A MANAGEMENT INFORMATION SYSTEM MODEL

FOR PROGRAM MANAGEMENT

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Scope of Study: This dissertation summarizes the development of a model to simulate the information system of a program management type of organization. The environment of a program management office is complex and the information flow does not follow precise channels. The information flows horizontally as well as vertically. The proposed model statistically determines the following parameters: type of messages, destinations, delivery durations, type processing, processing durations, communication channels, outgoing messages, and priorities. For this research, the total management information system of the program management organization is considered, including formal and informal information flows and both facilities and equipment. The model is written in General Purpose System Simulation II computer programming language for use on the Univac 1108, Executive VIII computer. The model is simulated on a daily basis and collects queue and resource utilization statistics for each decision point. The statistics are then used by management to evaluate proposed resource allocations, to evaluate proposed changes to the system, and to identify portential problem areas. The model employs both empirical and theoretical distributions which are adjusted to simulate the information flow being studied. Changes to the system require only the redefinition of the functions.

Findings and Conclusions: The model used in this research was evaluated and proven to be useful as a system analysis tool for the manager. It will simulate the information flow of a program management office's management information system. The usefulness of the model is limited only by the ability of the manager to design an output to satisfy his particular needs. The combination of empirical and theoretical distributions to achieve these objectives is boundless. This research represents a modest extension of the use of simulation in the study of complex problems. The simulation model will be used as a tool for further investigation into management information systems of program management organizations. Specifically, the model will be used as a system analysis technique to assess the alternative designs of management information systems for new program management offices and to evaluate proposed changes in the management information systems of existing program management offices.

ADVISER'S APPROVAL ______________________________

A MANAGEMENT INFORMATION SYSTEM MODEL

FOR PROGRAM MANAGEMENT

Thesis Approved:

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Thesis Adviser

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Dean of the Graduate College

PREFACE

Contemporary managers of Research and Development Organizations are under considerable pressure to improve their management information systems to effectively perform their managerial tasks. Management Science has brought to focus many available techniques which can be useful in managing research and development projects. One of these techniques which is of special importance to the program management concept is the use of simulation to study complex problems. This dissertation is a study of a theoretical model of a management information system for a program management office. The model demonstrates that the information flow in a complex environment can be modelled and that the changes to the information flow can be studied prior to implementation.

My employer is George C. Marshall Space Flight Center of the National Aeronautics and Space Administration (NASA) and I am presently assigned to the Skylab Program Office. In considering a thesis topic, I selected a subject which would be of benefit to personnel engaged in program management operations, especially to the National Aeronautics and Space Administration and to the George C. Marshall Space Flight Center. One such area is a need for improved management information systems within the program offices of NASA and other Federal agencies. My advisory committee approved my proposal to study this area.

The study was begun in 1971 and completed in 1972. It is divided into two parts: a literature review and the development of a theoretical model. The dissertation consists of six chapters; for the reader who is unable to read the complete dissertation, the final chapter, Summary and Recommendations for Further Investigation, will provide a survey of the complete research.

Chapter I, Introduction, is intended to present to the reader the necessary background on management information systems to fully comprehend the nature of the problem. This chapter discusses the role of dynamic organization and systems concepts relative to information flow and describes the program management concept and its need for an efficient management information system.

Chapter II, Scope of Study, defines the purpose and scope of the study within the framework of the program management concept. It also establishes the procedure to be used in developing the management information system model.

Chapter III, Statement of the Problem, defines the problem in detail. This chapter also describes deficiencies of the current methods of studying information flow and basic factors which contributed to the development of the theoretical model.

Chapter IV, Management Information System Model, describes the characteristics of the model and presents the model used in the study. This chapter also establishes the theoretical information flow within the program management office, and specifies how simulation models can be used in analyzing the system.

Chapter V, Application of the Model, describes the results of applying the model to a government program office. The existing management information system is described in terms of the theoretical model and simulated on the computer. An analysis of the application results concludes the chapter.

Chapter VI, Summary and Recommendations for Further Investigation, summarizes the entire study and identifies areas for further investigation.

I wish to express my sincere appreciation to the members of the advisory committee: Dr. J.R. Norton, General Engineering Department; Dr. T.B. Auer, Dr. H.K. Eldin, and Dr. J.E. Shamblin, Department of Industrial Engineering and Management. The committee assisted me in the planning of a study program as well as in the selection of a research subject. I am particularly indebted to Dr. Eldin, Thesis Adviser, who provided guidance during the research phase. I am also indebted to my wife, Sandra, for keeping a place for me

at home while I was at Oklahoma State University, and to Cindi, Connie, and Anthony, who were without a father for a few months.

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CHAPTER I

INTRODUCTION

Advancing Technology

Prior to the Industrial Revolution of the early 1800's, the advances in technology were few and usually there was a long time lag between the discovery and application of new scientific knowledge. Circa 1850, the number of advances in technology began to increase noticeably and the time lag between discovery and application of scientific knowledge began to decrease significantly. Innovations which had previously required centuries to complete were now developed in years and months. There was also evidence of other changes in the research environment. For instance, the time and cost of performing research began to increase noticeably while the useful life of the product continued to decrease (1).

The "Industrial Revolution" or "First Industrial Revolution" is applied to the era of increased scientific activity beginning in the 1800's and continuing until World War II. The rate of innovations since then has been so rapid that this postwar period is often referred to as the "Second Industrial Revolution." The increased tempo of scientific advancements of these eras has been the result of many factors. In recent years, the rate of expenditures for research and development has probably been the main catalyst to scientific advancements.

The First and Second Revolutions have several features which distinguish the two eras. The most significant features of the First Industrial Revolution were the replacement of human energy with mechanical energy, mass production, assembly lines, and integrated production (1). In contrast, the Second Industrial Revolution is distinguished by the development of atomic power, space flight, and electronic computers (2). Atomic power began with the Manhattan Project in World War II and is now used as a primary source of energy for nuclear powered ships and for electric generating plants. Space flights began with the launching of Sputnik in 1957. A climax of the space era was the landing of a man on the moon and returning him to earth safely in 1969. Electronic computers were first introduced in 1944 by Howard Aiken of Harvard University. Since that date, the electronic computer has progressed through three generations and is now in the fourth generation.

In many respects, the introduction of the electronic computer was a revolution within itself and is frequently referred to as the "Computer Revolution." According to Haas (3), the computer revolution is in full progress and could possibly continue until 1985; the reason being that the real potential of the computer is just now being explored. During the computer's early years, emphasis was directed primarily to the mechanization of clerical work and data processing activities. Now, the emphasis is shifting to the use of the computer as a management tool. In this respect, the computer can be used to facilitate management science techniques as well as serve as an integral part of a management information system.

Dynamic Organization Concepts

In addition to the development of atomic power, space flight, and electronic computers, the Second Industrial Revolution was responsible for a fourth important, but not generally recognized, innovation – the dynamic organization concept. This innovation was an indirect contribution of the development of atomic power and space flight. Both of these scientific endeavors required a large government-industry-university community and vast amounts of resources. Management of these efforts by the traditional organizations concepts was not possible. The classical model could not be used because it was too inflexible. This model is best used where the work is highly routinized and standardized (1). The neoclassical model had to be rejected for the same reasons as the classical since it differed only in that the human relation factor was considered with a higher priority. The professional model was much too cumbersome for the work at hand since it was, essentially, a dual model with bureaucratic mechanisms for routine activities and a system of relaxed constraints for innovative activities. The decisionmaking model was also unsuitable because, by nature, it was for a business type organization.

The primary organization requirement for the atomic bomb and space flight scientific endeavors was flexibility. None of the traditional models discussed above could provide the necessary flexibility to rapidly adjust the direction of the research to accommodate each new decision. Because of the phenomenal rates of expenditure of resources, a delay in making a decision could be catastrophic to costs and schedules. An almost equally important dynamic organization requirement for the atomic bomb and space flight projects was the need for timely information. To achieve a dynamic information flow, the lines of communication were completely redesigned. The traditional lines of communication were extended horizontally as well as vertically in a matrix fashion.

The dynamic organization concepts are essentially an extension of the systems engineering concepts of the 1940's and 1950's and are known today as systems concepts. The organizational scheme which was developed to incorporate the dynamic organization or systems concepts was program (project) management. Program management is basically a synthesis of systems engineering concepts and the concepts of information flows (1).

Systems Concept

The systems concept is the modern view of organizational theory and addresses the dynamic organizational requirements of large complex systems. Basically, the systems concept is an organizational model in which a set of subsystems or interrelated parts interact with each other to achieve desired goals. Johnson, Kast, and Rosenzweig (1) state that the "systems concept is primarily a way of thinking about the job of managing." This may be an oversimplification of a complex concept since it is not an easy concept to discuss or learn. Essentially, the systems concept does for management what systems engineering does for the engineer. The former is related to the organization and the latter to the hardware. Many managers prefer to use the term systems engineering even when referring to the management operations.

In using the systems concept, an organization is viewed as a set of subsystems such as marketing, finance, engineering, etc. Each subsystem has subgoals such as advertising, developing new products, etc. These subgoals form natural conflicts in competing for resources of the organization. The realistic methodology for resolving these conflicts is to consider the organization goal or systems goal to which all the subsystems contribute. The systems goal will be the best combination of subgoals selected to optimize the interaction of the competing subsystems.

All the subsystems are elements of the same overall system and require some linking mechanism. In the systems concept, the linking mechanism is the information flow, the energy flow, and the material flow (1). Information flows downward to the subsystems, releasing energy, materials, and feedback information, then flows upward to complete the control cycle. The information flow of a program management type organization is the subject of this dissertation.

Information Flow

Information flow exists in all organization. The converse of this statement is that if there is no information flow, there is no organization. This observation is quite clear to military strategists, as the primary concern of much of their strategic planning is how to stop or minimize the flow of information to the enemy. This may be as simple as using camouflage, communications silence, blackouts, etc., or it may require overt tactics such as disrupting the enemy's lines of communications. The success of the strategic planning is measured by the enemy's inability to organize his forces.

The most vital resource of any organization is its information. Information is the cohesive force of the organization, and a measure of the organization's cohesiveness or integrity is the quality of its information. Insight as to the nature of the organization can be gained from a study of the information flow within the organization. A model to study information flow will be presented in a later chapter of this dissertation.

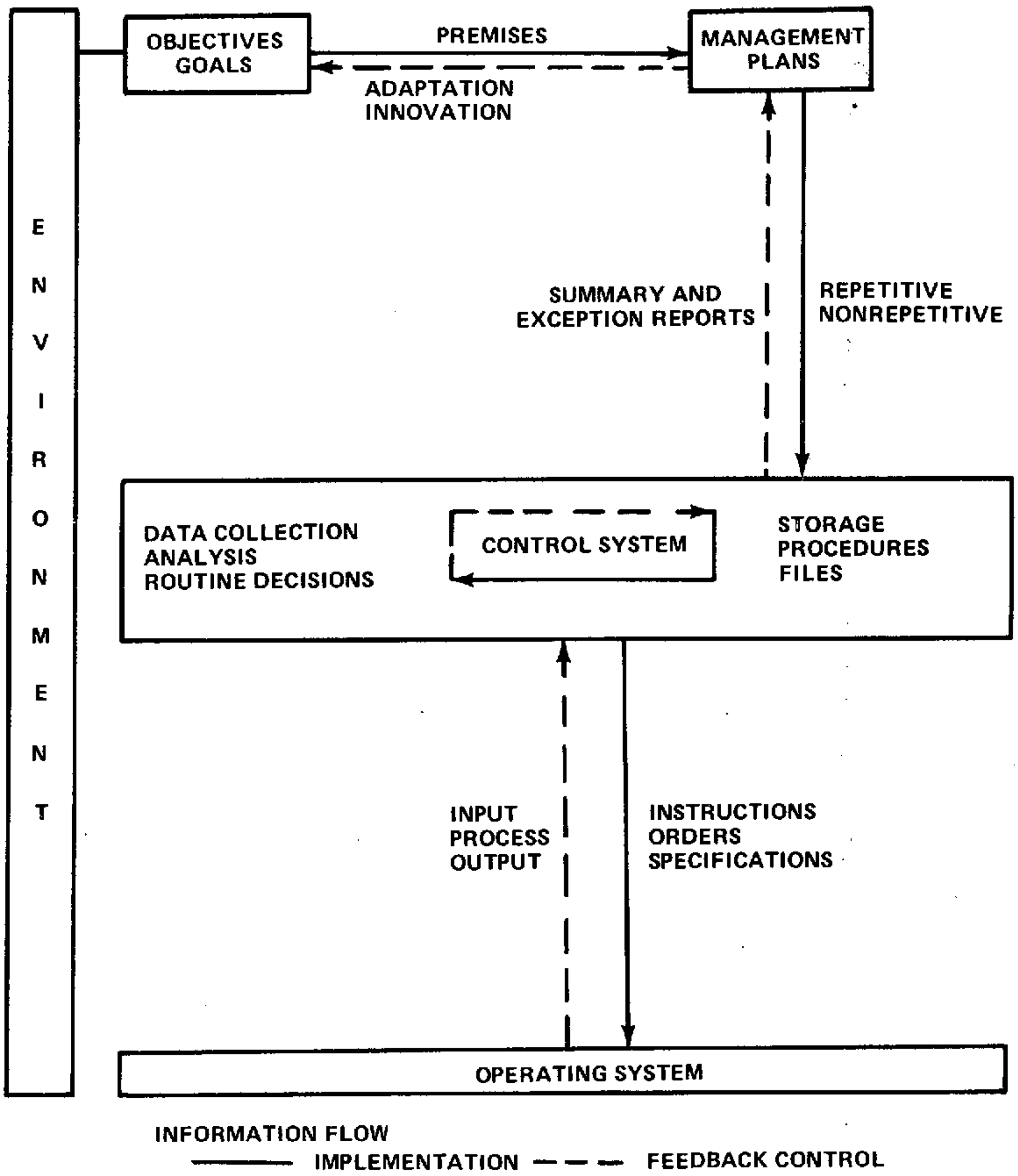
Information flow is actually an abstract attribute of the organization and can be analyzed only symbolically. This is normally accomplished through a mapping of the information flows of the organization. A model of a typical information-decision system is shown in Figure 1. The information flow as shown is the formal information flow. All organizations also have systems of informal or natural flows. In many organizations, especially program management types, the natural flows are as important, if not more so, than the formal information flow.

Organizational systems are designed to facilitate the flow of information among the members. A comprehensive study of the information flow requires mapping the information flows which is greatly facilitated by the use of a model. If the model can be manipulated, an assessment of the impact of proposed changes to the information flow is helpful in both the analysis of the existing systems and the design of new systems or changes to existing systems.

Program Management

As discussed previously, the need for dynamic organizational concepts came about as a result of advancing technology. The dynamic organizational concepts were embodied in the systems concept which includes the elements of information, energy, and material flows. The organizational model which incorporates all of these concepts is the program management model.

Program management was instituted as the requisite model for the management of large, complex hardware systems. Program management is a dynamic organizational model employing systems concepts to accommodate changing technical requirements in the research and development environment. Program management is a synthesis of system engineering and information systems. The program management model is predicated on a



Source No. 1

Figure 1. Information Flow in a Business Organization

less structured, but more dynamic, organization. The program manager is in a position of influence rather than authority. There are both vertical and horizontal relations cutting across the underlying functional organizations. These relationships are facilitated by the information flow which is the subject of this dissertation. Other distinguishing features of program management are product mission, participation of organizations outside of line control of the program manager, terminal date, and the assumption of major risks (4). The structure of program management organizations ranges from pure functional to pure program management and can be grouped into four major types. The figures of Appendix A show each of these types and a summary of the strengths and weaknesses of each type is given there (5).

An example of the matrix structure is NASA's Project Apollo. This highly sophisticated program began in 1960 when NASA was given the mission to land a man on the moon and to return him to earth safely. NASA was given the funding and manpower necessary to accomplish the mission but was not provided the most vital resource, the management expertise necessary to accomplish the mission. With the help of the systems engineers, NASA developed the matrix type program management model.

The success of NASA's program management concept is evident from the costs. Original estimates of cost were $20 billion over a 10 year time frame. The actual cost was approximately $25 billion, which is very near the original estimate when adjusted for inflation. Even more remarkable than cost, was the adherence to the time estimate. The 10 year program was finished exactly on schedule. This type of control of cost and schedule required the highest order of program management and an information system.

Management Information System

There is a range of definitions for management information systems to suit almost anyone's criteria. A sampling of these definitions are given below to give the reader a background for this section of the dissertation.

> A management information system is one that employs an electronic computer to provide information, when required to aid in managerial decision making (6).
>
> A management information system doesn't necessarily have anything to do with a computer. A management information system has to do with management and action information (7).
>
> A management information system is defined here to be the configuration of human and capital resources which results in the collection, storage, processing, retrieval, communication and use of data for management decisionmaking and control (8).
>
> A management information system is a management-oriented system characterized by information elements structured into a data base serving the information requirements of policy and operating management (9).
>
> A management information system is any system that has three attributes:
> —measures the impact of decisions
> —measures the environment
> —reacts in an appropriate time (10).

For the purposes of this research, a management information system was considered to be a complex system of people, equipment, and organizational relationships, operating within a set of constraints established by the nature of the organizational environment (11). In this context, the use of modelling techniques is necessary.

It is not necessary that a management information system employ an electronic computer. On the other hand, management information systems have, historically, been intrinsically linked to the state-of-the-art data processing equipment. The computer was originally developed as a result of the demand for a faster data processor. Once the computer was developed, innovations in computerized management information began and continues today. The third generation computer made it possible to develop large computer based management information systems and to provide for man-machine interaction. Kriebel (8) predicts that it will be another 15 years before a management information system will be developed that will exhaust the capability of the present generation of electronic computers.

The sophisticated management information system is essentially a dual system. One system is a computerized data processing system and the other is a computerized decisionmaking system. The latter system is related to management opportunities in operations and control and involves the use of simulation, linear programming and other management science techniques. The latter system is of interest to this research in that simulation is used to provide information to the manager relative to the operation of his information system.

CHAPTER II

SCOPE OF STUDY

Background

Resource allocation is one of the major planning tasks of the top management of any organization. For a program type organization, this task becomes one of determining the best mixture of resources among the various program offices. Determination of an optimal mixture is difficult from at least two different viewpoints. The first viewpoint considers the mature (nearly completed) program, and the other considers the young (newly created) program.

Figure 2 is a profile of the resource requirements of a program versus its life span. The phenomena to be noted are the gradual buildup of requirements during the early life of the program and the abrupt reduction of requirements near the end of its life. The buildup phase of the profile corresponds to the young program and the reduction phase to the mature program.

In contrast, a normative profile of the tendencies of programs is shown in Figure 3. Here, the profile indicates a tendency to build up rapidly during the early life of the program and to hold on to resources during its final phases. This latter tendency extends even beyond the life of the program as noted by the dashed portion of the profile.

Thus, top management is faced with the demands of the mature program for retention of resources on the one hand, and the demands of the young program for increased resources on the other. The current procedure for the allocation of resources in this competitive environment is to negotiate with the various program managers until all are

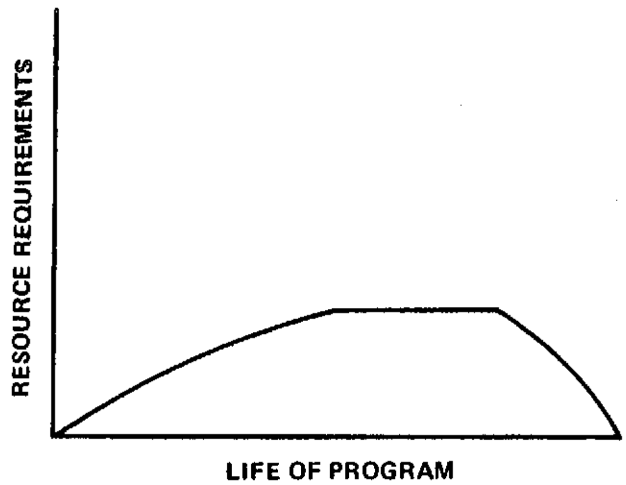


Figure 2. Resource Requirements of a Program Office

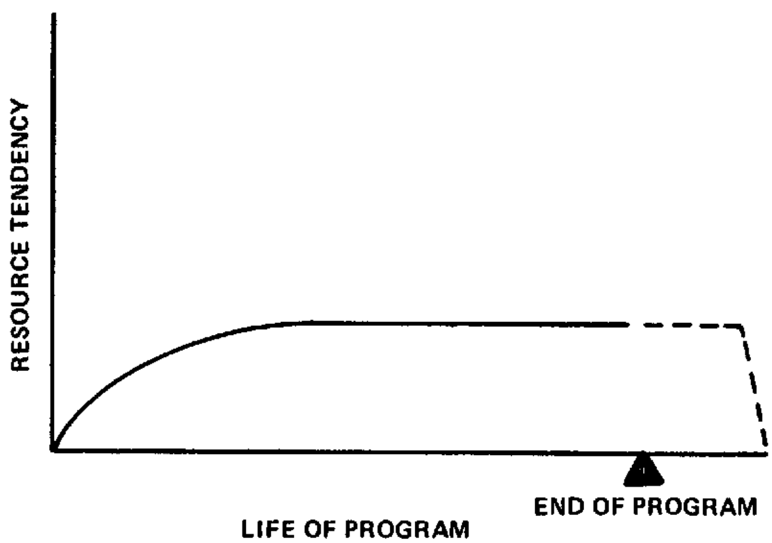


Figure 3. Profile of Tendencies for Resources

reasonably satisfied. Dissatisfaction with this procedure led the author to further investigation into the nature of program management.

The typical program manager at NASA operates in an environment similar to that shown in Figure 4. The program manager's need for a staff stems from his requirement to interface with the many elements shown, i.e., to gather and process data for decisionmaking. In this respect, the staff members are elements of his management information system. This concept is in complete agreement with the definition of Chapter I which stated that a management information system is a complex system of people, equipment, and organizational relationships, operating within a set of constraints established by the nature of the organizational environment.

Use of the above concept reduces resource allocation to a management information system design problem. At this point, the author narrowed the investigation to a study of the management information system of a program management type of organization.

Research in management information systems over the past 15 years has taken many different directions. The majority of the effort has been directed toward the automation of routine data processing activities. The remaining effort has been directed to information retrieval with only a minor portion of the effort being used to develop methods of using the computer to assist management in decisionmaking. This latter effort has been focused on using the computer to program lower-level, well-structured management control systems such as inventory control, production control, and resource allocation problems (8). Operations research prototype models now exist for all of these control systems.

In recent years, there has been a noticeable trend which indicates a growing interest in the use of the computer in the solution of ill-structured management problems. To date, two techniques which have shown promising results in the solution of these problems are heuristic and simulation solutions (8). The heuristic solution is essentially a trial and error process which uses human judgement at various nodes of the decision process. The

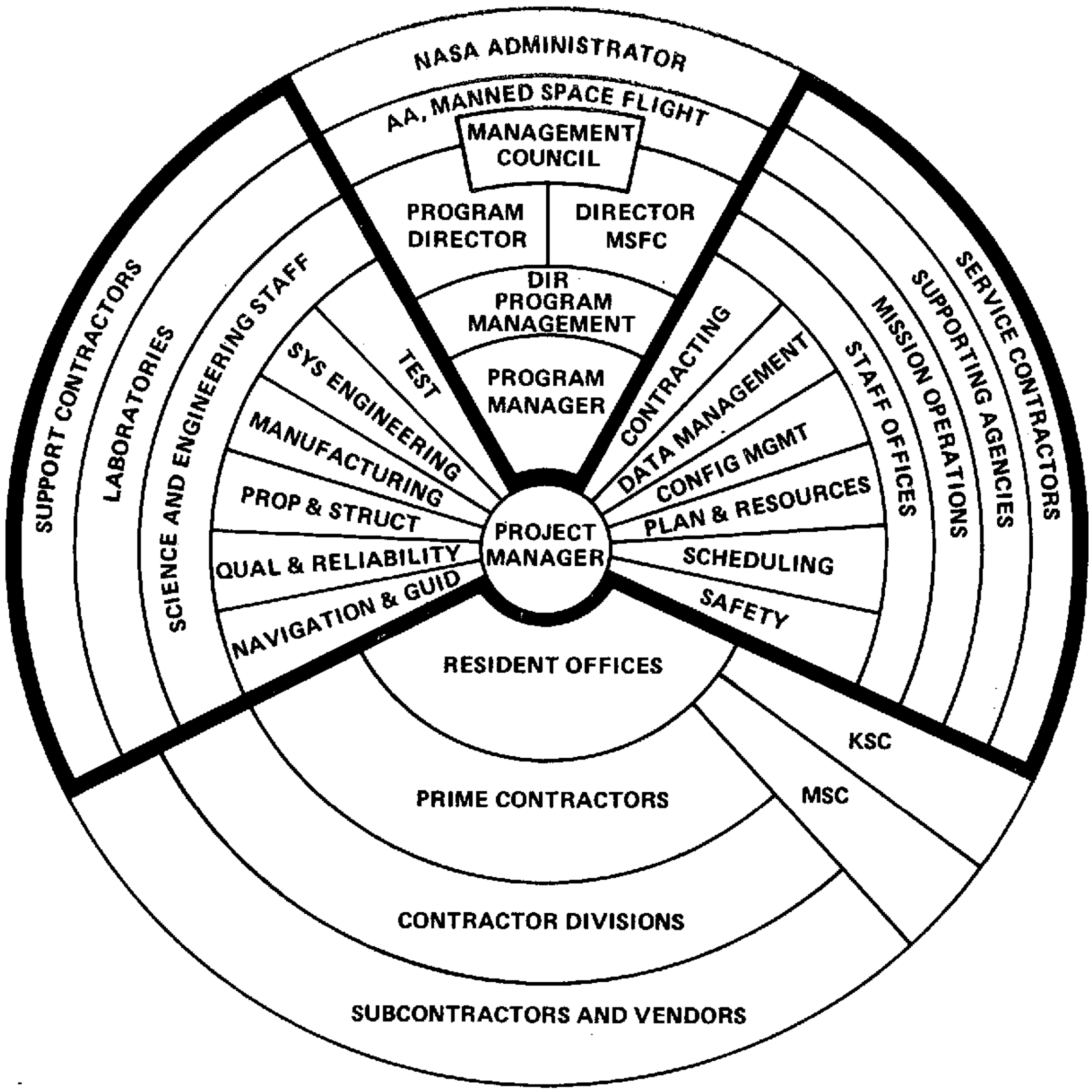


Figure 4. Program Relationships (NASA)

simulation solution is probably more versatile and can be used in the solution of complex problems in which the variables are largely unidentifiable and noncontrollable.

The management information system of a program management organization is much more complex than that of the traditional organization. The information flows horizontally as well as vertically. Also, the requirement for information fluctuates with each phase of the program. Much of the information flows through informal communication channels as well as the formal channels. To properly understand the information flow of a program office, the information flow must be visible. The proposal of this dissertation is to make the information flow symbolically visible through the use of a simulation model.

Purpose

The purpose of this dissertation is to construct a symbolic model of the information flow within a program management office, and to simulate the information flow when various alternative changes to the management information system are proposed. The goal is to provide management a tool for understanding and operating the management information system and to provide a means for evaluating resource allocation.

This investigation was undertaken by the author to contribute to the understanding of information flow in the less-structured environment of a program management office. It is the author's desire that the results of this research be used as the basis for further research into information flow leading to a prototype model for simulating information flows and for the allocation of resources within program management offices.

Scope

The field of management information systems has several areas for investigation which could bring useful results. The author selected the area of information flow within a program management organization because of intimate association with NASA program management for several years and because of an interest to study information flow by simulation.

The scope of this study is limited to a study of the formal and informal information flow in a program management organization. The model is to be as simplified as possible while being able to simulate the information flow of the system. The model will be validated using data from one of the NASA program management offices. Emphasis will be on the simulation of an existing flow and the effect upon the system when changes are introduced.

Procedure

The methodology utilized in this investigation was divided into four phases as shown in Figure 5. Phase I was directed to the initial aspects of research relative to defining the problem. First, an extensive literature survey of management information systems relative to information flows was conducted. Then the scope of the investigation was established and a statement of the problem was developed. At that time, factors relevant to the problem were identified.

Phase II was concerned with the model development, which involved two steps. First, a general model was developed (Appendix B). Then, a detailed model denoting the various decisions was developed. Finally, the detailed model was used to write the computer program.

Phase III was the data collection part of the research. Two forms, as shown in Appendix C, were sent to each member of the selected program office. These forms were then collected and followed up by personal interviews. The data were compiled and distributions were plotted. Standard distributions to be used in the simulation model were then selected. The model was then validated using empirical data.

Phase IV consisted of using the model to determine the impact of changes to the information system. Changes to the management information system were proposed and then simulated. The results were analyzed to determine the proper management course of action.

PHASE I. Statement of the Problem.

1. Search the Literature.
2. Define the Scope of the Problem.
3. Determine the Factors Relevant to the Problem.
4. Develop a Statement of the Problem.

PHASE II. Model Development.

1. Develop a General Model.
2. Determine the Nodes and Information Flows.
3. Develop a Detailed Model.
4. Write a Simulation Program.

PHASE III. Data Collection.

1. Send Forms to Organization Members.
2. Interview the Organization Members.
3. Determine the Distributions for the Simulation Model.
4. Evaluate the Model.

PHASE IV. Simulation Runs.

1. Propose Changes to the System.
2. Simulate the Information Flow After Making the Change.
3. Analyze the Results.
4. Make Recommendations.

Figure 5. Procedural Flow Chart for Model Development

CHAPTER III

STATEMENT OF THE PROBLEM

Basic Considerations

There is considerable pressure on the contemporary manager to improve his management information system. This pressure can come from within and without the organization. Internally, personnel changes, workload changes, or demands for more or better information may create pressure. Externally, the ability of competitive organizations to acquire vital information faster and more efficiently will force the manager to make changes in his management information system.

Whatever the source of the pressure, the real need of the manager is for a better understanding of his management information system. He should understand the information flow and what it is providing. The quality of information necessary to make decisions at a cost commensurate with the other economical variables is of primary importance. This knowledge can be gained only if the manager is willing and able to understand the information flow.

Current Procedures for Studying Information Flow

The usual method of studying a management information system is the use of models. The most primitive model is an organization chart. This model will give the analyst a distorted view of the organization unless it is supplemented with a description of the informal information flow. Thus, the analyst will usually attempt to map the formal and informal information flow of the organization being studied.

Two other models that are often used in the study of management information systems are the tabular chart, as shown in Figure 6, and the graphic flow chart, as shown in Figure 7 (11). The limitation of these models is that they are qualitative.

Another model which is widely used for studying the quantitative aspects of a management information system is the matrix concept (11). In this model, the information system is described in the form of a matrix and is manipulated by matrix mathematics. This model has both descriptive and quantitative advantages over the tabular and graphic flow chart models. The matrix model can be used to evaluate the system or the effects of changes to the system; however, the matrix mathematics can become cumbersome when used to analyze a complex system. Figure 8 shows how a tabular chart can be converted to a matrix form and Figures 9 and 10 show the same conversion process for a graphic flow chart.

Mapping of the formal and informal information flow using tabular or graphic flow charts, or a matrix, is satisfactory for many organizational studies. However, for large, complex organizations, additional insight to information flow is needed since the information flow is highly complex and dynamic. The study of the information flow in a complex organization is greatly enhanced if the information flow is made visible. The manager is able to understand the management information system best when he can see the information system in operation.

Since the information flow within an organization is an abstraction, it cannot be seen by the manager. The manager can see only the telephones, letters, people and all the other man-machine elements that make up a typical management information system. However, there is a way to make the information flow pseudovisible to the manager, and that is through the use of a symbolic model.

To use this method, the analyst gathers data relative to the external and internal information flows, to the makeup of the decisionmaking system, and to the types of data processing equipment used. The data are summarized in various tables and information flow

DATA FLOW CHART

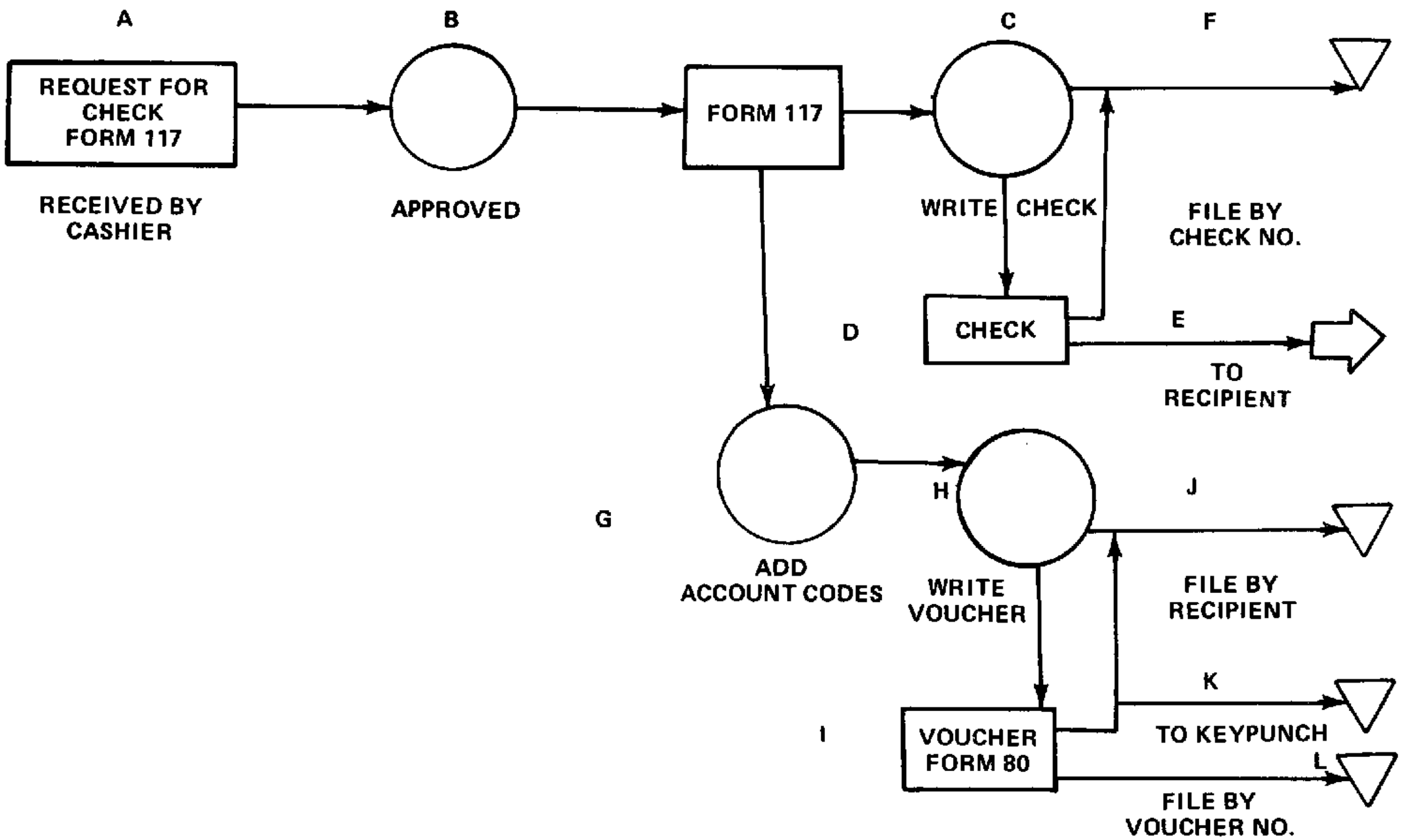
215-H-15

COMPANY HYPOTHETICS, INC.		PAGE 1 OF 1
SYSTEM MATERIAL RETURN		CHARTED BY E.D.H.
		DATE 3-27-68

DATA ELEMENT NO	DESCRIPTION	DOCUMENT: FORM 152	FORM 87c	FORM 6	FORM 43
1	VENDOR'S NAME	X	X		X
2	SHIP TO ADDRESS	X	X		
3	BILL TO ADDRESS		X		X
4	SHIPPING DATA	X	X		
5	QUANTITY	X	X	X	
6	DESCRIPTION	X	X	X	
7	UNIT PRICE		X		
8	TOTAL PRICE		X		
9	REASON FOR RETURN	X	X		

Source No. 11

Figure 6. Tabular Chart



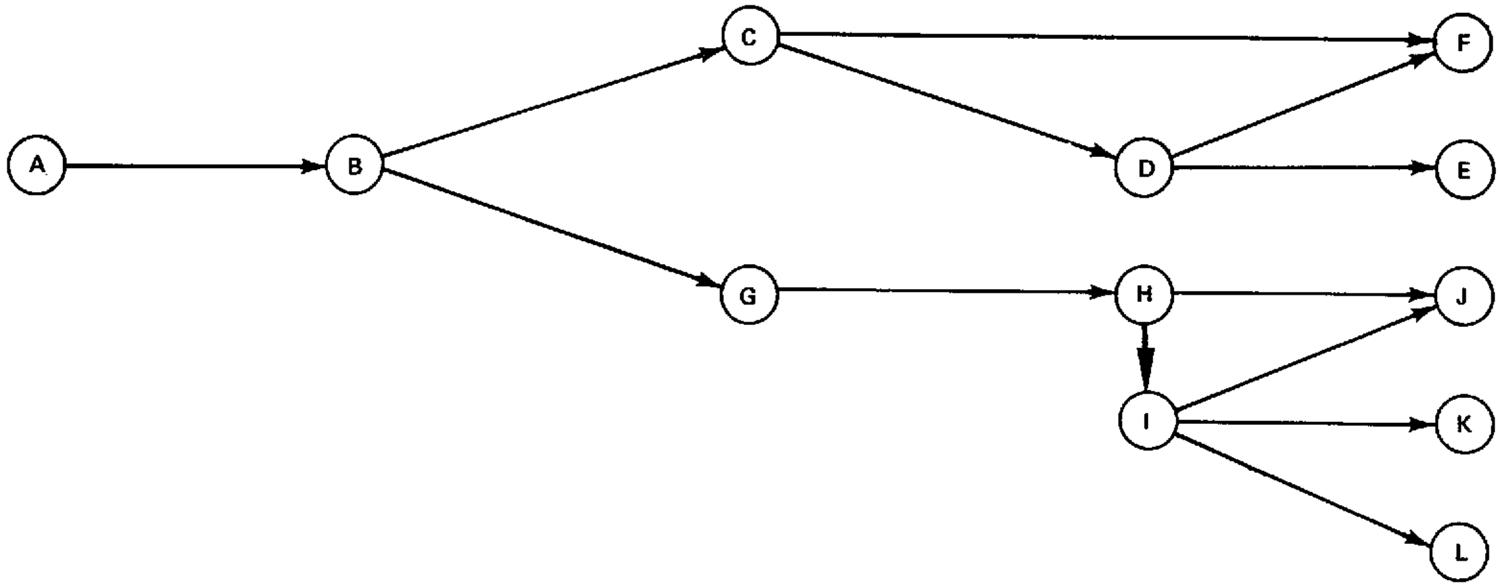
Source No. 11

Figure 7. Graphic Flow Chart

	152	87c	6	43
1	1	1	0	1
2	1	1	0	0
3	0	1	0	1
4	1	1	0	0
5	1	1	1	0
6	1	1	1	0
7	0	1	0	0
8	0	1	0	0
9	1	1	0	0

Source No. 11

Figure 8. Tabular Chart in Matrix Form



Source No. 11

Figure 9. Graphic Flow Chart Network

	A	B	C	D	E	F	G	H	I	J	K	L
A	0	1	0	0	0	0	0	0	0	0	0	0
B	0	0	1	0	0	0	1	0	0	0	0	0
C	0	0	0	1	0	1	0	0	0	0	0	0
D	0	0	0	0	1	1	0	0	0	0	0	0
E	0	0	0	0	0	0	0	0	0	0	0	0
F	0	0	0	0	0	0	0	0	0	0	0	0
G	0	0	0	0	0	0	0	1	0	0	0	0
H	0	0	0	0	0	0	0	0	1	1	0	0
I	0	0	0	0	0	0	0	0	0	1	1	1
J	0	0	0	0	0	0	0	0	0	0	0	0
K	0	0	0	0	0	0	0	0	0	0	0	0
L	0	0	0	0	0	0	0	0	0	0	0	0

Source No. 11

Figure 10. Graphic Flow Chart in Matrix Form

diagrams for development of a symbolic system model. The symbolic model may be described in analytical terms or in a computer simulation language.

Using the above methodology, changes to the management information system can be proposed and evaluated by manipulating the model either mathematically or by computer simulation. The selection of an alternative to be implemented using the results of the model study will depend to a large extent on the experience and judgement of the analyst.

Deficiencies of the Current Methods

The primary deficiency of the current methods of evaluating management information systems is the inability of the methods to assess the dynamic aspects of the information flow when changes to the system are made. Current methods use a static model and make an evaluation based on experience and judgement when the model is in a steady state condition. Cougar (12) reports that many designers are still using first generation system analysis techniques. The current methods indirectly assume that the dynamics of a change to the system is an irrelevant variable.

However, the dynamics of information flow is important in many highly complex, dynamic organizations. The transitional effects of making changes to the information flow of these organizations need to be determined prior to implementation (13). In a program management type organization, the mission may extend over several years, necessitating many changes to the management information system. The impact of these changes must be determined prior to implementation as the ongoing program must not be disrupted. Management Science now has several attractive methods for assessing the impact of changes. One of the more sophisticated techniques is the use of the computer to simulate the system being studied.

Statement of the Problem

The most basic problem of the study of information flow is that there is no theory of management information systems (8). One of the primary reasons for the continued existence of this problem is that management needs to be involved and has not chosen to do so. McKeever (14) states that in many instances, management has information problems of which they are not aware. Ackoff (15) asserts that the belief that management need not understand the information system is a myth. The literature is replete with admonitions for management to assume a more responsible role in the development and implementation of better information systems.

It is the thesis of this dissertation that if the manager can observe the existing management information system in operation, he will develop a better understanding of his organization. A study of the information flow of the organization should expose many potential problem areas. Simulation of the information flow will be invaluable to the manager in evaluating the impact of all proposed changes to the system.

The information flow in a program management type of organization is a complex process. One of the requirements of a program management organization is a highly flexible system. Changes to the system must not erode this flexibility and should be evaluated for dynamic impacts prior to implementation.

A tool of management science which is capable of the assessment of of the dynamics of information flow is simulation. This technique involves the development of a model of the real world and the simulation of the operation of the system by use of a computer. Simulation is especially useful in the study of transitional processes, in estimating values of model parameters and in treating causes of actions which cannot be formulated into the model (13).

The problem addressed in this dissertation is the consideration of the dynamics of information flow in a program management type organization. In particular, it is proposed that the technique of simulation be used to study the dynamics of information flow. Simulation of the information flow should expose the potential problem areas to which various solutions can be proposed and assessed. The use of simulation will maintain the flexibility of the system and provide insight on how to minimize disruption of the ongoing program.

Factors Affecting the Solution

A model is a representation of the real world and cannot incorporate all of the variables of the particular system being studied. Selection of the variables to be included in the model is a major factor affecting the solution. The ideal is to select only relevant variables while keeping the model simple. Ackoff (13) states that "an approximate model of a system that improves its performance is better than an exact model that does not."

Once the model is developed, it must be validated using historical data, if possible. The collection of data is another factor affecting the solution. The model will be no better than the data which is used to validate it.

The selection of the model also depends upon the type of problem that is to be solved. The three types of models which can be used are physical, schematic, and mathematical. In this dissertation, the latter model was chosen because of the need to model an abstraction and because of the ease with which a symbolic mathematical model can be simulated.

The solution of a problem by simulation does not necessarily provide an optimum solution. Variation in the solutions may be the result of the variables included in the model. Simulation solutions are to assist the manager in making a decision rather than to make the decision for him.

CHAPTER IV

MANAGEMENT INFORMATION SYSTEM MODEL

Simulation Models

The manager has traditionally relied upon intuition to solve complex management problems. In many instances, the use of conventional analytical methods was extremely difficult or even impossible because of the complexity of the problem or inability to define the problem. In other situations, the manager resorted to intuition because the problems were beyond the scope of his mathematical expertise.

The problems of management which fall into the complex category are usually concerned with the performance of a system. The manager's concern with the system is usually the allocation of resources in an optimum pattern such that the objectives are satisfied within the constraints of the system environment. The system is classified as complex when the change in one variable causes multiple changes throughout the system which are essentially indefinable. The interaction of these variables is the source of much anxiety for the manager. Simulation is proposed as the technique to expose the system's complexity to analysis and manipulation by the manager.

Simulation in its simplest form is expressed in scale models, mockup models, and mathematical models. These models have been in use for several decades; however, the use of computer simulation models as a method of analysis of system problems is relatively new to the vast majority of managers. Computer simulation was made possible by the development of the higher level computer languages. These languages have elevated simulation to the level of understanding of the manager. The simulation model can now be described to the desired detail of the real world such that the manager is able to grasp the system's significance upon the operations.

There are many advantages in the use of system simulation by the manager. The most important advantage is the insight to the system's operations. This insight is the key to the use of simulation to expose and solve many system problems. For instance, the manager can use the model to relate system variables, to predict the system's performance, to augment the selection of alternatives, or to evalute the impact of proposed changes to the system prior to implementation. Additionally, there are side benefits to be gained from the use of simulation to study a system. The first of these is a better understanding of the management tasks of planning, controlling, and operations. The second benefit is the usefulness of simulation to explain complex operations to others, and, finally, the manager usually finds that simulation is a learning device for the organization.

In summary, the primary value of system simulation for the manager is the increased capability to study complex problems where the interaction of specific events is not of particular importance but the system of interactions and trends is of interest. In using simulation to study system problems, the manager should be aware of the following observations (16):

1. Response is best if the manager or his analyst uses the computer rather than a programmer.

2. The cost of the simulation will depend upon the amount of detail used in the model.

3. The model can be made to duplicate the real world, if necessary.

4. The acquisition of data is difficult and should be minimized.

5. Computer time is cheap compared to the alternative of real world experimentation.

Management Information System Model

The management information system model used for this research was developed for a specific application to a program management type organization. The specific function selected for analysis was the information flow of the organization. Objectives of the research were to study information flow to evaluate resource allocation, to determine the potential problem areas, and to evaluate the effects of changes in the system prior to implementation.

The messages flowing within a program management organization are too complex to classify by the traditional business types, i.e., billing, invoice, etc. Thus, the messages were classified into four groups according to their nature: formal oral, informal oral, formal written, and informal written (17). Use of this scheme simplified the data collection scheme as well as the model.

In developing the model, an information decision scheme was used. Each message (meeting, telephone call, report, or memorandum) was represented as a transaction. Each decisionmaker was represented as a facility. The input messages at each facility caused the generation of all outgoing messages at that facility. Each message was given a time delay to represent the processing time. In addition, each message was given a delivery time, the time required to receive a message such as the length of a telephone call. The input messages are the incoming messages to the program office and the output messages are the outgoing messages.

Data required for the analysis was gathered through the use of the questionnaire shown in Appendix C, by research of office records, and by personal observation. For the simulation, only the statistical implications of the data were used.

The model was written in General Purpose System Simulation (GPSS) computer programming language for use on the Univac 1108, Executive VIII. The block diagram from which the program was written is included in Appendix D.

The model was kept simple to enhance its use by top management. For expediency, both empirical and theoretical distributions were used. The simulation was performed statistically using four generate blocks to create the four types of messages. The messages activated the system and kept it running as they flowed between the facilities. A timer allowed the model to run for the specified time. As each message was generated, it selected a destination from a distribution; assigned itself a priority and message type, a delivery time, a processing type, and a processing time; and determined the number of outgoing messages to create from a distribution.

After the simulation started, the message proceeded to the destination assigned and attempted to seize that facility. If the facility was already being used by another message, the incoming message entered a queue to await its turn based on a priority assigned. Each message was required to seize the destination facility twice, the first time for delivery of the message which had top priority and the second time for processing of the message. After completion of the processing, the incoming message was terminated and the outgoing messages were created and assigned destinations and processing times.

The model was used for simulating the behavior of an information-decision system at NASA. The research was directed toward developing a tool for further research into the nature of program management information systems. Specifically, the model will be used as a system analysis technique to assess alternative designs and to evaluate resource allocations of management information systems for new program offices within the NASA Program Directorate.

CHAPTER V

APPLICATION OF THE MODEL

Description of the Physical System

The simulation program used in this research simulates the physical system in Figure 11. The system represents the management information system of a typical program management office. It consists of decisionmakers and secretaries (information processors), and communication equipment (information transmitters and receivers). The basic problem to study is the system characteristics of the management information system as a function of the number of system elements. The system characteristics to be observed are the utilization of the processing and communication facilities, the delays, and the potential problems of the system which cannot be identified otherwise.

Messages flow into the system from external sources as shown in Figure 11. The arrival of messages is assumed to be a Poisson distribution based on sample data and recommendations of the literature (13). The mean arrival time was determined by a study of sample data and the management questionnaire. The system is simulated on a daily basis to correspond to the real world system; messages left over from the previous day remain in the system for subsequent processing.

The arriving message is first assigned a number to correspond to its message type; e.g., meetings are labeled number one, telephone calls number two, reports number three, and memorandums number four. The message is then assigned to a specific facility (decisionmaker) for processing. This assignment is selected from an empirical distribution. The message is then assigned a delivery duration, a type of processing, and a processing

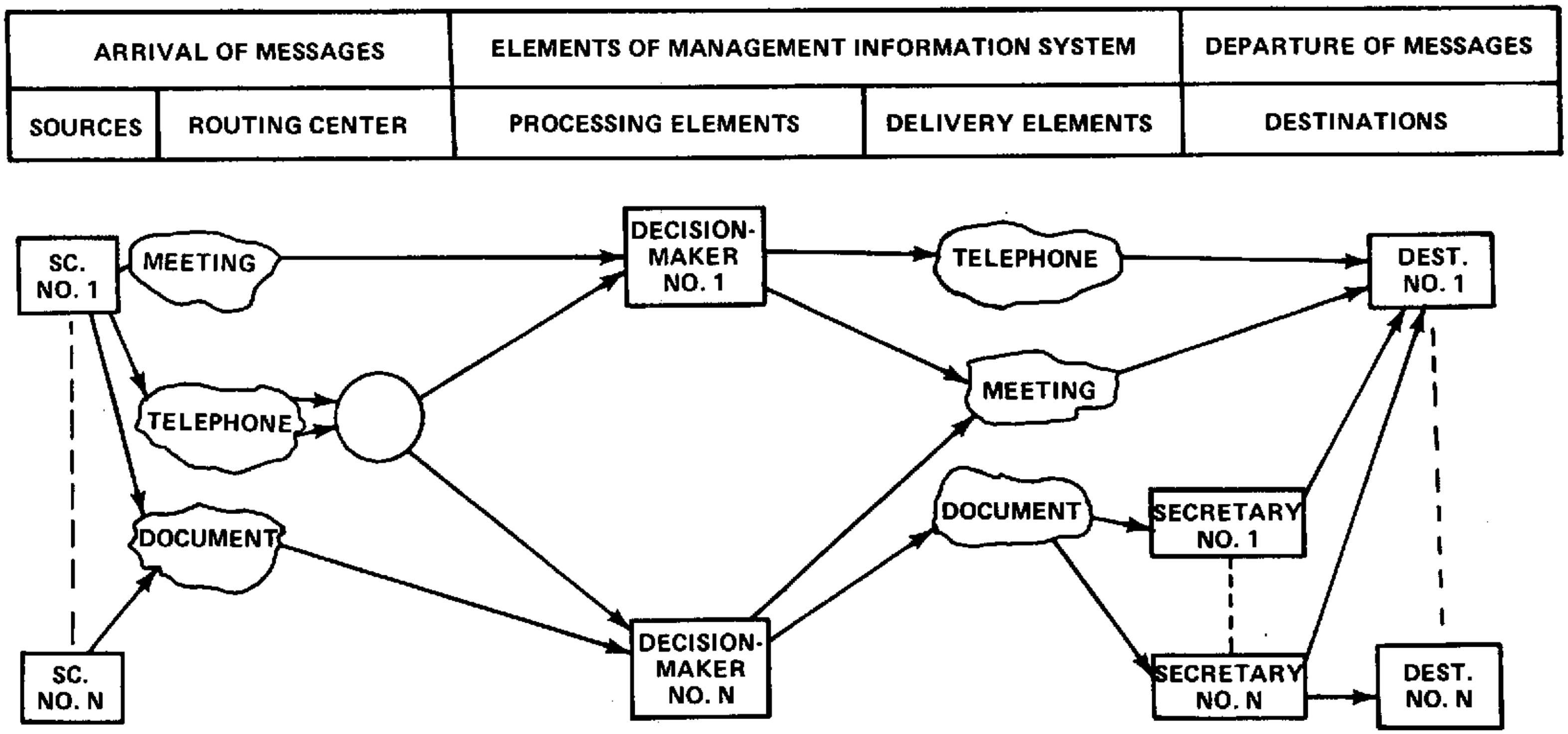


Figure 11: Management Information System of a Program Office

duration. The durations are assigned from theoretical distributions, and the type of processing is assigned from an empirical distribution. Finally, the arriving message is assigned the number of outgoing messages to create using an empirical distribution.

The arriving message attempts to preempt the assigned facility (decisionmaker) based on its priority. It cannot preempt if it has a lower priority than the message currently at the facility or if the message currently at the facility has already preempted. If the message cannot preempt, it will enter a queue based on its priority and will be in contention for the facility when it becomes available. Incoming telephone calls must also locate the assigned channel and determine if it is available. If both the channel and the facility are available, the message is delivered; otherwise, it enters a queue on one or both of the system elements.

After the message is delivered, the facility is released and the message immediately enters a queue on the same facility for processing. All messages being delivered have precedence over messages being processed. The messages being processed are taken from the queue on a first-in, first-out basis. Two types of processing are used in the model, read and file or read and take action. The processing duration depends on the type of processing assigned.

The creation of outgoing messages is initiated by the arriving message. Outgoing messages are assigned a type number, a destination number, a secretary, a processing duration, and a delivery duration. The type number, destination, and the secretary are assigned from an empirical distribution; the delivery and processing duration are assigned from a theoretical distribution. These messages then proceed to the facility assigned and contend for its services in the same manner as the arriving messages. They have priority for delivery; otherwise, they are handled on a first-in, first-out basis.

To increase the realism of the system, a special feature was added to the program to account for the unavailability of personnel because of absence. This subprogram will select personnel at random and remove then from the management information system for a random period of time. The period of time which simulates a person's absence is assigned a higher priority to assure that the facility is unavailable during the simulation.

A government program office was selected for data sampling. The sampling was accomplished by three methods. First, the management questionnaire of Appendix C was distributed to each member of the organization. Of the forms sent, 72 percent of the Phase I forms and 24 percent of the Phase II forms were returned. The data were largely inadequate because the respondents were biased in their estimates of the number of messages received and the time required to process messages.

Next, data samples were taken from the historical files. These provided the best samples but were largely inadequate in that very few records existed. To supplement the first two methods, observations were made. This also proved to be difficult since the employees being observed viewed the procedure with suspicion and biased their work accordingly.

The selection of distributions to use in the simulation was a synthesis of the data samples collected from the three sources. The judgement of the collector and the recommendations of the literature strongly influenced the final choices. Where possible, the fitting of distributions was accomplished by the NASA method described in NASA Technical Memorandum TM X-64588 (18).

Programming Language and Computer Requirements

The simulation program was written from the generalized block diagram shown in Appendix D. The language used was GPSS II for use on the Univac 1108, Executive VIII. The program consists of approximately 100 blocks, 30 functions, and 5 variables. The approximate time to run the program is 5 minutes.

Model Inputs and Outputs

The model was developed for a program management type organization; therefore, much of the logic was built in, eliminating the need for a large number of inputs. The distributions and remaining logic was input by the use of functions and variables. Changes to the system may be made by the use of new functions.

The outputs of primary interest to the manager are the utilization of the facilities (decisionmakers), and the queue statistics. Other outputs which the manager may desire are the distribution of the amount of time that the facilities are in use daily. Only the first two outputs were included within the scope of this research; the use of the standard GPSS output for analysis is discussed later.

Model Execution

The model was set up to simulate an 8 hour day. Multiple days can be simulated by varying the START card. The study of the system characteristics, with fewer or more facilities, requires only the changing of the functions; these changes can be made by the use of the CLEAR START option in GPSS II.

The simulation program was written for simulating the management information system of a government program management office consisting of 25 decisionmakers, 3 secretaries, and 11 communication channels.

Analysis

The data used in the analysis of the management information system studied are presented in Figures 12 through 15. Figures 12 and 13 are typical graphs of the current utilization of the facilities and the predicted utilization after changes to the system are made. Figures 14 and 15 show typical maximum queues of the current system and the predicted queues after changes to the system are made.

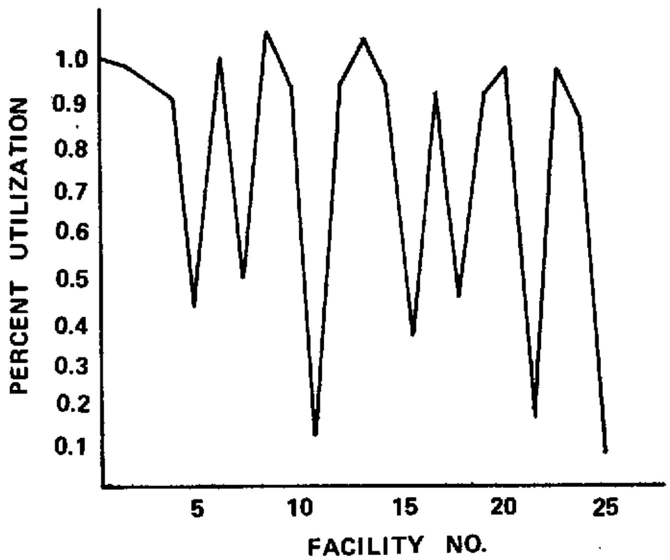


Figure 12: Facility Utilization (Current)

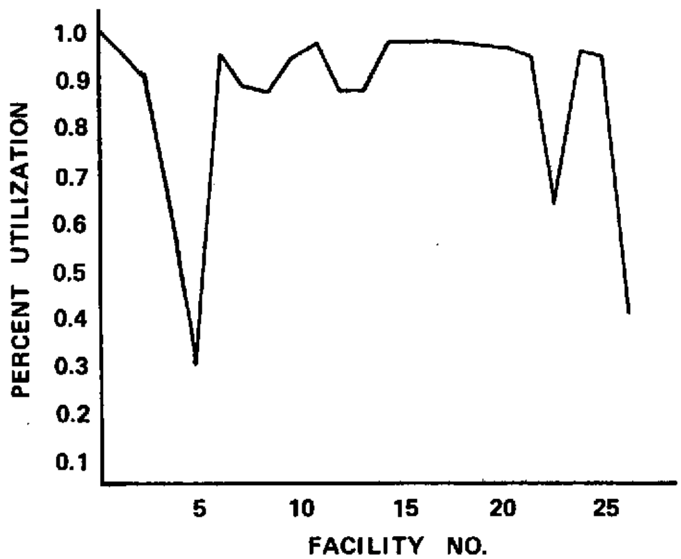


Figure 13: Facility Utilization (Predicted)

The simulation was run for a period of 30 days to introduce equilibrium into the system. The same sequence of events for different alternatives was reproduced by the use of the same sequence of random numbers to compare the alternatives.

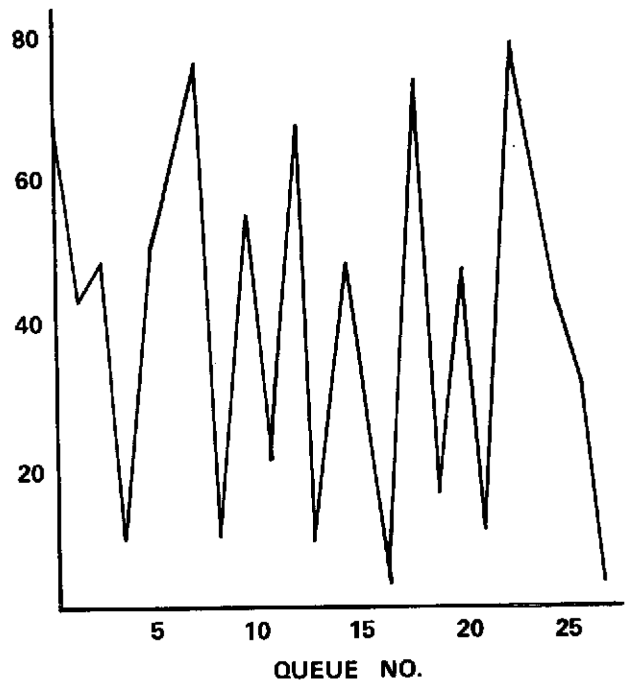


Figure 14: Maximum Queues (Current)

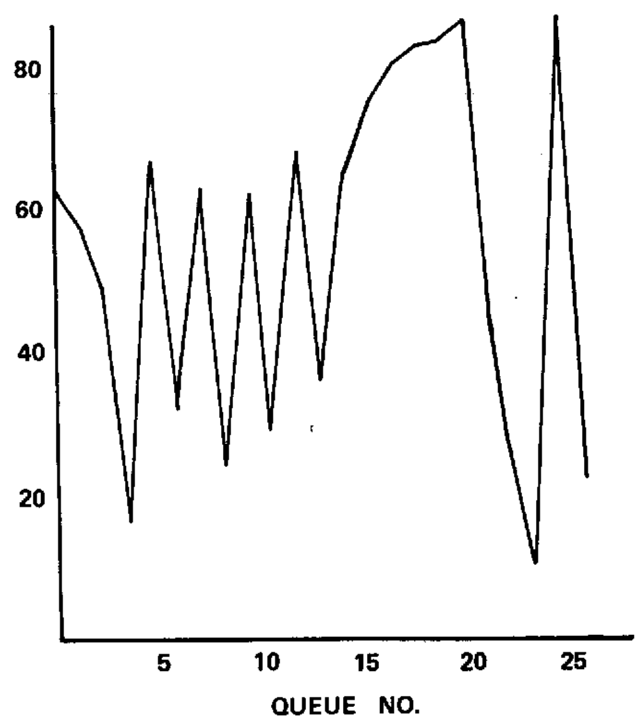


Figure 15: Maximum Queues (Predicted)

The initial run was made to determine if the output adequately represented the system being studied. Minor adjustments were then made to correct the model output. The model was then run through several simulations to study various changes to the system. A comparison of the alternatives was made by analysis of the standard GPSS output.

For the system actually modelled, the evaluation of alternatives by simulation appeared to be reasonable, the limitation being the accuracy of the data and the degree to which the model represents the real world system. The judgements of the system analyst and the decisionmaker are the final criteria as to the usefulness of the model and to what use will be made of the results of the simulation (19). In this research, the manager desired to reassign personnel from one program office to another. The simulation shows the effect of the removal of personnel from the management information system. The results of the simulation are to assist the manager in making a decision; not to make a decision for him.

CHAPTER VI

SUMMARY AND RECOMMENDATIONS FOR FURTHER INVESTIGATION

Summary

The nature of many organizations is often considered to be so complex that it defies analysis by the modern researcher. Management scientists have found that in many instances, the complexity of the environment can be reduced through the use of models and simulation. This research centered around one such organization and utilized a computer simulation model.

A program management organization is included in the context of large complex organizations by the literature (1). It differs from the traditional organization in several respects. The most important difference is the dynamic environment in which it operates and the need for maximum flexibility. The flexibility must be maintained throughout the life of the program, especially near its terminal date when there is a tendency to revert to a traditional form of stable organization.

Research into the nature of program management organizations presents a challenge to the management scientist. Within the network of complexity of the program management organization, there are trends and patterns which can be identified and used to reduce the complexity by models and statistical analysis. The opportunities for investigation into program management operations is limited only by the researcher's interest.

One area of program management which has been virtually unexplored is the analysis of information flow. This area has been avoided because of the complexity of the information flow. This research was undertaken to determine if the information flow could be reduced to meaningful form. The procedure used involved the use of a computer simulation model and is considered to be a relatively new approach in that the management information system of a complex organization is simulated. Previous work has been mostly centered around the study of selected areas of well-defined management information systems (19) (20).

The proposed concept was developed for a program management type organization but could be applied to other type organizations by changing the model. The technique uses a model to simulate the information flow within an organization to evaluate resource allocations, to identify potential problem areas, and to simulate the system when changes to the system are proposed. The evaluation of the simulation results by the manager provides insight as to the preferred alternative, or to the operation of the system when a proposed change is implemented.

The research for the dissertation was accomplished in four phases. The first phase was to search the literature and to define the problem. The second phase was concerned with the development of a model and the writing of a program for simulating the system on a computer. The third phase was to collect data and determine the distributions for the model. The last phase was to experiment with the model and to analyze the results.

Current procedures for studying information flow range from the use of organization charts to define the flow to highly developed matrices to manipulate the flow. The simpler charts are qualitative and are limited in their usefulness. The matrix model can be manipulated, but this requires the use of complex mathematics. The proposed model offers the advantages of the current models and, additionally, provides a method for simulating the dynamics of the information flow of a program management office. The model can be detailed to the exact real world environment, if desired. Practically, the model is developed in gross form and is refined as the experimentation progresses. Justification for detailed modelling seldom exists because of the money and time involved.

Simulation of the management information system has several advantages for the manager. The most important advantage is that he can observe the system in operation and determine the potential problem areas. Other advantages are: The complexity of the environment is reduced to understandable form, the performance of the system can be observed, alternative designs can be studied, and changes to the system can be evaluated prior to implementation. The simulation model provides visibility to the manager for planning system operations and for learning the system.

Each message was represented as a transaction and each decisionmaker as a facility. The messages flowed among the decisionmakers and competed for resources. Outgoing messages were initiated by the incoming messages. Each message had a time delay to account for delivery duration and for processing duration. The model operates statistically for selection of message type, destination, delivery duration, type processing, processing duration, and creation of outgoing messages.

Data for the research were gathered by the use of a management questionnaire, by a review of office records, and by personal observation. The data were used for validating the model and for experimentation.

After the simulation has begun, the incoming messages seek their assigned destination and attempt to preempt the facility based on their priority. After preempting, the message is delivered and then placed in a queue on the same facility for processing. When processing is completed, the incoming message creates outgoing messages and is then terminated. Outgoing messages are sent through a processing cycle similar to that of the incoming messages.

Both theoretical and empirical distributions are used in the model. The theoretical distributions are used for generating messages and for delivery and processing durations. Empirical distributions are used for assigning destinations and message types. Selection of the distributions to be used was based on the literature, on data samples, and on experimentation. The judgement of the system analyst strongly influenced the final choices.

The simulation model was written in GPSS II for use on the Univac 1108, Executive VIII. The language is simple and can be used by the relatively inexperienced manager.

Experimentation consisted of simulating the information flow in a government program office consisting of 25 decisionmakers, 3 secretaries, and 11 communication channels. The existing information flow was simulated to determine any potential problem areas. A change was then made to the system based on resource allocations and the information flow simulated to study the effects of the change. The experimentation was concluded with an analysis of the results.

The general conclusion of the research is that the information flow of a program management organization can be modelled and simulated so that specific conclusions can be drawn. Additionally, the results of this research are applicable to other complex organizations. Finally, the results of this research should be helpful in the development of a prototype model for program management offices.

Recommendations for Further Investigation

One of the purposes of this study was to identify areas for additional research. The use of simulation to study complex systems is a fertile area of research. The study of the management information systems of program type organizations has been very limited to date and is also a fertile area. Specific areas for additional research are outlined below.

The first recommendation concerns the data requirements for the simulation. Data are difficult to collect and to analyze. The investigation should center around the collection of original data to be used in the simulation. For instance, one method would be to attach a log to each incoming document so that the user could record all the desired information. The processing durations, number of out-going messages, destinations, and other information would be recorded. These logs could be supplemented by a log of meetings and the necessary information required for the simulation. Telephone calls would require some method of personal observations.

The second recommendation concerns the detail of the model. The present generation of computers has the capability of simulating an exact model of the real world. But, such a model is seldom justified and the knowledge gained by the model is hardly worth the effort. The investigation should be directed toward determining the detail of the model as opposed to its application.

The third recommendation concerns the nature of the distributions used in the model. One problem to investigate is the choice of an empirical or theoretical distribution for the model. Another problem to investigate is which theoretical distribution to use if one is to be selected. The literature has recommendations about the distributions in general, but a more specific recommendation is needed.

The fourth recommendation would be to investigate the possibility of a generalized model. Such a model would be applicable to any complex organization and have the capability to redefine itself during simulation. This research could lead to a prototype model.

The fifth recommendation would be to investigate the possibility of studying only segments of the management information system. For instance, the manager may be interested only in telephone calls. The model used in this research could possibly be used by modifying it. For instance, all the generators, except the telephone calls, could be removed from the system and replaced with a facility that simulates all these activities.

There are several less specific recommendations for further research. Among these are the following:

1. Determine methods to remove redundant information from the system.

2. Study the effects of computerizing the management information system of a program management organization.

3. Determine the contribution which each type of message (meeting, telephone call, report, or memoranda) makes to the total information flow.

4. Evaluate the information flow as a function of the life span of the program.

5. Evaluate the information-decision system as a function of the information flow.

Conclusion

The model used in this research has been evaluated and proven to be useful as a system analysis tool for the manager. It will simulate the information flow of a program management office's management information system as professed in the introduction. The usefulness of the model is limited only by the ability of the manager to design an output to satisfy his particular needs. The combination of empirical and theoretical distributions to achieve his objectives is boundless.

The research described herein represents a modest extension of the use of simulation in the study of information flow of complex organizations. The proposed model included the statistical selection of message type, destinations, delivery duration, processing type, processing time, communication channels, and the number of outgoing messages to create. The results of this study should be used to extend this study even farther. The management scientist researcher should not be content until the capabilities of both the third and fourth generation computers have been used. The final objective of this dissertation has been directed to the promotion of such an interest.

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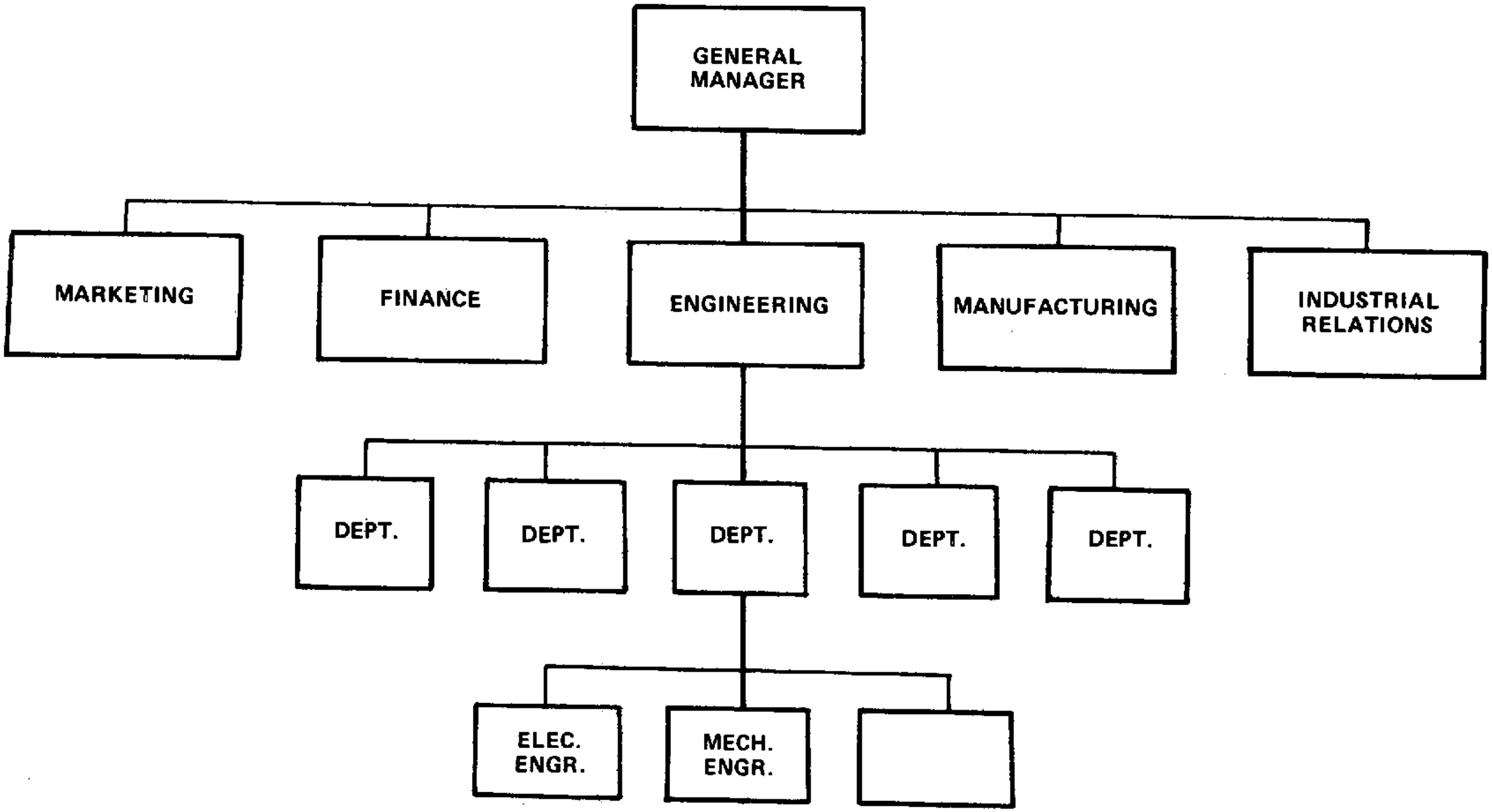
APPENDIX A

PROGRAM MANAGEMENT STRUCTURE TYPES



Source No. 5

Figure 16. The Functional Structure

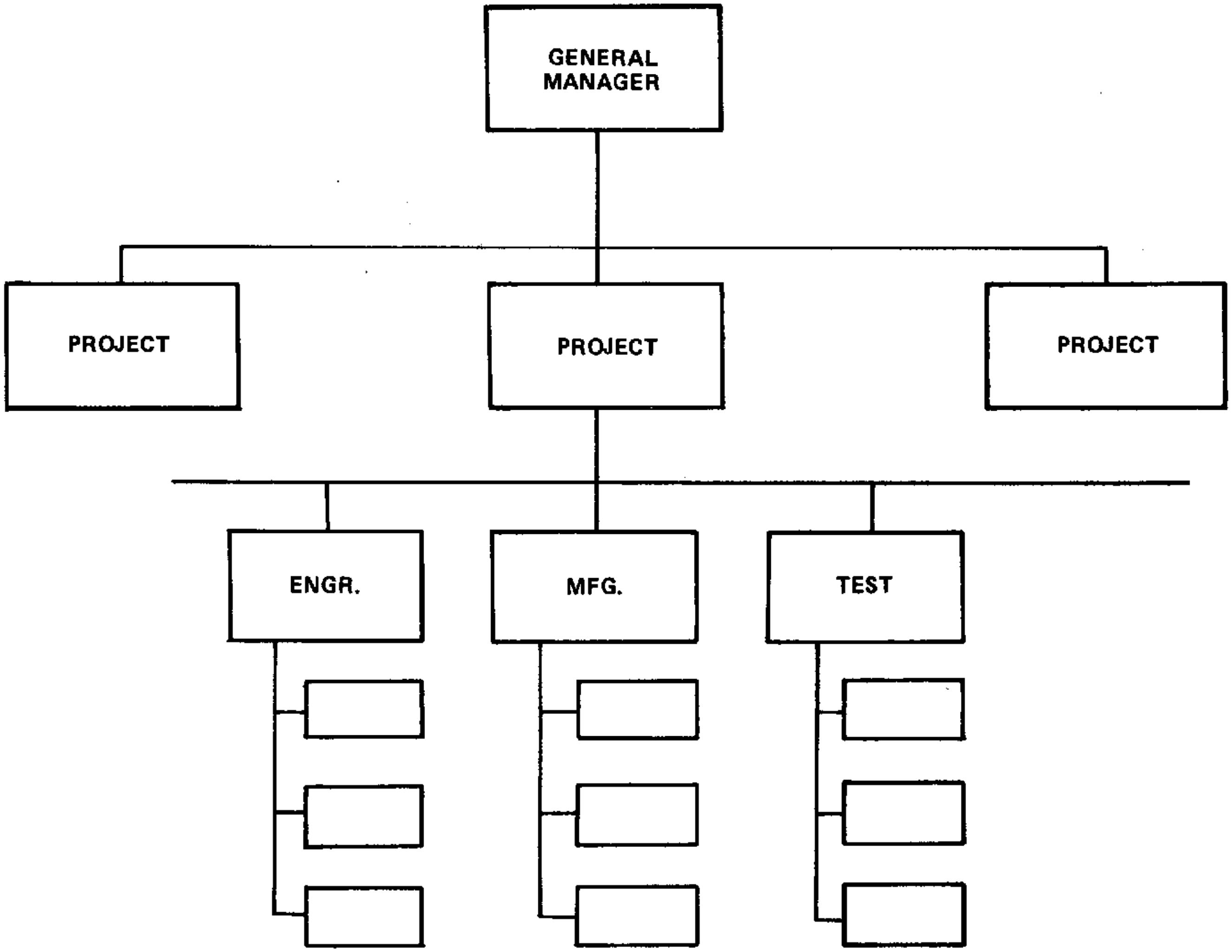


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Figure 17: The Pure Project Structure

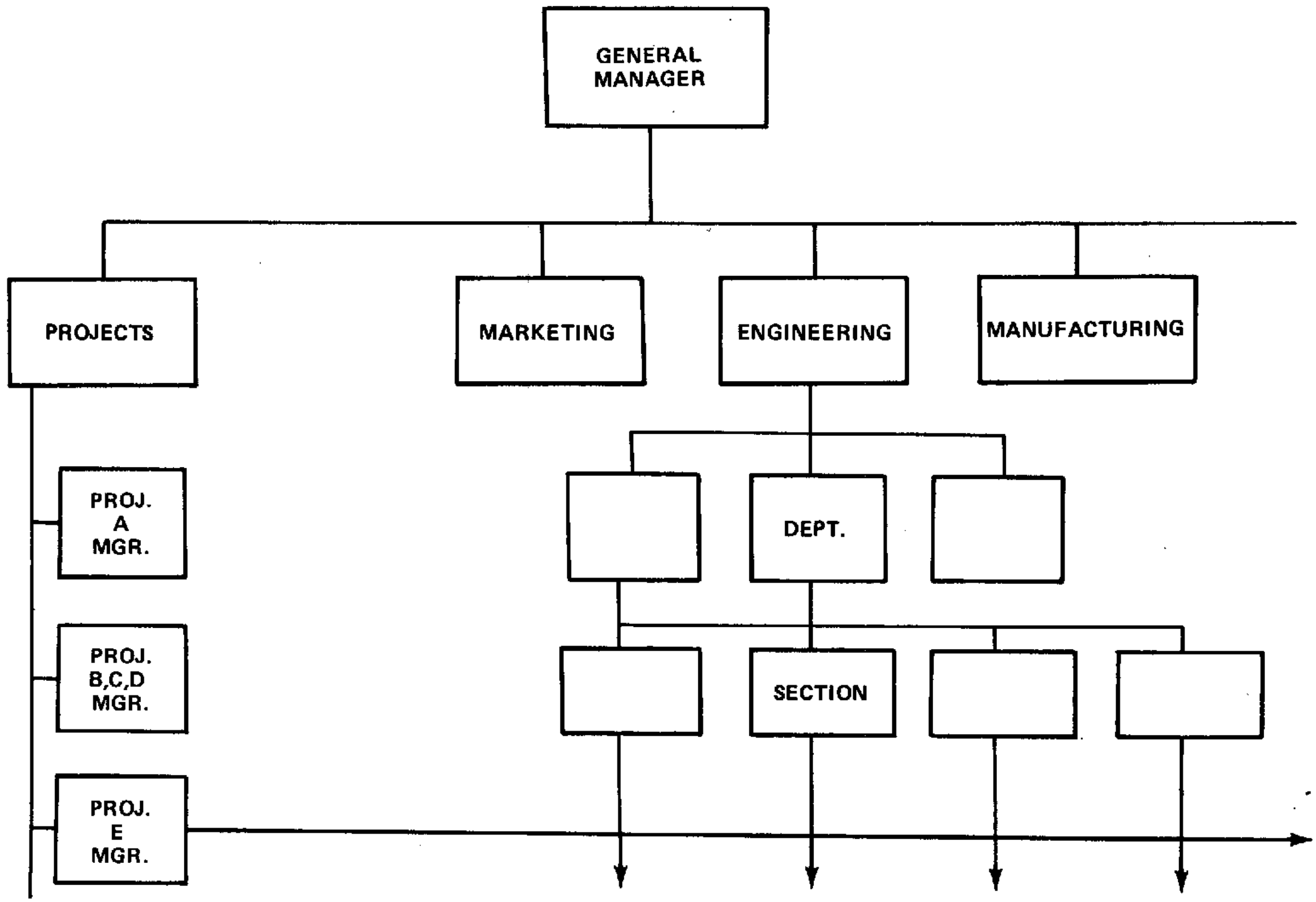

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Figure 18: The Combination or Matrix Structure

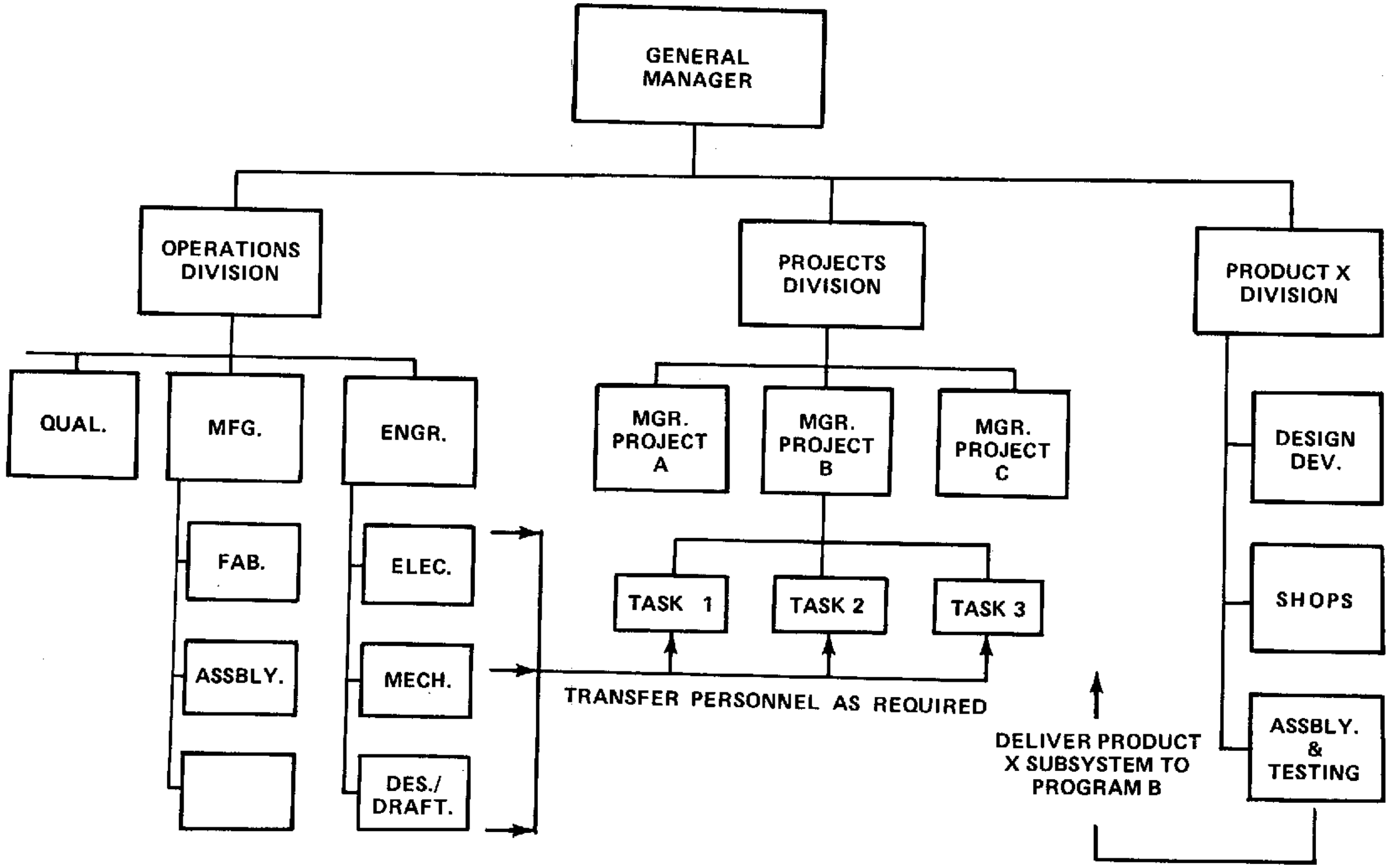

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Figure 19: The Interwoven Structure

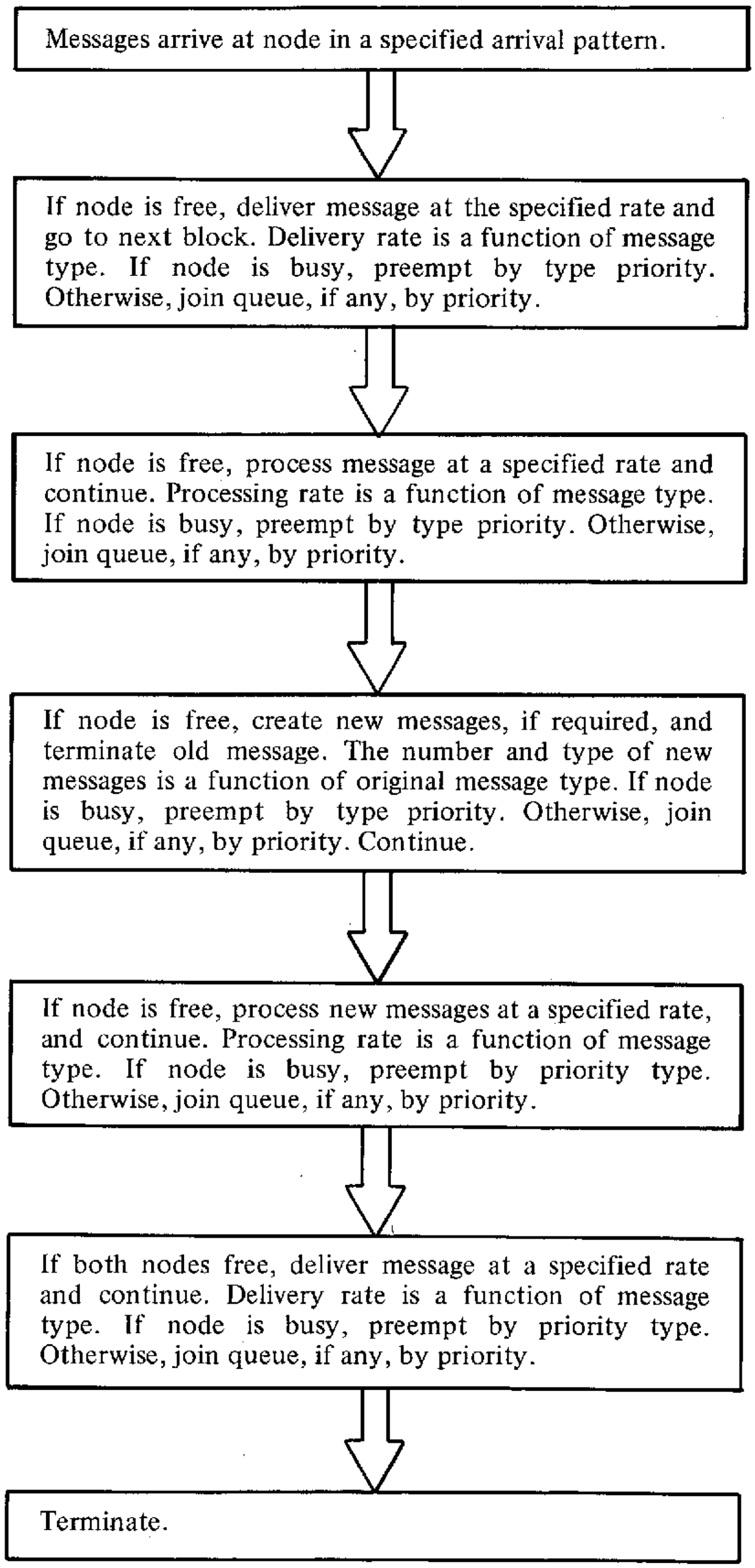
	Pure Functional (Fig. 1)	Pure Project (Fig. 2)	Matrix (Fig. 3)	Interwoven (Fig. 4)
Strengths	Flexibility in use of manpower Grouping of specialists Transferability of technology Continuity in functional disciplines	Complete line authority over project Single goal Fewer levels in organization Faster response Simpler communication	Advantages of pure project and functional organization Flexible pool of technical specialists Technical and managerial integration and focal point in project manager Consistent management approach to all projects Reassignment of people without changing the organization	More fully utilizes strengths of pure project than does the matrix Retains functional units for technical specialists Esprit de corps of single project, single goal group
Weaknesses	No focal point or responsibility for project Project-oriented integration difficult Coordination complex Schedule slippages and cost overruns	Poor use of resources in multiproject Uneconomical use of resources and facilities No homerooms for specialists Poor transfer of technology New organization for each project	No line authority over functional organization Sophisticated and expensive planning and control systems Large number of task and organizational interfaces Delicate balance of power between project and functional organizations	Unknown future assignments and personnel growth Poor transfer of technical knowledge Difficult to have uniform management practices among projects

Source No. 5

Figure 20: Summary of Strengths and Weaknesses

APPENDIX B

INFORMATION SYSTEM MODEL


Messages arrive at node in a specified arrival pattern.
If node is free, deliver message at the specified rate and go to next block. Delivery rate is a function of message type. If node is busy, preempt by type priority. Otherwise, join queue, if any, by priority.
If node is free, process message at a specified rate and continue. Processing rate is a function of message type. If node is busy, preempt by type priority. Otherwise, join queue, if any, by priority.
If node is free, create new messages, if required, and terminate old message. The number and type of new messages is a function of original message type. If node is busy, preempt by type priority. Otherwise, join queue, if any, by priority. Continue.
If node is free, process new messages at a specified rate, and continue. Processing rate is a function of message type. If node is busy, preempt by priority type. Otherwise, join queue, if any, by priority.
If both nodes free, deliver message at a specified rate and continue. Delivery rate is a function of message type. If node is busy, preempt by priority type. Otherwise, join queue, if any, by priority.
Terminate.

APPENDIX C

MANAGEMENT QUESTIONNAIRE

MANAGEMENT QUESTIONNAIRE CONCERNING

INFORMATION FLOW WITHIN THE

PROGRAM OFFICE

(Phase I)

The purpose of the attached Management Questionnaire is to gather subjective data to be used in the correlation of statistical data gathered through empirical methods. The collection of this data is a very vital part of my dissertation research. Your cooperation in an early completion of the questionnaire is solicited.

Please return the questionnaire to me within the next two days. If you have questions, call me on intercom 23.

David L. Shipman
Ph.D. Candidate
Oklahoma State University

1. How many formal oral sessions (technical meeting, reviews, conferences, movies) do you attend daily?________________ Weekly?__________ __________ Monthly?__________________________

a. Who is the sponsor of these sessions?________________________
____
What per cent of the total number of sessions is spent with each sponsor?______________________________________
b. What is the average length of each session?______________
c. What per cent of your time is spent in all sessions?_________
d. What per cent of the sessions require further action by you? _______________________ What type of action is required?____
____
What per cent of the total number of actions does each type constitute?____
How long does it take to process each type action?___________
____

2. How many informal oral sessions (briefings, informal reviews, person-to-person conversations, telephone conversations) do you attend daily? _____________________ Weekly?___________________ Monthly?___________

a. Who is the sponsor of these sessions?________________________
____
What per cent of the total number of sessions is spent with each sponsor?______________________________________
b. What is the average length of each session?______________
c. What per cent of your time is spent in these sessions?________
d. What per cent of the sessions require further action by you? ________________ What type action is required?____________ __________________ What per cent of the total number of actions does each type constitute?____________________
____
How long does it take to process each type action?___________

3. How many formal written documents (Management reports, technical reports) do receive daily?_________________ Weekly?__________________ Monthly?____

a. From whom do you receive these documents?__________________
____

What per cent of the total number of doucments come from each source?______
b. How much time do you spend reviewing each document?______
c. What per cent of your time is spent reviewing these documents?
______
d. What per cent of the documents require further action by you?
______
What type action is required?______
What per cent of the total number of actions does each type represent?______ How long does it take to process each type action?______

4. How many informal written documents (memoranda, informal reports, personal letters) do you receive daily?______ Weekly?______ ______ Monthly?______

a. From whom do you receive these documents?______
______
What per cent of the total number of documents come from each source?______
b. How much time do you spend reviewing each document?______
c. What per cent of your time is spent reviewing these documents?
______
d. What per cent of the documents require further action by you?
______ What type of action is required?______
______ What per cent of the total number of actions does each type constitute?______
______ How long does it take to process each type action?______

5. How many formal oral sessions (technical meetings, reviews, conferences, movies) do you hold daily?______ Weekly?______ ______ Monthly?______

a. Who attends these sessions?______
______
What per cent of the total number of sessions is spent with each attendee?______
b. What is the average length of each session?______
c. What per cent of your time is spent in these sessions?______
d. How much time is spent preparing for a session?______

6. How many informal oral sessions (briefings, informal reviews, person-to-person conversations, telephone conversations) do you hold daily?______ ______ Weekly?______ Monthly?______

a. Who attends these sessions?______
What per cent of the total number of sessions is spent with each attendee?______
b. What is the average length of each session?______
c. What per cent of your time is spent in these sessions?______
d. How much time is spent preparing for a session?______

7. How many formal written documents (management reports, technical reports) do you originate daily?__________ Weekly?__________ Monthly?__________

a. To whom do you send these reports?__________

What per cent of the total number of reports is sent to each addressee?__________

b. How long does it take you to prepare a report?__________

c. How do you transmit these reports?__________

What per cent do you transmit by each method?__________

d. How long does it take to transmit by each method?__________

8. How many informal written documents (memoranda, informal reports, personal letters) do you originate daily?__________ Weekly?__________ Monthly?__________

a. To whom do you send these reports?__________

What per cent of the total number of reports is sent to each addressee?__________

b. How long does it take you to prepare a report?__________

c. How do you transmit these reports?__________

What per cent do you transmit by each method?__________

d. How long does it take to transmit by each method?__________

MANAGEMENT SURVEY OF INFORMATION FLOW WITHIN THE PROGRAM OFFICE

(Phase II)

There are two logs to be used in this management survey, an incoming log and an outgoing log. Please record all official information received or sent by you on these logs.

The purpose of this survey is to obtain empirical data to determine the statistical distributions of transmission and processing times which will be used in the validation of a management information system model.

The log is simple and relatively easy to keep. To assist you in filling out the forms, a sample log has been filled in. There are also lists of sources and destinations, transmission types, processing types, and types of information included.

If you have any questions, please contact me. Please, remember to record all telephone calls and person-to-person conversations when official information is exchanged.

David L. Shipman
Ph.D. Candidate
Oklahoma State University

SOURCES AND DESTINATIONS FOR INFORMATION

I. Program Office elements (SKYLAB)

II. Program Directorate elements (Non-SKYLAB)

III. Intra-Center elements (Non-Program Management)

IV. Inter-Center elements (Non-MSFC)

V. Headquarters elements

VI. Principal Investigator elements

VII. Contractor elements

VIII. Union elements

IX. Other (Designate the source or destination used)

METHODS OF TRANSMISSION OF INFORMATION

I.	Oral Formal
II.	Oral Informal
III.	Mail
IV.	Courier
V.	TWXT

PROCESSING TECHNIQUES FOR INFORMATION

I. Read and File

II. Read and Take Action

III. Read and Relay

IV. Process Outgoing Messages

TYPES OF MANAGEMENT INFORMATION

I. ORAL AND VISUAL INFORMATION

A. FORMAL

- Technical Meetings
- Reviews
- Conferences
- Displays and Exhibits
- Motion Pictures

B. INFORMAL

- Briefings (informal reviews)
- Person-to-person conversations
- Telephone conversations

II. WRITTEN INFORMATION

A. FORMAL

- Management reports
- Technical reports

B. INFORMAL

- Memoranda
- Informal reports
- Personal letters

INCOMING LOG

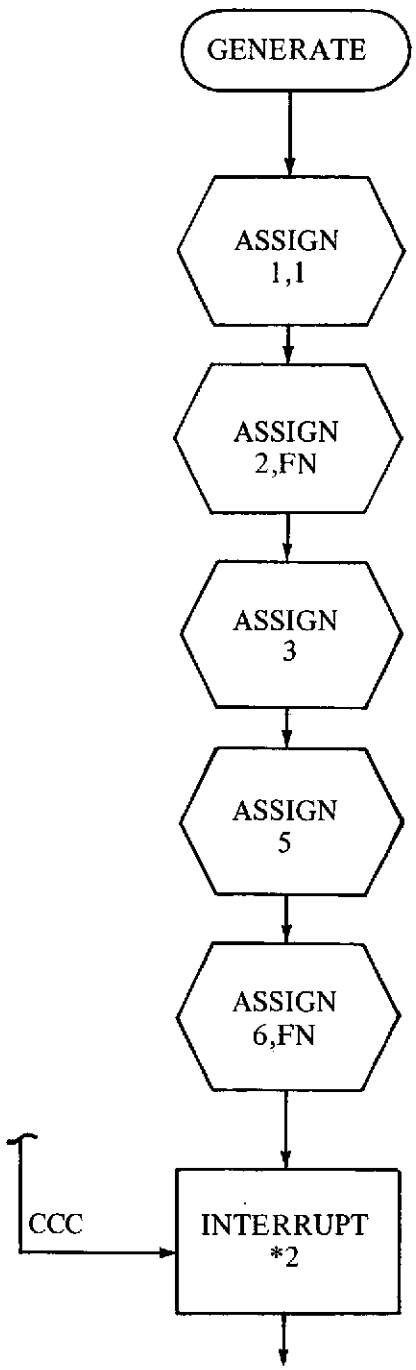
Date	Source	Type	Method of Transmission	Time Required to Transmit	Method of Processing	Time Required to Process

OUTGOING LOG

Date	Destination	Type	Method of Transmission	Time Required to Transmit	Time Required to Process

APPENDIX D

FLOW CHART OF THE MAIN PROGRAM



Generate type I messages and assign a priority of 4.

Assign message type I to Parameter 1.

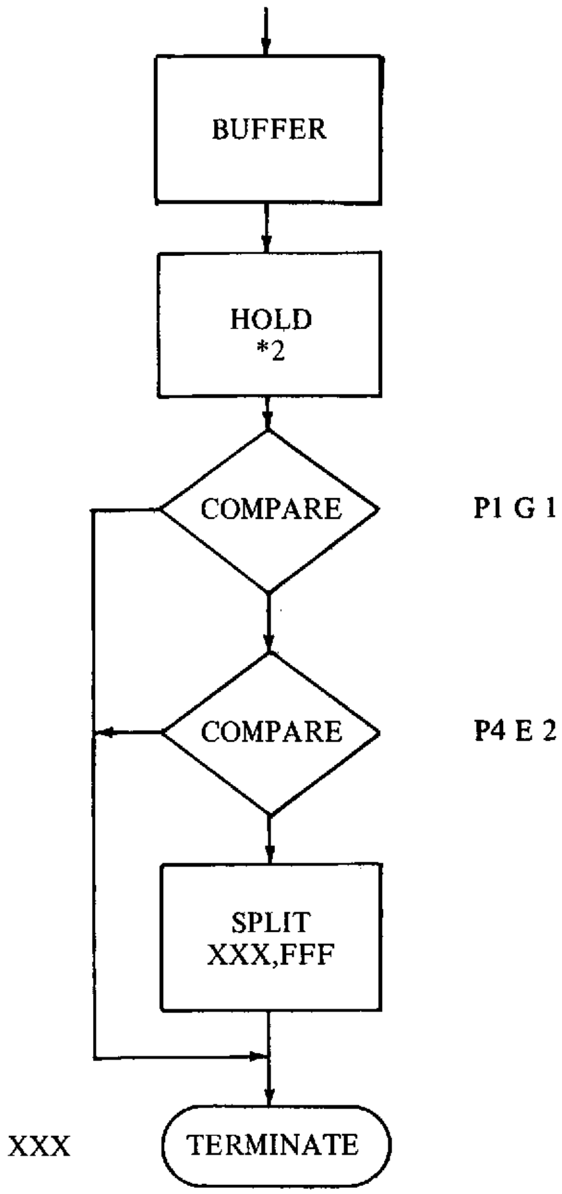
Assign a destination to Parameter 2 using FN.

Assign a mean delivery duration to Parameter 3.

Assign a mean processing duration to Parameter 5.

Assign the number of outgoing messages to Parameter 6 using FN.

Interrupt the decisionmaker designated by Parameter 2 and deliver the message.



Allow waiting messages to deliver before proceeding.

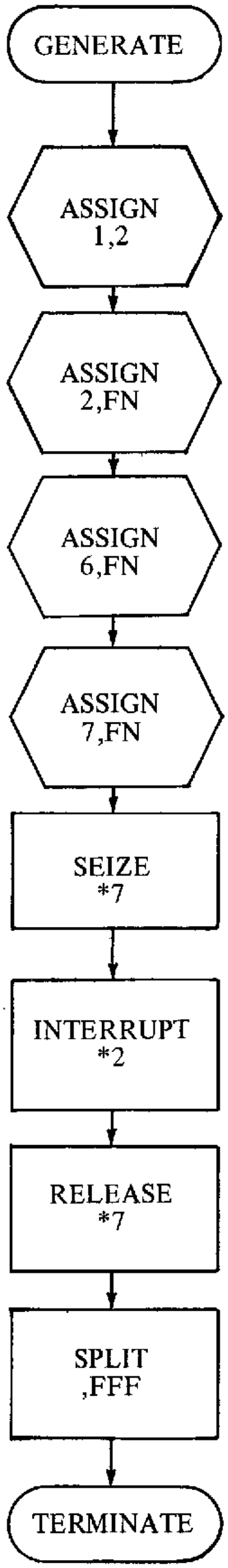
Hold the decisionmaker until the message is processed.

Terminate Type 1 messages, allow other messages to proceed.

Terminate message if no further action is required.

Create all outgoing messages and send to FFF for processing.

Terminate all incoming messages.



Generate type II messages and assign a priority of 3.

Assign message type II to Parameter 1.

Assign a destination to Parameter 2 using FN.

Assign the number of outgoing messages to Parameter 6.

Assign a telephone line to Parameter 7 using FN.

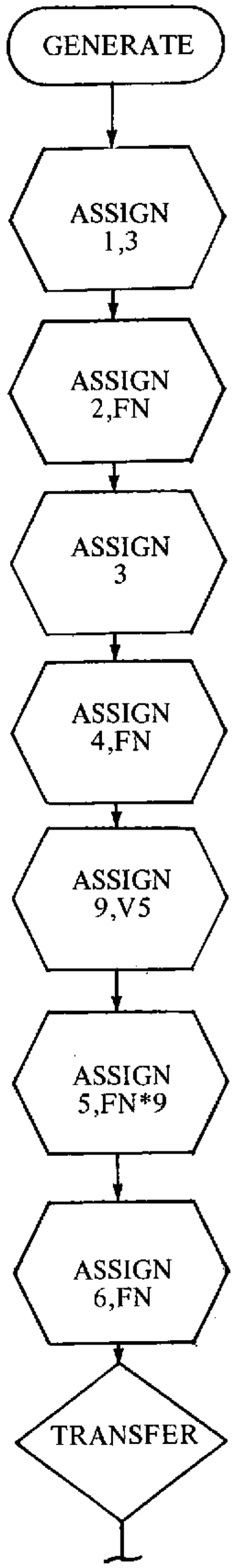
Seize the telephone line designated in Parameter 7.

Interrupt the decisionmaker designated in Parameter 2.

Release the telephone line designated in Parameter 7.

Create all outgoing messages and send to FFF for processing.

Terminate all incoming messages.



Generate type III messages and assign a priority of 1.

Assign message type III to Parameter 1.

Assign a destination to Parameter 2 using FN.

Assign a mean delivery duration to Parameter 3.

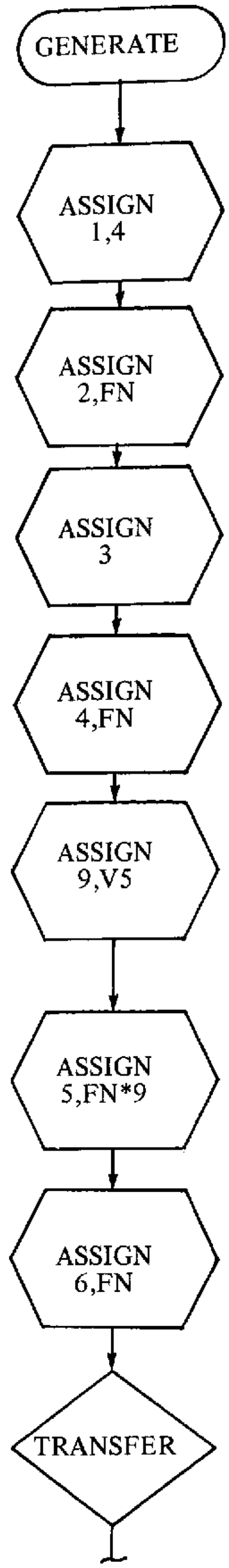
Assign a type processing to Parameter 4 using FN.

Assign a value to Parameter 9 using a variable relating message type and type processing.

Assign a processing duration to Parameter 5 using the FN specified in Parameter 9.

Assign the number of outgoing messages to Parameter 6 using FN.

Transfer all incoming messages to block CCC for delivery and processing.



Generate type IV messages and assign a priority of 2.

Assign message type IV to Parameter 1.

Assign a destination to Parameter 2 using FN.

Assign a mean delivery duration to Parameter 3.

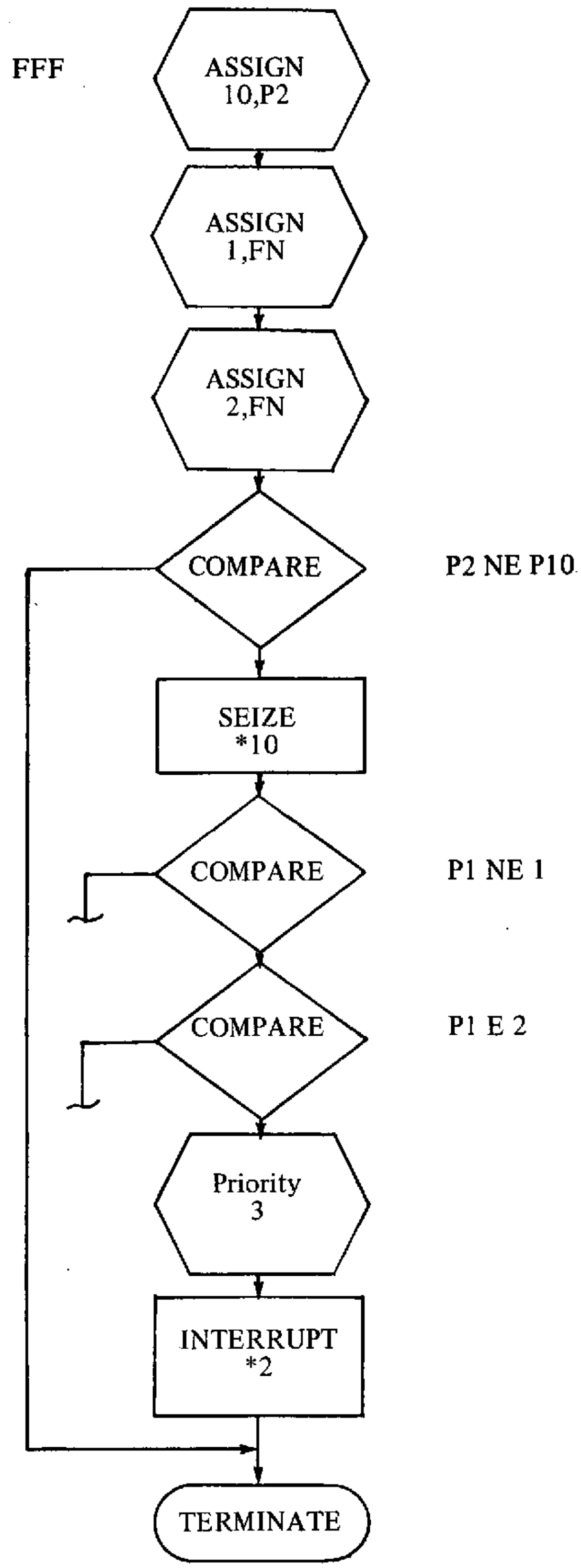
Assign a type processing to Parameter 4 using FN.

Assign a value to Parameter 9 using a variable relating message type and type processing.

Assign a processing duration to Parameter 5 using the FN specified in Parameter 9.

Assign the number of outgoing messages to Parameter 6 using FN.

Transfer all incoming messages to block CCC for delivery and processing.



Assign destination specified in Parameter 2 to Parameter 10.

Assign a message type to Parameter 1 using FN.

Assign a destination to Parameter 2 using FN.

Check to determine if the sender and the receiver are the same.

Seize the sender to process the outgoing message.

Send type 1 messages to JJJ for delivery.

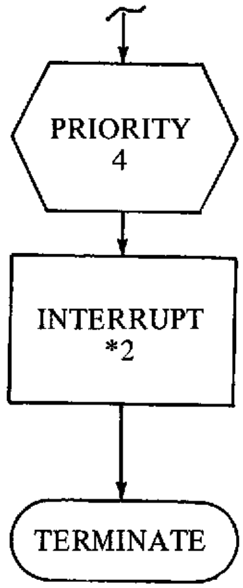
Send message types III and IV to KKK for typing.

Assign a priority of 3 to all type II outgoing messages.

Interrupt the decisionmaker specified in Parameter 2 and deliver the message.

Terminate all type II outgoing messages.

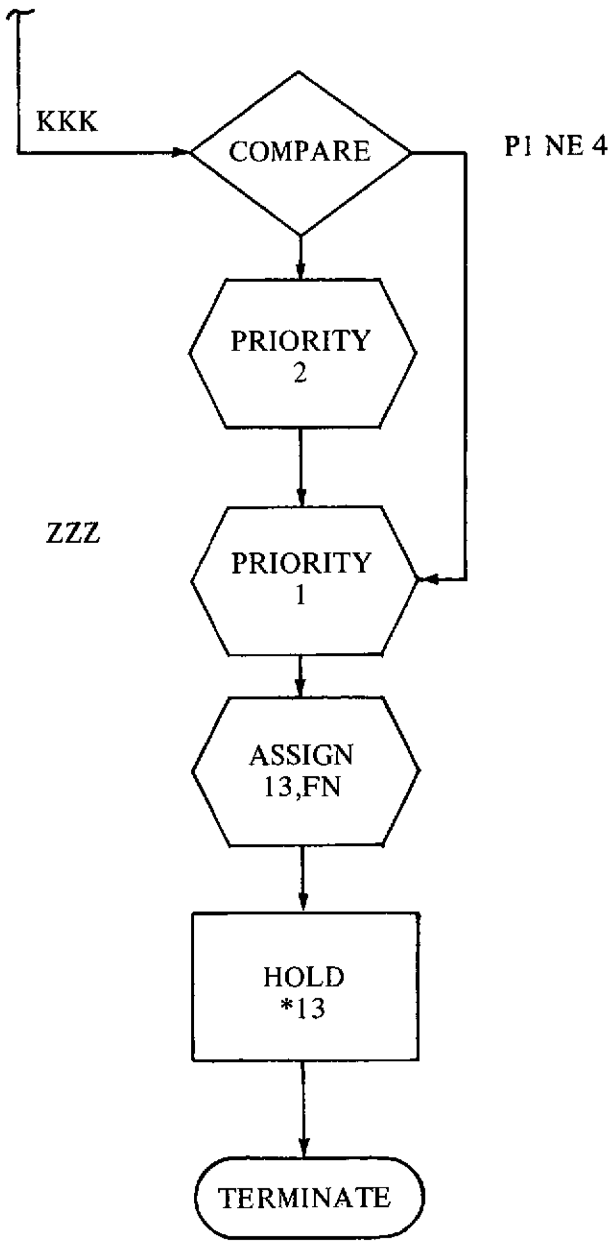
JJJ



Assign a priority of 4 to all type I outgoing messages.

Interrupt the decisionmaker specified by Parameter 2 and deliver the message.

Terminate all type I outgoing messages.



Send type III messages to ZZZ for assignment of priority.

Assign a priority of 2 to type IV messages.

Assign a priority of 1 to type III messages

Assign a secretary to type the outgoing messages using FN in Parameter 13.

Hold the secretary designated in Parameter 13 until the typing is completed.

Terminate all type III and IV outgoing messages.

VITA

David Leon Shipman

Candidate for the Degree of

Doctor of Philosophy

Thesis: A MANAGEMENT INFORMATION SYSTEM MODEL FOR PROGRAM MANAGEMENT

Major Field: Engineering

Biographical:

Personal Data: [redacted], the son of Hubert L. and Bessie M. Shipman; married to Sandra [redacted] Shipman; father of Cynthia, Connie and Anthony Shipman.

Education: Attended grade school in Dallas, Texas, graduated from Pleasant Grove High School in Dallas, Texas, in 1948; received the Bachelor of Science from the University of Texas, with a major in Civil Engineering in January, 1958; completed course work for the Master of Science degree at the University of Alabama in Huntsville in 1970; completed requirements for the Doctor of Philosophy degree in July 1972 at Oklahoma State University in Stillwater, Oklahoma. Graduated from the U.S. Naval Flight School, Pensacola, Florida, in November, 1952.

Professional Experience: General – Design, construction, and management experience in structural and mechanical engineering (including materials), highway engineering, urban development, park development, bridge engineering, architectural engineering, military engineering, budgeting, planning, programming, program control, structural engineering, mechanical engineering, engineering contracts, materials engineering. NASA – Design, construction, mechanical, and management experience in structural, mechanical, and electrical engineering. Experience on Saturn IB and Saturn V Launch Support equipment, Saturn IB Launch Vehicle Systems (Ordnance Systems, Structural Systems, Systems Test and Checkout Requirements, and Environmental Control Systems), and Skylab Program Office in the areas of system engineering, operations, systems management, engineering contracts, program budgeting, planning and control, and configuration management. Navy – Maintenance experience in Mechanical Engineering (Jet Power Plants). Flight experience in both propeller and jet powered aircraft. Commander in the Naval Air Reserve, served as the commanding officer of Naval Air Reserve Unit OPCON 6M1 for two years.