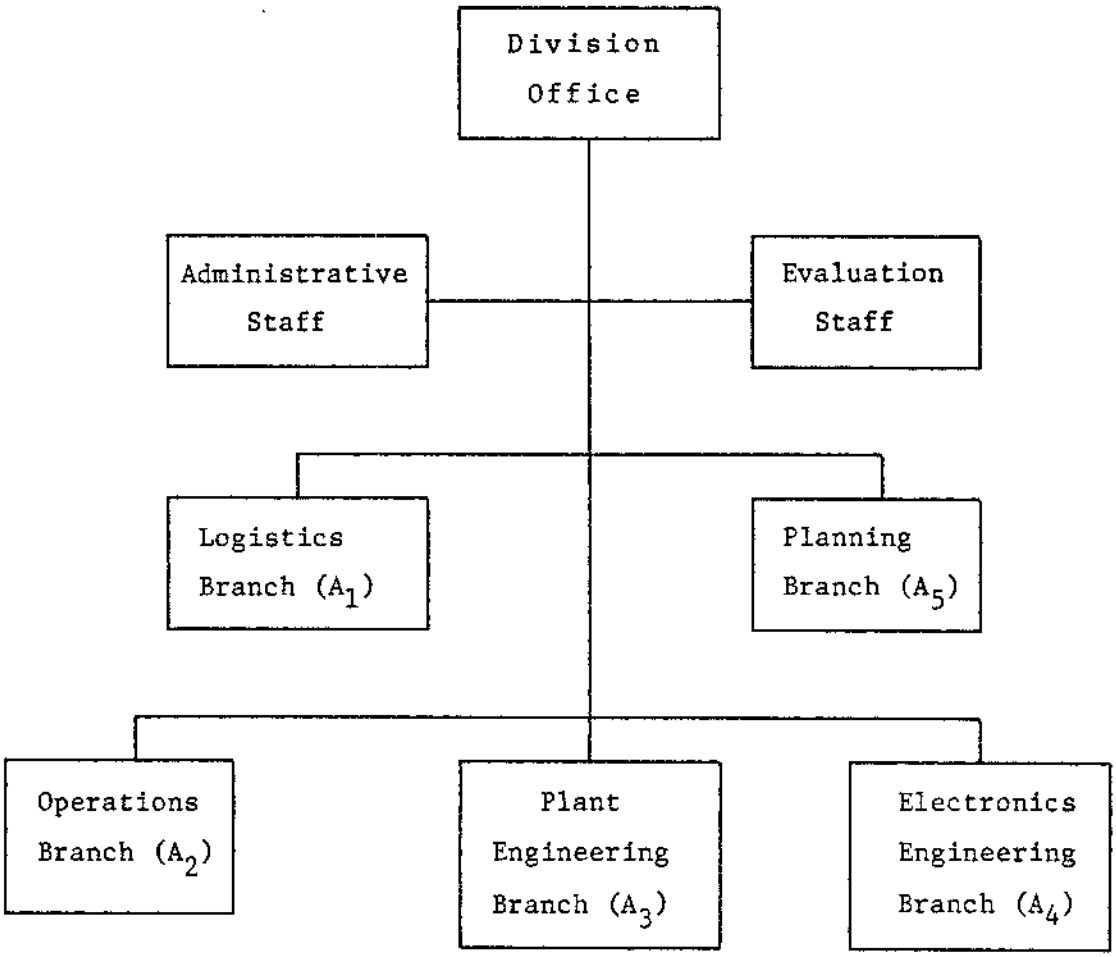
FUNCTIONS: (1) LOGISTICS (E_1)

(2) OPERATIONS (E_2)

(3) ENGINEERING (E_3)

(4) SYSTEMS PLANNING AND ESTABLISHMENT (E_5)

MODEL-A ORGANIZATION



STRUCTURE TYPE: FUNCTIONAL

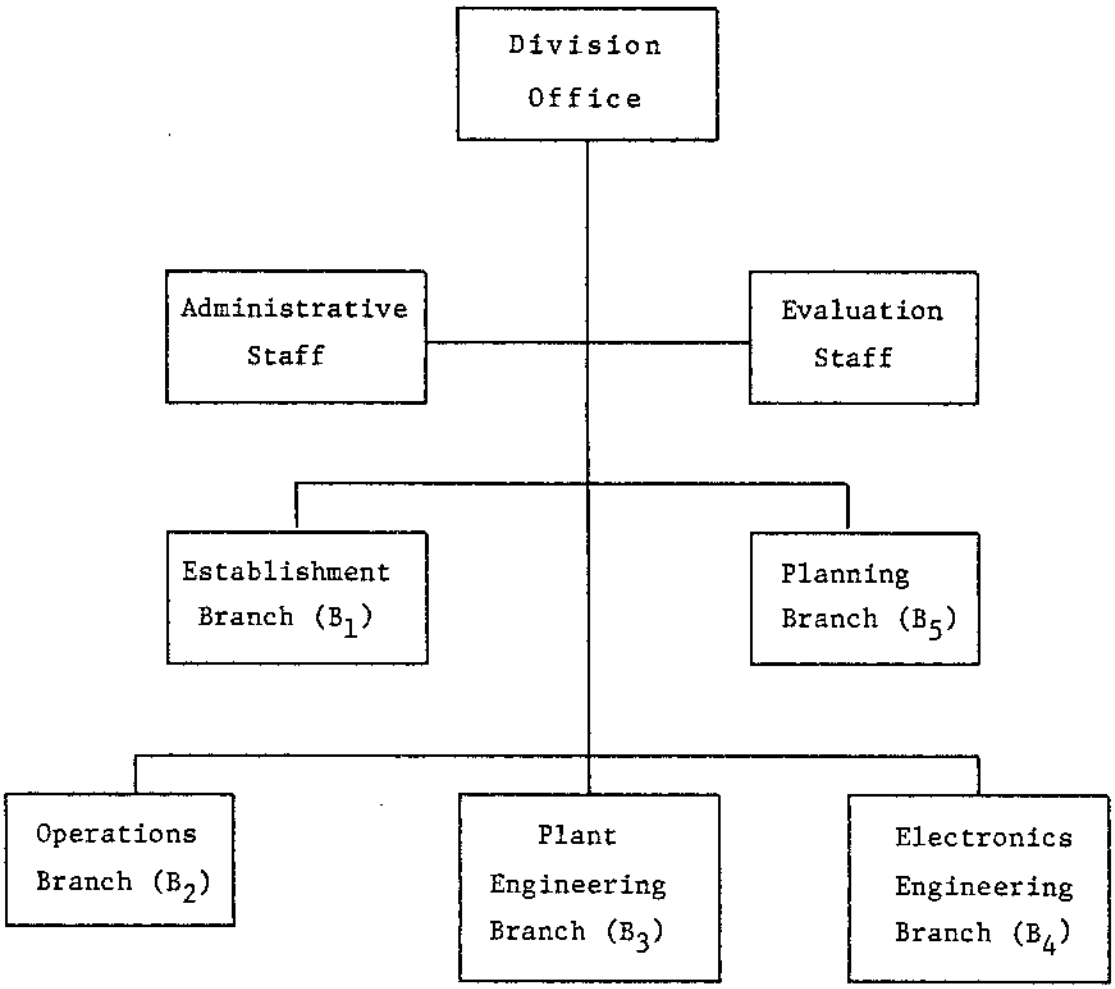
FUNCTIONS: (1) LOGISTICS (A_1)

(2) OPERATIONS (A_2)

(3) PLANT ENGINEERING (A_3)

(4) ELECTRONICS ENGINEERING (A_4)

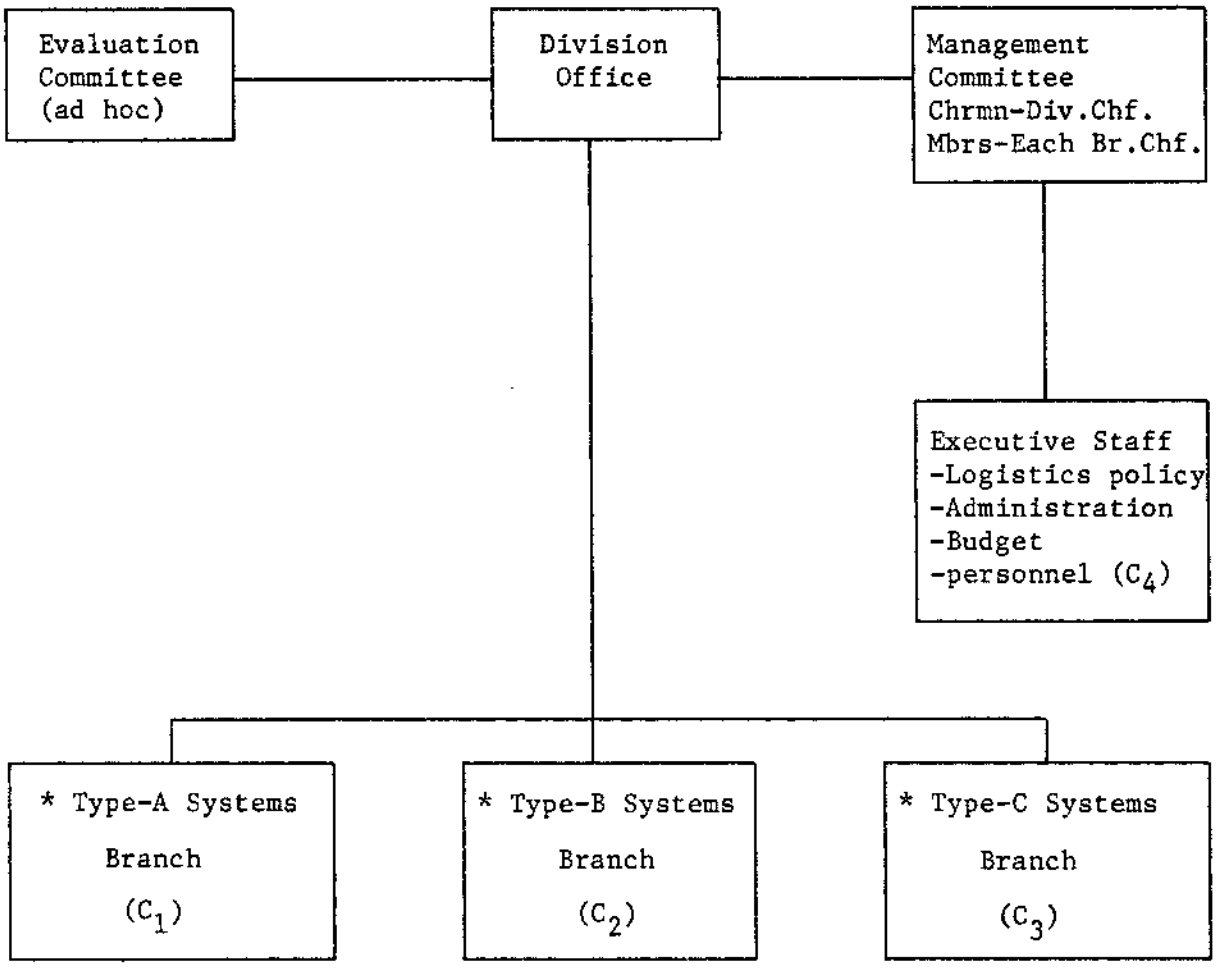
MODEL-B ORGANIZATION



STRUCTURE TYPE: FUNCTIONAL

FUNCTIONS:
(1) ESTABLISHMENT (B_1)
(2) OPERATIONS (B_2)
(3) PLANT ENGINEERING (B_3)
(4) ELECTRONICS ENGINEERING (B_4)
(5) PLANNING (B_5)

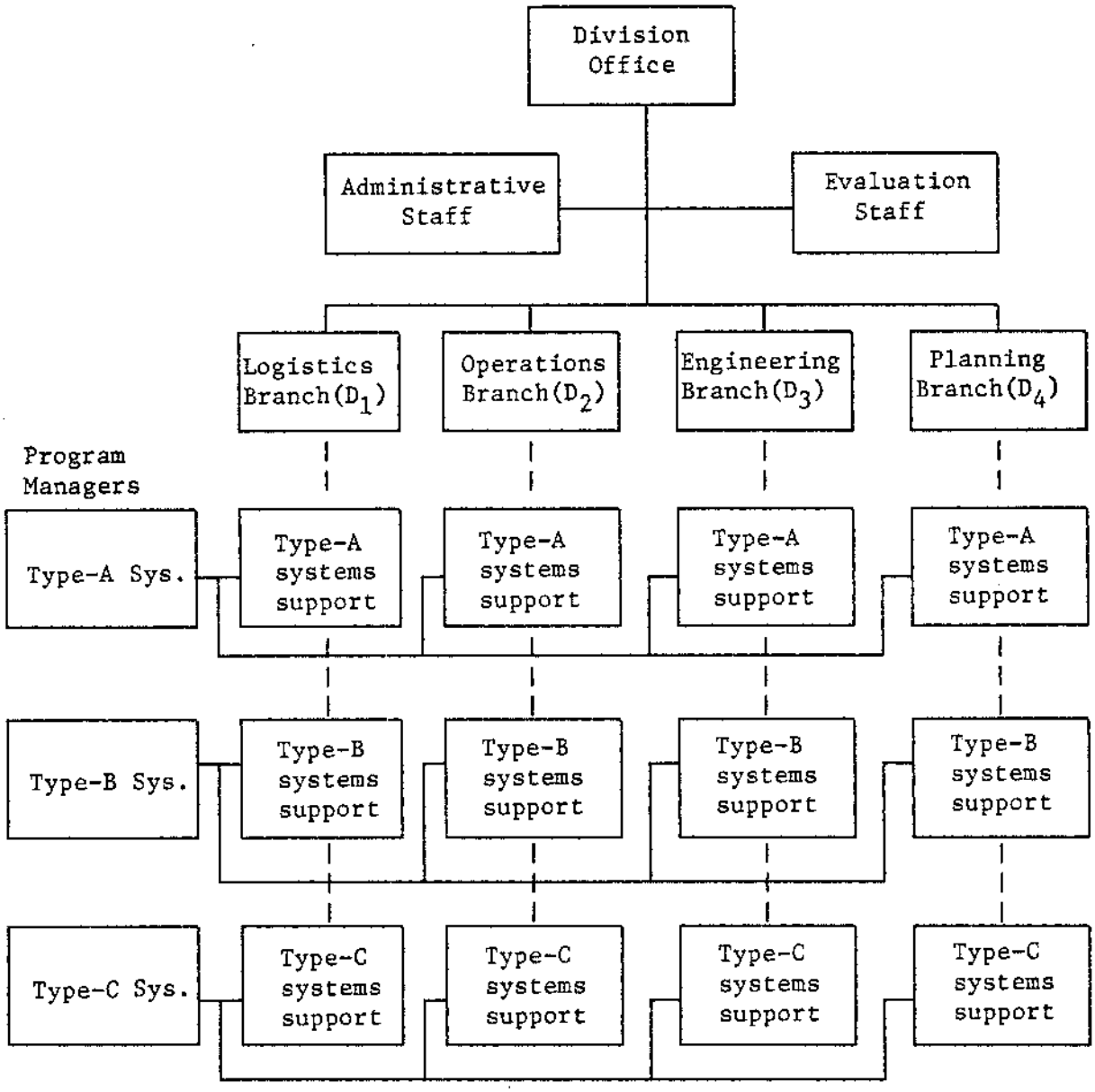
MODEL-C ORGANIZATION



STRUCTURE TYPE: PROJECT MANAGEMENT

*FUNCTIONS: ALL FUNCTIONS SUCH AS LOGISTICS, OPERATIONS, ENGINEERING, AND ESTABLISHMENT ARE ASSIGNED TO EACH SYSTEMS BRANCH NECESSARY FOR THE BRANCH TO ACHIEVE IT'S OBJECTIVES.

MODEL-D ORGANIZATION



STRUCTURE TYPE: MATRIX

FUNCTIONS: FUNCTIONAL SUPPORT IS ASSIGNED TO EACH PROGRAM MANAGER AS REQUIRED. LINE MANAGEMENT IS PROVIDED BY THE PROGRAM MANAGERS AND ADMINISTRATIVE MANAGEMENT IS PROVIDED BY THE APPROPRIATE FUNCTIONAL BRANCH.

APPENDIX B

STATISTICAL DATA OF SIMULATION STUDY-EXISTING ORGANIZATION

EXISTING ORGANIZATION ANALYSIS OF
SIMULATION STUDY - FIRST QUARTER, 1970

ORGANIZATION			REQUIRED COORDINATION (C_r)					
Structure	Branch	Sample Size	E_1	E_2	E_3	E_4	E_5	Total
O_E	E_1	33	-	25	19	2	27	73
	E_2	17	7	-	12	4	14	37
	E_3	26	4	25	-	6	16	51
	E_4	18	2	16	9	-	7	34
	E_5	15	5	11	15	6	-	37
Total		109	18	77	55	18	64	232

EXISTING ORGANIZATION ANALYSIS OF
SIMULATION STUDY - SECOND QUARTER, 1970

ORGANIZATION			REQUIRED COORDINATION (C_r)					
Structure	Branch	Sample Size	E_1	E_2	E_3	E_4	E_5	Total
O_E	E_1	38	-	30	20	-	24	74
	E_2	23	5	-	6	-	10	21
	E_3	34	10	25	-	5	27	67
	E_4	32	-	29	20	-	15	64
	E_5	21	6	17	21	3	-	47
Total		148	21	101	67	8	76	273

EXISTING ORGANIZATION ANALYSIS OF
SIMULATION STUDY - THIRD QUARTER, 1970

ORGANIZATION			REQUIRED COORDINATION (C_r)					
Structure	Branch	Sample Size	E_1	E_2	E_3	E_4	E_5	Total
O_E	E_1	32	-	23	27	-	25	75
	E_2	19	3	-	11	-	7	21
	E_3	28	7	20	-	1	15	43
	E_4	22	3	18	12	-	2	35
	E_5	31	13	23	29	3	-	68
Total		132	26	84	79	4	49	242

EXISTING ORGANIZATION ANALYSIS OF
SIMULATION STUDY - FOURTH QUARTER, 1970

ORGANIZATION			REQUIRED COORDINATION (C_r)					
Structure	Branch	Sample Size	E_1	E_2	E_3	E_4	E_5	Total
O_E	E_1	25	-	17	13	-	16	46
	E_2	18	2	-	4	-	7	13
	E_3	28	5	22	-	3	22	52
	E_4	18	-	14	4	-	3	21
	E_5	25	8	22	23	3	-	56
Total		115	15	75	44	6	48	188

APPENDIX C

STATISTICAL DATA OF SIMULATION

STUDY-MODEL-A

MODEL-A ORGANIZATION ANALYSIS OF
SIMULATION STUDY - FIRST QUARTER, 1970

ORGANIZATION			REQUIRED COORDINATION (C_r)					
Structure	Branch	Sample Size	A_1	A_2	A_3	A_4	A_5	Total
O_A	A_1	34	-	26	18	14	13	71
	A_2	17	7	-	9	12	13	41
	A_3	13	3	12	-	6	6	27
	A_4	33	6	29	2	-	4	41
	A_5	12	3	9	10	11	-	33
Total		109	19	76	39	43	36	213

MODEL-A ORGANIZATION ANALYSIS OF
SIMULATION STUDY - SECOND QUARTER, 1970

ORGANIZATION			REQUIRED COORDINATION (C_r)					
Structure	Branch	Sample Size	A_1	A_2	A_3	A_4	A_5	Total
O_A	A_1	43	-	30	23	11	6	70
	A_2	23	5	-	6	3	9	23
	A_3	13	6	9	-	10	8	33
	A_4	56	6	48	9	-	13	76
	A_5	17	4	15	12	11	-	42
Total		152	21	102	50	35	36	244

MODEL-A ORGANIZATION ANALYSIS OF
SIMULATION STUDY - THIRD QUARTER, 1970

ORGANIZATION			REQUIRED COORDINATION (C_r)					
Structure	Branch	Sample Size	A_1	A_2	A_3	A_4	A_5	Total
O_A	A_1	32	-	23	26	9	1	59
	A_2	19	3	-	7	7	6	23
	A_3	20	8	12	-	7	10	37
	A_4	34	3	29	2	-	3	37
	A_5	27	10	20	21	24	-	75
Total		132	24	84	56	47	20	231

MODEL-A ORGANIZATION ANALYSIS OF
SIMULATION STUDY - FOURTH QUARTER, 1970

ORGANIZATION			REQUIRED COORDINATION (C_r)					
Structure	Branch	Sample Size	A_1	A_2	A_3	A_4	A_5	Total
O_A	A_1	25	-	17	17	7	3	44
	A_2	19	3	-	3	5	6	17
	A_3	19	5	15	-	7	5	32
	A_4	29	2	22	3	-	8	35
	A_5	23	5	20	19	15	-	59
Total		115	15	74	42	34	22	187

APPENDIX D

STATISTICAL DATA OF SIMULATION

STUDY-MODEL-B

MODEL-B ORGANIZATION ANALYSIS OF
SIMULATION STUDY - FIRST QUARTER, 1970

ORGANIZATION			REQUIRED COORDINATION (C_r)					
Structure	Branch	Sample Size	B_1	B_2	B_3	B_4	B_5	Total
O_B	B_1	5	-	12	3	7	4	26
	B_2	17	10	-	9	12	12	43
	B_3	10	6	10	-	7	6	29
	B_4	34	14	32	3	-	6	55
	B_5	53	29	26	21	16	-	92
Total		119	59	80	36	42	28	245

MODEL-B ORGANIZATION ANALYSIS OF
SIMULATION STUDY - SECOND QUARTER, 1970

ORGANIZATION			REQUIRED COORDINATION (C_r)					
Structure	Branch	Sample Size	B_1	B_2	B_3	B_4	B_5	Total
O_B	B_1	3	-	1	3	3	1	8
	B_2	21	3	-	5	2	11	21
	B_3	14	9	10	-	10	8	37
	B_4	52	12	46	6	-	14	78
	B_5	62	29	46	31	20	-	126
Total		152	53	103	45	35	34	270

MODEL-B ORGANIZATION ANALYSIS OF
SIMULATION STUDY - THIRD QUARTER, 1970

ORGANIZATION			REQUIRED COORDINATION (C_r)					
Structure	Branch	Sample Size	B_1	B_2	B_3	B_4	B_5	Total
O_B	B_1	4	-	4	3	3	-	10
	B_2	19	2	-	7	7	7	23
	B_3	20	8	12	-	8	11	39
	B_4	32	1	27	1	-	4	33
	B_5	57	30	40	42	31	-	143
Total		132	51	83	53	49	22	258

MODEL-B ORGANIZATION ANALYSIS OF
SIMULATION STUDY - FOURTH QUARTER, 1970

ORGANIZATION			REQUIRED COORDINATION (C_r)					
Structure	Branch	Sample Size	B_1	B_2	B_3	B_4	B_5	Total
O_B	B_1	2	-	2	2	1	2	7
	B_2	18	1	-	2	4	8	15
	B_3	19	9	14	-	7	6	36
	B_4	29	6	22	3	-	8	39
	B_5	47	25	36	29	21	-	111
Tota.		115	41	74	36	33	24	208

APPENDIX E

STATISTICAL DATA OF SIMULATION STUDY-MODEL-C

MODEL-C ORGANIZATION ANALYSIS OF
SIMULATION STUDY - FIRST QUARTER, 1970

ORGANIZATION			REQUIRED COORDINATION (C_r)					
Structure	Branch	Sample Size	C_1	C_2	C_3	C_4		Total
O_C	C_1	24	-	2	3	3		8
	C_2	22	-	-	2	1		3
	C_3	51	7	7	-	7		21
	C_4	12	6	8	7	-		21
Total		109	13	17	12	11		53

MODEL-C ORGANIZATION ANALYSIS OF
SIMULATION STUDY - SECOND QUARTER, 1970

ORGANIZATION			REQUIRED COORDINATION (C_r)					
Structure	Branch	Sample Size	C_1	C_2	C_3	C_4		Total
O_C	C_1	23	-	-	1	2		3
	C_2	28	-	-	2	3		5
	C_3	67	13	11	-	10		34
	C_4	34	18	25	19	-		62
Total		152	31	36	22	15		104

MODEL-C ORGANIZATION ANALYSIS OF
SIMULATION STUDY - THIRD QUARTER, 1970

ORGANIZATION			REQUIRED COORDINATION (C_r)					
Structure	Branch	Sample Size	C_1	C_2	C_3	C_4		Total
O_C	C_1	31	-	-	-	4		4
	C_2	25	-	-	1	5		6
	C_3	47	5	12	-	4		21
	C_4	29	20	22	20	-		62
Total		132	25	34	21	13		93

MODEL-C ORGANIZATION ANALYSIS OF
SIMULATION STUDY - FOURTH QUARTER, 1970

ORGANIZATION			REQUIRED COORDINATION (C_r)					
Structure	Branch	Sample Size	C_1	C_2	C_3	C_4		Total
O_C	C_1	13	-	1	-	-		1
	C_2	22	1	-	8	2		11
	C_3	43	6	9	-	6		21
	C_4	37	19	27	26	-		72
Total		115	26	37	34	8		105

APPENDIX F

STATISTICAL DATA OF SIMULATION STUDY - MODEL-D

MODEL-D ORGANIZATION ANALYSIS OF
SIMULATION STUDY - FIRST QUARTER, 1970

ORGANIZATION			REQUIRED COORDINATION (C_r)					
Structure	Branch	Sample Size	D_1	D_2	D_3	D_4		Total
O_D	D_1	34	-	25	22	12		59
	D_2	17	6	-	13	13		32
	D_3	47	5	43	-	11		59
	D_4	11	3	8	8	-		19
Total		109	14	76	43	36		169

MODEL-D ORGANIZATION ANALYSIS OF
SIMULATION STUDY - SECOND QUARTER, 1970

ORGANIZATION			REQUIRED COORDINATION (C_r)					
Structure	Branch	Sample Size	D_1	D_2	D_3	D_4		Total
O_D	D_1	42	-	30	27	4		61
	D_2	23	5	-	8	7		20
	D_3	71	8	57	-	22		87
	D_4	16	3	15	16	-		34
Total		152	16	102	51	33		202

MODEL-D ORGANIZATION ANALYSIS OF
SIMULATION STUDY - THIRD QUARTER, 1970

ORGANIZATION			REQUIRED COORDINATION (C_r)					
Structure	Branch	Sample Size	D_1	D_2	D_3	D_4		Total
O_D	D_1	32	-	22	28	2		52
	D_2	19	3	-	11	4		18
	D_3	55	9	42	-	12		63
	D_4	26	10	15	26	-		51
Total		132	22	79	65	18		184

MODEL-D ORGANIZATION ANALYSIS OF
SIMULATION STUDY - FOURTH QUARTER, 1970

ORGANIZATION			REQUIRED COORDINATION (C_r)					
Structure	Branch	Sample Size	D_1	D_2	D_3	D_4		Total
O_D	D_1	25	-	17	18	3		38
	D_2	19	3	-	5	6		14
	D_3	46	7	36	-	12		55
	D_4	25	6	21	23	-		50
Total		115	16	74	46	21		157

APPENDIX G

QUESTIONNAIRE

INSTRUCTIONS FOR FILLING OUT QUESTIONNAIRE

Accompanying this questionnaire you will find organization charts representing possible ways which the division in which you are employed could be organized. The chart labeled "Existing Organization-E" represents the way the division is presently organized. There are four additional charts labeled respectively "Model Organization-A," "Model Organization-B," "Model Organization-C," and "Model Organization-D," which represent possible alternative ways which the division could be organized.

Please evaluate the "Existing" and four "Model" organizations as depicted by the organization charts with regard to the function for which your unit is presently responsible. In rating each organization please circle the appropriate number on the "0 to 5" rating scale under each item rated and opposite the sub-item corresponding to the organization rated (see pages 2 and 3). "0" on the scale indicates a very low opinion and "5" indicates a very high opinion for the particular item being rated.

In addition please give the following indicated information concerning your job, background, and experience:

1. Title of your present position _____.
2. Describe very briefly the duties of your present position: _____

   _____.
3. Number of employees you supervise _____.
4. Total years of employment with Agency _____.
5. Total years of employment other than in Agency _____.
6. Briefly describe experience other than with Agency:

7. Age _____.
8. Years of employment in "Existing Organization" _____.
9. Years of experience in managerial capacity _____.

10. Please indicate in the matrix below your impressions with regard to the amount of coordination that is required between branches in performing their assigned functions. Write the appropriate number in each block in the matrix according to the following notation:

    0 - No coordination required for normal functioning of the two organizations.
    1 - Very little coordination required for normal functioning of the two organizations.
    2 - Average amount of coordination required for normal functioning of the two organizations.
    3 - Above average amount of coordination required for normal functioning of the two organizations.

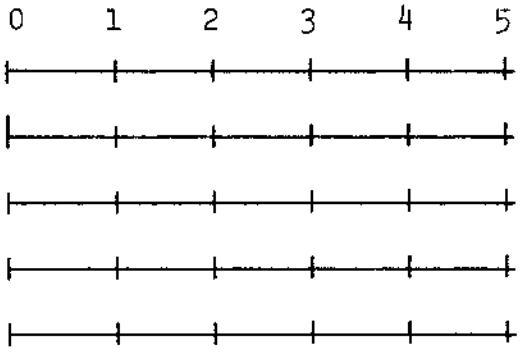
    x - No opinion.

	Logistics (E_1)	Optns.Br.(E_2)	Engnrng.(E_3)	Freq.Util.(E_4)
Optns.Br.(E_2)				
Engrng.Br.(E_3)				
Freq.Util.Br.(E_4)				
Sys.Plng.&Est.(E_5)				

QUESTIONNAIRE

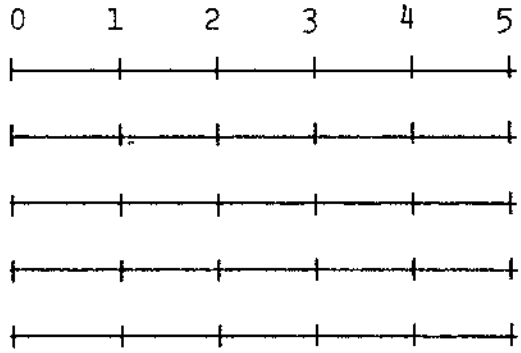
1. Planning your functional responsibilities.

   a. Existing Organization
   b. Model-A Organization
   c. Model-B Organization
   d. Model-C Organization
   e. Model-D Organization



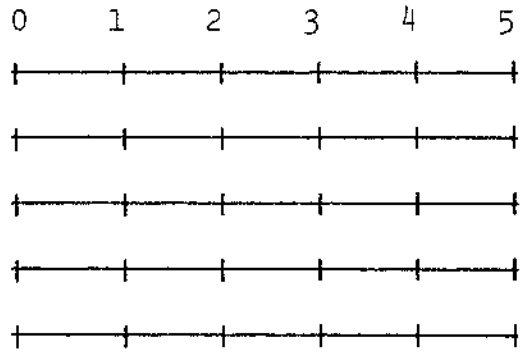
2. Organizing your functional responsibilities.

   a. Existing Organization
   b. Model-A Organization
   c. Model-B Organization
   d. Model-C Organization
   e. Model-D Organization



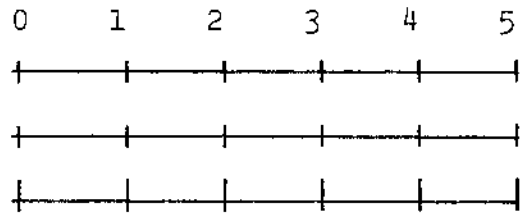
3. Directing your functional responsibilities.

   a. Existing Organization
   b. Model-A Organization
   c. Model-B Organization
   d. Model-C Organization
   e. Model-D Organization



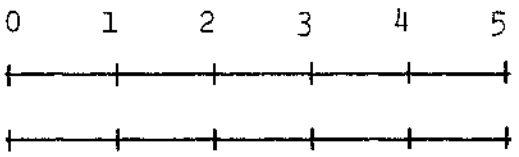
4. Controlling your functional responsibilities.

   a. Existing Organization
   b. Model-A Organization
   c. Model-B Organization



d. Model-C Organization

e. Model-D Organization



5. Coordinating your functional responsibilities.

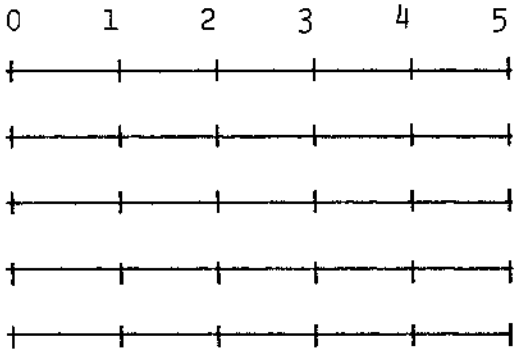
a. Existing Organization

b. Model-A Organization

c. Model-B Organization

d. Model-C Organization

e. Model-D Organization



6. Communications.

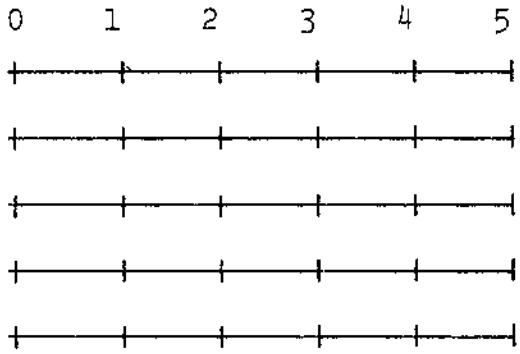
a. Existing Organization

b. Model-A Organization

c. Model-B Organization

d. Model-C Organization

e. Model-D Organization



7. Use of employees' talents.

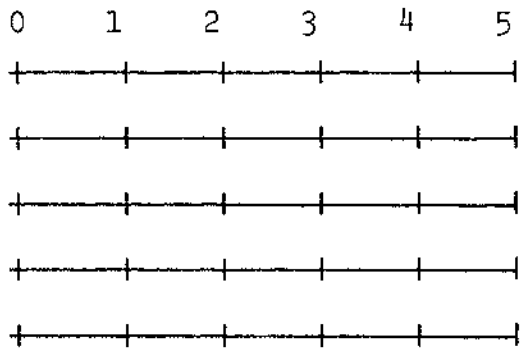
a. Existing Organization

b. Model-A Organization

c. Model-B Organization

d. Model-C Organization

e. Model-D Organization

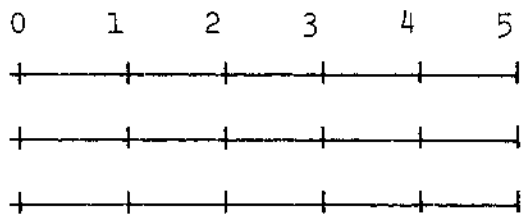


8. Decision-making.

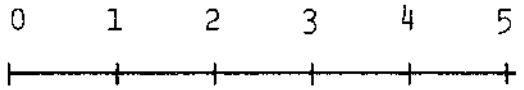
a. Existing Organization

b. Model-A Organization

c. Model-B Organization



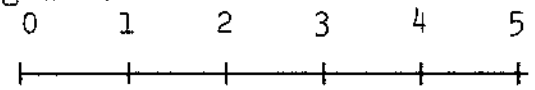
d. Model-C Organization



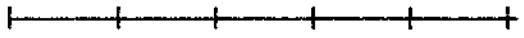
e. Model-D Organization

9. Achievement of organizational goals.

a. Existing Organization

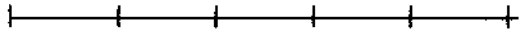


b. Model-A Organization



c. Model-B Organization

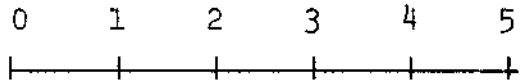
d. Model-C Organization



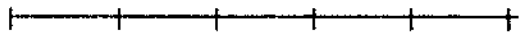
e. Model-D Organization

10. Overall opinion of each organization.

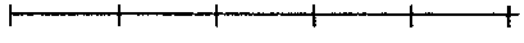
a. Existing Organization



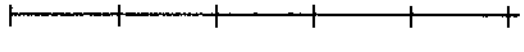
b. Model-A Organization



c. Model-B Organization



d. Model-C Organization



e. Model-D Organization

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