ORGANIZATIONAL EFFECTS UPON MANPOWER UTILIZATION IN RESEARCH AND DEVELOPMENT

by

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PREFACE

It is hoped that this study will assist in achieving more efficient utilization of technical manpower in the space program and other government supported research and development efforts.

The research was performed by Mr. Goodman in partial fulfillment of the requirements for the Doctor of Business Administration degree at Washington University. Mr. Goodman is now an acting assistant professor at the Graduate School of Business at U. C. L. A.

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CHAPTER I

THE RESEARCH PROBLEM AND THE HYPOTHESES

Introduction

This study investigated the effect of two basic types of organizational form on the stability and flexibility of manpower in research and development companies engaged in various projects for the United States government. Important criteria for selecting one organizational form rather than another were also explored, since such criteria provided the rationale for choosing a specific organizational form.

Specifically, the project management and the matrix management forms of organization were investigated within the context of the defense/aerospace sector of the United States economy. Six defense/aerospace contractors were selected for study through the use of a case study technique. A series of hypotheses were developed and tested concerning the influence of these forms of organization on manpower flexibility, turnover, staff planning, and organizational choice.

Current and Historical Background to the Research Problem

This section describes the schedule and cost performance of several research and development projects and is included in order to indicate the apparent difficulties in the management of research and development and, thereby, establish the importance of this study.

Roberts[1] highlights the results of several studies that have been made regarding the effectiveness of research and development projects.

> A RAND Corporation report on major procurements of Air Force equipment included the calculated ratios of the latest estimates of average product cost to the earliest such estimates that could be found. Of twenty-two projects examined, only two were found in which the predicted average costs were correct. In the other twenty projects, the costs were underestimated initially by amounts ranging from 20 per cent to 5,760 per cent. Six missile projects, for example, have been underestimated by an average of 1,710 per cent. In a more moderate case, nine aircraft fighter projects were found to be off by an average of 240 per cent.[2]
>
> A similar RAND report on slippages in R and D schedules states: "Out of thirteen [aircraft] engines studied, four passed the 50-hour [acceptance] test 2 to 4 years later than the date estimated when development was begun; another four were 1 to 2 years late in passing the test; while

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[1]Edward B. Roberts, "Toward a New Theory for Research and Development," Industrial Management Review, Fall, 1962, pp. 30-31.

[2]Paraphrased by Roberts from A. W. Marshall and W. H. Meckling, "Predictability of the Cost, Time, and Success of Development," RAND Corporation Report: P-1821 (Santa Monica: RAND Corporation, December 11, 1959), p. 22.

> five completed the test within twelve months of the estimated time of completion."[3]
>
> Finally, a study made earlier this year [1962] established that these problems are still current, having already shown up in the brief experiences of NASA. This research uncovered that in 26 contracts studied, each of which was over one million dollars in size, the current estimated cost increases range up to 502 per cent, with an average increase of 80 per cent. Of the 10 contracts in this sample which had reached completion, the final cost increases average 105 per cent.[4]

These studies are drawn only from the Department of Defense and the National Aeronautics and Space Administration experience but similar findings have been reported with respect to commercial research.[5] These studies seem to establish that the management of research and development projects typically have suffered from various forms of uncertainty which are reflected in cost and time overruns.

Table 1 summarizes another study of research and development projects in which cost and time overruns are quite apparent. With this additional evidence of the difficulty of managing research and development, it is well to suggest areas of study which might have a significant

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[3]Quoted by Roberts from Burton Klein and William Meckling, "Applications of Operations Research to Development Decisions," Operations Research, May-June, 1958, pp. 359-360.

[4]Paraphrased by Roberts from T. W. Finch, "Factors That Influence Changes in Cost and Time Schedules of Research and Development Contracts" (unpublished Master's thesis, School of Management, Massachusetts Institute of Technology, 1962), pp. 40-41.

[5]Roberts, op. cit., pp. 29-30.

impact upon such problems. This study focuses on management organization as a possible area within which major contributions might be made. The following section presents the generally articulated features of the major forms of management organization used in the aerospace industry's research and development divisions.

TABLE 1

DEVELOPMENT COST AND TIME VARIANCE FACTORS IN 12 WEAPONS PROJECTS*

Project	Percentage actual cost is of original estimate	Percentage actual time is of original estimate
A	400	100
B	350	230
C	500	190
D	200	n.a.
E	n.a.	70
F	700	180
G	300	130
H	200	100
I	240	130
J	250	130
K	70	100
L	300	140
Average	320	136

*Adapted from Merton J. Peck and Frederic Scherer, The Weapons Acquisition Process: An Economic Analysis (Boston: Division of Research, Graduate School of Business Administration, Harvard University, 1962), p. 22.

The Study Area of Organization Form in Research and Development

Two basic organizational models for the management of research and development have been developed. One is the project management approach;[6] the other is the matrix management form.[7] As presented here these two approaches are the extreme examples of what in practice is seldom so extreme or pure. They are shown below in Figures 1 and 2.

The project management organization, with two major exceptions, is a traditional line organization. In the traditional approach the organization is grouped by functions, while in the project approach the organization is grouped by projects, each containing several functions. In the traditional line approach the organization is expected to "last forever," while in the project approach the organization is expected to last only for the duration of the project.

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[6] Project management will be used throughout this report in spite of the general tendency to use project and program management interchangeably. In the defense industry the program management nomenclature is rather prevalent, while in the construction industry program management is called project management.

[7] A functional management approach has been identified but it really is an extreme form of the matrix management approach and in most cases this report will treat it as such. See Donald G. Marquis and David M. Straight, Jr., "Organizational Factors in Project Performance," Working Paper No. 133-65 (Cambridge: Massachusetts Institute of Technology, School of Management, August, 1965).

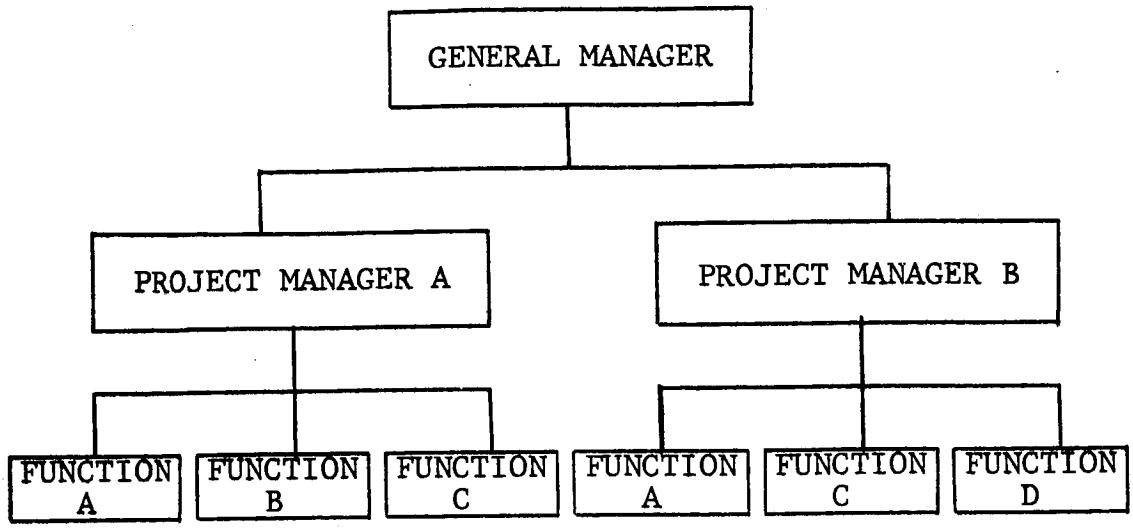

Fig. 1.--Project Management Organization

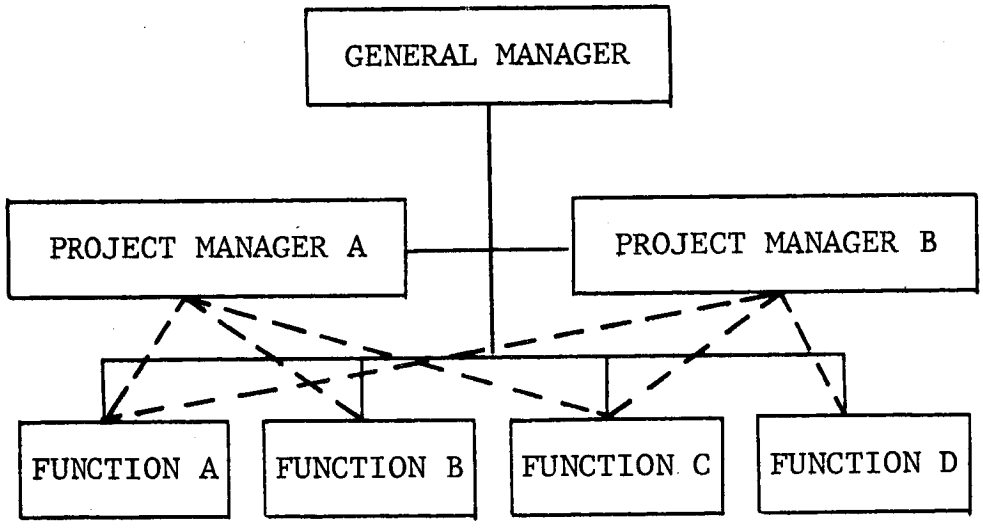

Fig. 2.--Matrix Management Organization

On the other hand, the matrix management model also has a great similarity to the traditional line organization. In this case a traditional line organization is used as a base, and the matrix management responsibilities are an overlay on the organization. In such an organization, the project manager has the responsibility for accomplishing the given job, but he has no direct authority over the personnel working on the job. He is able to "control" or coordinate the program only through the use of technical decision making, allocation of funds to the various work groups, and personal or moral suasion. By contrast, under the project management approach, the project manager has both the responsibility and the direct authority over the personnel working on the project.

Using the terms "vertical structure" to describe project management and "horizontal structure" to describe matrix management, one author says the following about the organizational problem:

> The obvious organizational goal is to seek the advantages of both the vertical structure in which control and performance associated with autonomous management are maintained for a given project, and the horizontal in which better continuity, flexibility, and use of scarce talents may be achieved in a technical group.[8]

Table 2 indicates the usually cited advantages and disadvantages of the two approaches.

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[8]Paul O. Gaddis, "The Project Manager," Harvard Business Review, XXXVII (May-June, 1959), 89-90.

TABLE 2

SUMMARY OF ORGANIZATIONAL IMPACT OF PROJECT MANAGEMENT VERSUS MATRIX MANAGEMENT

Concept	Matrix Management	Project Management
Control over personnel	Personnel on project report to other supervisors who have several objectives which are not coincident with that of the project manager.	Personnel on project report directly to the project manager.
Supervisory effect of technical effectiveness	Greater effectiveness is implied by direct supervision of engineers by technically superior managers.	Less effectiveness is implied by the direct supervision of engineers by technically inferior managers.
Flexibility of manloading	Personnel can be transferred for short periods of time since a functional manpower pool with other work can be rearranged in the short-run.	Peak manpower needs must be met by overtime while valleys in manpower needs cannot be handled in the short-run due to organizational barriers to temporary transfer.
Project communication	Understanding of the relationship between functions is poor and this results in communication problems.	Understanding of the relationship between functions is good and this results in a lessening of communication problems.
Utilization of scarce personnel	Utilization is good due to the ability of specialists to swing from project to project as the need arises.	Utilization is poor due to the inability of specialists to work on other projects.

TABLE 2 (continued)

SUMMARY OF ORGANIZATIONAL IMPACT OF PROJECT MANAGEMENT VERSUS MATRIX MANAGEMENT

Concept	Matrix Management	Project Management
Quick reaction capability	Quick reaction capability is hampered by poor communications and lack of priority control over other programs and facilities.	Quick reaction capability is aided by good communications and control over personnel and facilities. It is hampered by the short-run manpower inflexibility.
Maintaining technical capability	Ready contact is maintained with others in same technical specialty, aiding group to keep abreast of the state-of-the-art.	Infrequent contact is maintained with others in technical specialty, hindering ability to keep abreast of the state-of-the art.
Cost control	Cost control is better due to flexibility of man-loading but less effective due to the lack of direct control over the performance of the personnel.	Cost control is poorer due to the tendency of personnel to continue on the project during work load valleys but is more effective due to direct control over the performance of the personnel.

A careful analysis of the information in Table 2 reveals that neither organizational pattern stands out as being fundamentally better and this seems to be verified by the organizational patterns present in industry. Among

leading companies, there is no consensus whether project management is better than matrix management, whether matrix management is better than project, or whether some hybrid is best. An executive of a large aerospace corporation stated that his company had oscillated back and forth between the two approaches, and had never successfully come to grips with a clear understanding of the benefits of either approach.[9]

Actual determinants of the optimal organization form for a given project would include many other diverse factors. For example, the size of the project and the previous experience of management can be expected to affect the way a project should be handled. Other variables that relate to the optimal choice of an organization have been very succinctly cited by Sherman Kingsbury:

> It was stated in the beginning that an organization is a social system involving numerous degrees of complexity. These degrees of complexity include formal and informal patterns of organization, patterns of communication, authority structures, leadership behavior, formal and informal standards of behavior, rewards and punishments, etc. Most important is the point that a social system is a constellation of people who have functioned together for some time, and have evolved all these attributes of their social system out of <u>their</u> own personalities.[10]

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[9]This comment was made during an interview on September 16, 1965.

[10]S. Kingsbury, "Organizing for Research," in C. Heyel (ed.), <u>Handbook of Industrial Research Management</u> (New York: Reinhold Publishing Corp., 1959), pp. 89-90.

The Major Hypotheses of This Study

Research is generally more productive when the focus of a research study is directed toward the testing of well-developed hypotheses. The following sections will introduce the major hypotheses of this study and outline the basic reasoning which suggested them.

Flexibility

The initial hypotheses are derived from the information contained in Table 2, "Summary of Organizational Impact of Project Management Versus Matrix Management." The concept of flexibility of manloading has been widely recommended as a major advantage of the matrix management approach. A study by Weidenbaum and Rozet,[11] however, indicates that the defense industry shows a very small propensity to maintain--at the individual firm's own risk--a staff in anticipation of new work. A direct implication of this study is that a company either has funded work for its staff or it terminates its employment. Therefore, the technical staff of a company must be considered more or less fully employed. That is to say, all technical personnel are working on tasks that must be accomplished

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[11] M. L. Weidenbaum and A. B. Rozet, Potential Industrial Adjustments to Shifts in Defense Spending: An Analysis of a Reduction in Strategic Programs (Menlo Park, Calif.: Stanford Research Institute, 1963).

under the terms of one contract or another.[12] If a peak demand occurs on one project--and sufficient time is not available for hiring additional staff--it can only be met by drawing people from another project. Conversely, in periods when work is temporarily low there is a tendency for projects to continue to use their assigned personnel rather than to share them. The work load effect on flexibility is hypothesized to be stronger than the normally articulated organizational effect. This leads to the following hypotheses.

> HYPOTHESIS ONE: Flexibility of manloading on a research and development project is a function of the work load level in the corporation.
>
> HYPOTHESIS TWO: Flexibility of manloading on a research and development project is not a function of organizational form.

A fuller discussion of the derivation of these hypotheses will be found in Chapter III.

Staffing

The basic importance of the staffing problem can be seen from this comment by Robert Moore:

> Recruitment efforts cannot be wholly effective if entered into haphazardly or sporadically. To reach desired manpower goals there must be a well planned, continuous program. Crisis hiring and crash programs give temporary but sometimes

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[12] The term contract, as used here, includes tasks relating to company interest, such as research, as well as customer interest.

> questionable relief, and are likely to become a habit of recruitment.[13]

Personnel departments, in order to prevent the problems which arise from crisis recruiting, attempt to forecast future needs and to maintain a relatively steady recruiting effort. Generally, the uncertainty of future needs and, specifically, the official authorization to hire are the two main obstacles to achieving a smoothly operating recruiting plan. The uncertainty of the future is hedged by the use of a probabilistic approach applied to the outstanding new business proposals. The manpower implications of potential new business are calculated and then factored by the probability of winning each proposal. The result of such a process is an estimate of future manpower requirements. Personnel departments then feel reasonably comfortable mounting a recruiting effort for personnel who could fit relatively well into any of the likely new business efforts.

This planning procedure, though, is complicated by the need for an official authorization to hire. In a matrix organization, the responsibility for hiring personnel for new business lies with the functional manager and he can issue to personnel an official authorization to hire. Conversely, in a project organization there is usually no

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[13] R. F. Moore, "Recruitment," in C. Heyel (ed.), Handbook of Industrial Research Management (New York: Reinhold Publishing Corp., 1960), p. 369.

person who has the responsibility to staff for potential new business and, therefore, no person is designated who can issue an official authorization to hire. This leads to the following hypothesis.

> HYPOTHESIS THREE: A research and development organization which is matrix organized will tend to have a longer definite planning horizon for staffing than will a research and development organization that is project organized.

A fuller discussion of the derivation of this hypothesis will be found in Chapter III.

Turnover

The fourth hypothesis is concerned with the impact of organizational form on personnel turnover rates. The feeling of completion that arises at the end of a project seems to suggest to the personnel working on the project that such a period is a reasonable time in which to search for new challenges both inside and outside the company. The end of the project is more strongly felt in a project organized company than in a matrix organized company. This heightened sense of completion occurs, in part, from the requirement to physically transfer personnel from one project area to another and thus break up the existing informal behavior pattern. Due to this accentuated sense of completion, it is expected that the turnover rates will probably be higher, therefore, in project organized companies than in matrix organized companies. Formally stated, the hypothesis is as follows.

HYPOTHESIS FOUR: The turnover rate for technical personnel who terminate voluntarily with the sense of project completion as a contributory factor will be greater in project organized companies than in matrix organized companies.

A fuller discussion of the derivation of this hypothesis will be found in Chapter III.

The Selection of a Particular Organizational Form

Many considerations must be balanced by management when it is faced with the decision to create a new organization. Should it be similar to the present organization or should it be radically different? What are the major problems which can be partially solved by the proper choice of an organization?

The attributes of various organizational forms are manifold. Table 2, presented earlier, has identified several of the major attributes relating to the organization of a research and development project. The management of a research and development company must "trade off" the effects of each attribute upon the overall objectives of the company. This "trade-off" study will result in the selection of what is considered the most appropriate organizational form. The general management of a company (i.e., the general manager, the controller, the contracts manager, etc.) and the project management of a company weigh the attributes differently perhaps, and thereby arrive at different preferences regarding the best organizational

form.

The underlying factors here are the different objectives of the two levels of management. The major objective of project management is the solution of the technical problem in a fashion which will produce the greatest project profit. The major objective of general management is the allocation of company resources so as to maximize progress on all projects within the company and produce the greatest possible company profit. As the maximization of company profit must occasionally be accomplished at the expense of a particular project's profit, an essential conflict arises between general management and project management. Each level of management, then, will potentially prefer an organizational form which will minimize the other level's ability to frustrate its objective. This leads to the following hypothesis.

> HYPOTHESIS FIVE: Project management will tend to prefer the project form of organization, while general management will tend to prefer the matrix form of organization.

A fuller discussion of the derivation of this hypothesis will be found in Chapter IV.

Summary

The first section of this chapter demonstrated that the management of research and development historically has been subject to various forms of uncertainty which are reflected in schedule and cost overruns. It was suggested

that one of the areas of study which is relevant to the understanding of such a problem is that of management organization. With regard to management organization, a series of distinctions between the project and the matrix forms of management were examined. These distinctions, then, led to hypotheses which contrasted the two organizational forms on the dimensions of stability and flexibility of manpower, staffing plans, and organizational preference.

The following chapter discusses the basic research methodology and the specific procedures utilized in the testing of the above hypotheses. The later analytical chapters will discuss the procedural details as they become relevant to the study at hand.

CHAPTER II

THE RESEARCH METHODOLOGY

The Basic Methodology

A multiple case study approach was the basic methodology used for this investigation. The adoption of this method was made only after careful consideration of other alternatives, such as simulations or large-scale statistical surveys, since the unique character of individual research and development organizations makes the process of generalization quite hazardous. To know which of numerous differences between two research and development projects or two research and development organizations are critical to differences in outcome is often impossible. This difficulty has led many investigators to the use of the case study technique.[1]

The primary usefulness of the case method approach arises directly from the wealth of descriptive material made available by such an approach. Although a large portion of this study is devoted to the collection of

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[1]For example, see Charles D. Orth, III, Joseph C. Bailey, and Francis W. Wolek, Administering Research and Development (Homewood, Ill.: Richard D. Irwin, Inc., and the Dorsey Press, 1964), or James R. Bright, Research, Development, and Technological Innovation (Homewood, Ill.: Richard D. Irwin, Inc., 1964).

quantitative data, descriptive material was collected at every opportunity.

There is a major limitation to the case study approach as a basic research methodology, which is as follows: The development of generalizations from a series of case studies is dependent upon similarities in data and data-gathering techniques. If a similarity in data and data-gathering techniques is not present in the various cases analyzed, it is difficult to derive valid generalizations.

The researcher sought in this research to apply consistent research techniques from case to case. As the researcher moved from company to company, great care was taken to provide for the consistent selection of data. This is further discussed in Chapter III. A summary of the value of the case approach can be found in the following comment which was written in answer to the following question: "What usefulness has a case study when there are probably thousands of uniquely different situations?"

> The answer to this question can be derived from a consideration of the two principal categories of empirical analysis which are open to a researcher doing a single case study. A first category of case analysis has been called a <u>particularizing</u> analysis; it is limited in scope to a description and explanation of the single case and to the dynamics through which the subject of case study continues to operate. A second avenue is open to a researcher who wishes to broaden the horizons of a single case study. This second approach is known as a <u>generalizing</u> analysis, and it utilizes the single case as a means of developing generalizations or a body of theory concerning a broader field of knowledge of which the case study is

but one part.

> If a case study primarily presents a word portrait of a group or organization, or if it is simply a recording of events or observations--such a case study would be described as a particularizing analysis. The principal usefulness of a particularizing analysis is that it may be used to build upon or to further extend an existing body of knowledge or set of concepts. A generalizing analysis, however, aims at developing a theory or general hypotheses concerning an area or concept which is not well understood.[2]

The major thrust of this study is one of generalizing analysis, and for this reason six organizations were studied.

Reliability Considerations in Basic Data Gathering Techniques

In a gross sense the gathering of data in social science research is limited to three different techniques: the study of documents, interviewing, and observation.[3] It is imperative to comment on each of these techniques with regard to their inherent reliability.

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[2]Raymond L. Hilgert, "An Analytical Study of a Multiple-Union Organization Using a Behavioral Science Approach" (unpublished Ph.D. dissertation, Graduate School of Business Administration, Washington University, 1963), p. 10. The concept of particularizing and generalizing is from Seymour Lipset, Martin Trow, and James Coleman, Union Democracy (Garden City, N.Y.: Doubleday and Co., Inc., 1962), pp. 86-87.

[3]Suggested by Leon Festinger and Daniel Katz (eds.), in Research Methods in the Behavioral Sciences (New York: Dryden Press, 1953), p. 240.

The Study of Documents

The use of documentary evidence has the unique advantage of being the only factual source of data available for the researcher who desires an historical view of an institution. It might be argued that the reminiscences of participants is another source of factual data, but this source is clouded by the selective filtering of such participants' memory. Not to negate the value of such reminiscences, it must be pointed out that the reliability of this form of information is necessarily less than the documents of the same period. Documentary evidence basically suffers from biases of the documentor at the time, but does not suffer from alteration of memory due to later occurrences.

Although documents can be considered facts, there is a spectrum of reliability associated with different types of documents. The reliability of a document can be roughly estimated by a consideration of the controls placed upon its preparation and maintenance. A brief handwritten memo has the lowest reliability, as it is only subject to one control--that of the originator. Therefore, it can only be construed to express the belief of the originator.

At the other end of the reliability spectrum, control is very formal, detailed, and effective. An example of a document in this category might be a tabulation run showing the time charged by various individuals in a particular week. Such a run is prepared by the implementation of

a number of detailed rules and guidelines and is checked explicitly for accuracy at several points in the process. In the defense industry such a tabulation run is also subject to internal, external (private), and governmental audit. Additionally, since certain documents are part of a larger system of information gathering and reporting, it is possible to independently verify the data. For instance, the accounting tabulation run giving hours worked by individuals should be consistent with the accounting tabulation run showing payroll expenditures. It is reasonable to believe that the accounting system tabulation run on individual time-charging is a generally reliable representation of the actual expenditure of effort.

Interviewing

A discussion of interviewing can be introduced by a summary of its strengths and weaknesses as presented by Festinger and Katz.

> In short, if the focal data for a research project are the attitudes and perceptions of individuals, the most direct and often most fruitful approach is to ask the individuals themselves. . . . Observational methods are less likely to be useful for the measurement of attitudes and perceptions and are obviously unable to probe the past or to determine an individual's intentions for the future. The criteria of directness and economy and the ability to collect data about beliefs, feelings, past experiences, and future intentions have widened the range of application of the interview. . . . In summary, the interview and questionnaire appear as powerful instruments for social research. . . . Perceptions, attitudes, and opinions which

cannot be inferred by observation are accessible through interviews.[4]

As suggested by the above comment, interviewing techniques usually are more reliable in gathering information regarding perceptions and attitudes. As pointed out by Goode and Hatt,[5] there are still many pitfalls in interviewing techniques that must be avoided in order to establish a satisfactory level of reliability. Given an awareness and careful treatment of the pitfalls (these are discussed more fully in a later section of this chapter), the interview becomes a reasonably reliable tool for the gathering of data concerning attitudes and perceptions.

Personal Observation

Though recognizing that personal observation is the third data-gathering technique in the social sciences, it is not germane to this study to discuss the reliability of such a technique, as personal observation was not employed in the course of this study.

This discussion leads naturally into an explanation of the specific data-gathering techniques used to provide information on each of the hypotheses.

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[4] Ibid., pp. 330-331.

[5] William J. Goode and Paul K. Hatt, Methods in Social Research (New York: McGraw-Hill Book Co., Inc., 1952).

Specific Data-Gathering Procedures

From an over-all point of view, each company was studied over a period of two months. The first month was normally spent in meeting the management of the company and gaining an understanding of their personnel and accounting systems. Then in discussion with the general manager, an interview list was drawn up and appointments scheduled during the second month. Concurrent with the interview schedule, actual data from the personnel and accounting files were gathered. There was some opportunity to overlap the effort at two companies; thus the calendar time for field research took about ten months. The following sections specifically describe the data-gathering approaches.

Manpower Flexibility

Data for the flexibility hypothesis were collected primarily from the accounting records of the companies studied. On a reliability continuum, accounting data in research and development companies can be considered to be fairly reliable because of the extremely detailed control procedures used in the accumulation and checking of such data. Of course, even with the use of elaborate control procedures, the data are subject to some error or distortion. Yet it is the opinion of the author that the data used have a fairly high degree of reliability, notwithstanding the flaws in the control systems, as these data are externally audited by both the government for contract

purposes and independent auditors for financial statement purposes.

Within each organization, a manpower flexibility index was extracted from the company's accounting records. This index was defined and calculated over a series of time periods as the ratio of the number of personnel charging time directly to contracts to the number of said personnel charging directly to two or more contracts. A percentage of overtime to direct time was calculated to serve as a work pressure index. These data were gathered from as far previous as the accounting tabulation runs were available within a three-year limit. The specific procedures used and the analytical application of these data are discussed in the manpower flexibility section of Chapter III.

Staffing

The collection of staff planning data was from documentary evidence, the basic data source being planning documents used by the various companies. These planning documents consisted of individual, authorized employee requisition and/or authorized manpower requirement forecasts. On a reliability continuum planning documents would fall somewhere near the midpoint. Company plans generally do represent budgetary authorizations to hire, but there is little control used in the development of these plans as compared with the control used on accounting systems and drawing sets.

The firms were asked to supply data from their recruiting plans for the purpose of determining how far into the future they were able to make definite staffing plans. Current staffing levels were obtained from payroll records which could be considered much more reliable than the planning data. In anticipation of the possibility that the range of staffing plans was related to how difficult it was to recruit certain types of personnel, data were gathered in categories used in the United States Employment Service statistical series on nonagricultural job openings.[6] This series then was used to develop a scarcity index for use in weighting the planning data.[7]

The actual form used to collect the above data appears in Appendix A to this chapter. The actual research results suggested that the application of this scarcity index would not prove fruitful, as there were some overpowering confounding pressures in the form of policy and market restrictions. Therefore, the analysis in Chapter III is limited primarily to a presentation of the data, without the aid of any elaborate form of quantitative techniques or indices.

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[6] Employment Service Statistics (Washington, D.C.: Bureau of Employment Security, U.S. Government Printing Office), monthly.

[7] Suggested by the work of Hugh Folk, "Excess Demand for Engineers and Scientists: 1949-1964," Working Paper 6504 (St. Louis: Department of Economics, Washington University, April 5, 1965).

Turnover

In collecting data concerning manpower turnover, certain difficulties were encountered. In two of the companies the actual data, i.e., exit interviews, were considered so sensitive that the researcher was barred from personally reading the actual reports. Hence, the data in these companies were gathered by extensively interviewing the person in the company who normally conducts exit interviews. For the other companies, the researcher was able to analyze actual written reports of exit interviews. In the former case, the data represent an estimate by the exit interviewer of the percentage of voluntary quits by engineers who mentioned any sense of project completion. In the latter case, the data are an actual enumeration of the percentage of voluntary engineering quits by engineers who were judged from the reports to have terminated due to a "sense of completion."

In either case the determination of the "sense of completion" was handled by the researcher in the following manner. Exit interview reports were carefully read and screened for key words relating to the concept of conclusion and to the concept of project. When both concepts were found in the same report, in a manner similar to this: "Well, the hardware phase was over . . . ," the report was scored as having a sense of project completion. Using this technique, exit reports were studied as far back as they were available up to the limit of three years; the

percentage of engineering quits with a sense of project completion was then calculated. A further discussion of the specifics of this procedure is found in the turnover section of Chapter III.

Reliability of Exit Interviews

The usefulness of employing exit interviews in this research should be further discussed in view of criticisms of the reliability of such data. Criticism of exit interviews generally follows the logic that a voluntary termination may be a sign of "dissatisfaction" and/or "insecurity" for the employee. Under such conditions, it becomes crucial that a trained interviewer question the terminating employee, in order to hope to determine or arrive at the actual or true reasons for the employee's leaving. Even the use of a trained interviewer may not be sufficient to get at the truth if the employee is concerned that he not "burn his bridges behind him." The exiting employee may thus purposely disguise the sources of his dissatisfaction.[8] For these reasons great care must be exercised in the extraction of data from exit interview material.

It is the opinion of this author that reasons for

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[8]Adapted from Paul Pigors and Charles A. Meyers, Personnel Administration (5th ed.; New York: McGraw-Hill Book Co., Inc., 1965), p. 303. See also Stephen Habbe, "Postemployment Inquiry Found Helpful," Management Record, XXII (October, 1960), 8-10, and Wayne L. McNaughton, "Use of the Post-exit Questionnaire," Journal of Personnel Administration and Industrial Relations, II, No. 3 (Fall, 1955), 103-112.

voluntary termination relating to project completion are sufficiently socially acceptable so as to be revealed by the employee in a properly conducted exit interview. This would seem true, since the end of a project is beyond the control of both the company and the employee; typically, no one would feel threatened by this sort of reason for termination. This opinion leads the author to suggest that for the purposes of this specific research, the reliability of the exit interviews was somewhat higher than it would be if the topic studied were of a more emotional nature, i.e., personality conflicts, mismatches between the value system of the employee and the employer, or the like. In summary, the reliability of the data gathered from the exit interviews for the purpose of testing the turnover hypothesis, although less than optimal, was considered adequate and of research significance.

Executive Opinion on the Choice of Organizations

The collection of executive opinion was accomplished by using a patterned interview technique.[9] The form was prepared to elicit executive opinion regarding organizational preference, organizational design criteria, performance of different types of organizations vis-à-vis design criteria, and authority distribution. (The final

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[9]Major assistance in the over-all preparation of the interview form was derived from Goode and Hatt, op. cit.

interview form used is shown in Appendix B to this chapter.)

The selection of individual managers was based upon the definition of the fifth research hypothesis, which suggested that there exists a "conflict in roles" between general management and project management. In classifying the managers selected, the following definitions were employed: (1) A man whose position in his company required him to make decisions regarding the "maximization" of operation profit, to the occasional detriment of specific project profit, was considered to be a member of the set termed "general management." (2) A man whose position in the company required him to make decisions regarding the "maximization" of project profit, to the occasional detriment of operation profit, was considered to be a member of the set termed "project management."

Using the above definitions, the managers selected were classified as being in either general management (e.g., general manager, controller, manager of contracts) or in project management. In most cases the interviews were conducted with all members of project management and general management within the profit center under study. The only exceptions were caused either by security restrictions or by extended travel plans on the part of a particular individual.

The material contained within the interview form was pretested by interviewing a number of faculty members of Washington University, several of whom had previous

experience within the defense industry.[10] This pretest procedure considerably improved the content, wording, and presentation of the interview form.

The interview form was flexible enough to permit an expansion of any specific point that the managers felt was not adequately covered by the questions asked. The interview form itself typically took about a half hour of a manager's time; yet, most of the actual interviews lasted from one to one and one-half hours. The interest expressed by most managers during their interviews was a good indication of their concern about the subject matter of the interview. Under the conditions of rapport indicated, the lack of major expansions to the content of the interview by the managers was considered as an indication that the interview form had a reasonably high level of general validity.

The research interviews began with an identification of the researcher and an introduction to the study. The first questions asked established the manager's experience with the three organizational forms[11] and his present position. After these general data were gathered, the

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[10]Material contained within the interview form was adapted from Donald G. Marquis and David M. Straight, Jr., Organizational Factors in Project Performance, Working Paper 133-65 (Cambridge: Massachusetts Institute of Technology, School of Management, August, 1965), p. 13.

[11]For the purposes of the questionnaire, the functional form was included to allow for a better scale of responses. It is defined on the cards in Appendix B to this chapter.

primary question was then asked, namely, "Which of the three organizational forms do you prefer?" The question as stated in the interview form had to be qualified by the use of a concept of project size. The question sometimes became, "How would you organize a new research and development project that was from 5 to 10 per cent of your company's present gross sales?"

Most of the questions relating to the criteria section were easily understood by the respondents; a major exception was "flexibility of staffing." This was explained to mean the ability to transfer men into and out of the project as work level demands would suggest. Within the authority section, the major source of confusion arose from a question regarding the assignment of priority; this was explained to mean priority within the project and not priority between projects. The specific data reduction techniques used on the various portions of these data are explained along with the results presented in Chapter IV.

Description of Organizations Studied

The first and primary concern in the selection of organizations for study was that they exhibited the specific organizational forms desired for investigation. To this end, great effort was expended to locate a sample representative of both the matrix and project forms of organization.

It was recognized at the outset that it would be

unlikely for the researcher to find firms which would represent a virtually "pure" organizational form and that selection of firms for study would have to be made on the basis of a "predominance of form" criteria. The management of each company contacted was asked to supply data which showed what percentage of the technical staff reported (for merit review) to personnel who were project managers. A high percentage reporting thusly was considered a project organizational form, and a low percentage was considered a matrix organizational form (see Table 3, page 40).

A secondary but important criterion for selection, aside from the limitation of this study to the defense/ aerospace complex, was the pragmatic one of access and time to pursue the study. Only those firms willing to grant access to sufficient amounts of data were studied. As a result of these considerations, the final sample was limited to six organizations; however, during the course of the study, thirteen additional organizations were investigated for inclusion.

Access to each organization was gained by the personal referral of either Dr. Donald Brennecke of Washington University, St. Louis, or Dr. George Steiner of the University of California, Los Angeles. Each of these men suggested companies and personnel in the companies as contacts for gaining permission to study the particular firm. The contacts included one corporation vice president,

two company[12] general managers, one engineering manager, one project manager, and one manufacturing manager. The companies were located in either the midwestern or the far western region of the United States. The field research was accomplished during the period from July, 1966, to April, 1967.

The organizations studied will be described briefly with reference to six descriptive dimensions: size, products, technical/production index,[13] character of parent organization, major customers, and organizational form. Since a major precondition to granting access was the assurance of confidentiality, the descriptive terms used are necessarily broad. Each company has been coded with a four-letter name with the first letter appropriate to identify the organizational form: The first letter "P" with the code names is used to symbolize project; similarly,

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[12]All organizations studied were divisions of large corporations. For the purpose of this report, the parent corporation will be referred to as the corporation, and the division will be referred to as the company.

[13]The ratio of technical sales to production sales is an estimate made by the researcher based on total company sales and the total payroll of the technical staff. This estimate was made to symbolize a major characteristic of each of the companies. PAST does not manufacture equipment and so the sole effort is the provision of technical services. MUNI earns the major portion of its sales from the production of equipment and so the major technical effort is production support rather than design and development. These two examples were detailed to suggest how the companies view their technical resources based on whether the index is low or high.

the first letter "M" is used to symbolize matrix.

Brief Descriptions of the Project Organized Companies

The company coded PUCK has annual gross sales in the range of $50 million to $100 million. The company's products can be considered ordnance, the term being used to imply that the major technical effort of this company is mechanical and chemical engineering. It has a high level of production orders for its designs; the index of engineering or technical sales dollar to production sales dollar of 0.17 is intended to symbolize this concept. The parent corporation does the major portion of its volume in the consumer/industrial products market, while the company's major customers are NASA and the Navy. The company is organized in a project fashion, as noted by the fact that 80 per cent of the technical personnel report to project rather than functional managers, even to the extent of creating some project forms within larger projects. The technical staff is in the range of 500 to 1,000 men.

PAST has an annual gross sales of less than $50 million and a technical staff of less than 500 men. The major product of this company is the supply of technical services covering the full range of engineering effort short of actual production. The nature of this product implies a technical/production index of infinite value as the divisor (production dollars) is equal to zero.

The parent corporation does the major portion of its volume in the consumer/industrial products market, while the company's major customer is the Air Force. The "projectized" organizational form has been adopted by the company, and approximately 75 per cent of its technical work force reports to project managers.

PAAN has sales over $100 million and a staff exceeding 1,000. Its product is both the design and production of aerospace systems. Since aerospace production is limited to relatively few copies of any one design, the technical/production index for this company is approximately 1.0. The parent corporation is primarily a Department of Defense and NASA supplier, while the company's major customer is NASA. Although a significant volume is handled under a matrix form of organization, the predominant form of this company is that of a project organization. This is apparent from the fact that approximately 70 per cent of the technical staff report to project managers.

Brief Descriptions of the Matrix Organized Companies

The company coded MUNI has a gross sales figure of less than $50 million and a technical staff size of less than 500 men, which is the smallest of the divisions studied. The major product of this company can be classified as mechanical support equipment, and the major technical effort, correspondingly, is mechanical engineering. The sales of this company are composed largely of manufactured

products rather than design; therefore, the technical/production index of the company is approximately 0.05. The parent corporation does the major part of its volume in the consumer/industrial products market, while this company's major customers are the Army and the Navy. The company has adopted the matrix form of organization, as indicated by the low percentage of technical personnel (8 per cent) reporting to project managers.

The company coded as MACH has a gross annual sales volume of under $50 million, which requires the employment of between 500 and 1,000 technical personnel. The major product of this company is the design and production of major electronic sub-systems. Consequently, there is a fairly high level of design and analysis needed, which results in a technical/production index of approximately 0.33. The parent corporation is basically an electronic sub-system supplier whose customers are rather equally balanced, similar to the company, between the Army, the Navy, and the Air Force. This balance is represented on the table as DOD (Department of Defense). The organizational form adopted by this company is the matrix, as only 7 per cent of the technical personnel report to project managers.

The sixth organization studied has been coded as MEST. This company is producing annual sales which range between $50 million and $100 million. The staffing level of the company is in excess of 1,000 technical personnel,

and its products are similar to that of MACH, i.e., electronic sub-systems; it follows, therefore, that the technical/production index is approximately 0.33. The parent corporation of this company is a major supplier of goods to the consumer/industrial market of the United States, while the company is basically a supplier to two major customers: the United States Air Force and NASA. The organizational form adopted by this company is clearly one of a matrix type with only 3 per cent of the technical personnel reporting to project managers. All the above data are summarized in Table 3.

Summary

The chapter has discussed the basic methodology employed in this research--the multiple case approach. Also included has been a description of the companies studied and the specific procedures used to gather data in the field. This chapter concludes Part I, "The Research Problem and Approach to Study." Part II, "The Research Findings and Analysis," which follows, presents the hypotheses in greater detail than Chapter I and reports the specific data gathered in support of or refutation of these hypotheses.

TABLE 3

DESCRIPTION OF COMPANIES STUDIED

Company	PUCK	PAST	PAAN	MUNI	MACH	MEST
Sales $x10^6$	50-100	Under 50	Over 100	Under 50	Under 50	50-100
Technical Staff	500-1000	Under 500	Over 1000	Under 500	500-1000	Over 1000
Products	Ordnance	Aerospace Technical Services	Aerospace Equipment	Support Equipment	Electronics	Electronics
*$\frac{\text{Technical Sales \$}}{\text{Production Sales \$}}$	0.17	Inf.	1.0	0.05	0.33	0.33
Parent corporation's market	Consumer and/or Industrial	Consumer and/or Industrial	Aerospace	Consumer and/or Industrial	Electronics	Consumer and/or Industrial
Company's major customer	NASA/Navy	USAF	NASA	Army/Navy	DOD	USAF/NASA
Percentage of technical staff reporting to project managers for merit review	80	75	70	8	7	3
Company organizational form	Project	Project	Project	Matrix	Matrix	Matrix

*Note: See footnote 13, page 35.

APPENDICES TO CHAPTER II

APPENDIX A

STAFFING QUESTIONNAIRE

STAFFING QUESTIONNAIRE*

Hello, my name is Dick Goodman. I am with the Graduate School of Business Administration of Washington University, St. Louis, Missouri. I am conducting a study concerning the organization of research and development projects. I have secured the permission of your management to ask for your cooperation in answering several questions relating to the study. Before we start allow me to assure you that your responses will be held in the strictest confidence. The data resulting from this study will be so aggregated that the source of any particular answer will be completely disguised. No reference will be made to any specific individual or company. Do you have any questions before we go on?

On the form on the next page please indicate by category your present staffing level and your authorized additions by need date. If you are facing a downturn, please indicate by category and date the magnitude of your firm plans. The second page following contains a few questions relating to the reasons for your present plans. Please answer those as completely as possible.

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*A more detailed discussion of the use of this questionnaire and the results derived from its use are found in Chapter III.

Category	Present Manpower Level	Need This Month	Need Next Month	Need 3rd Month	Need 4th Month	Need 5th Month	Need 6th Month	Need 7th Month	Need 8th Month	Need 9th Month
Chemical engineers										
Civil engineers										
Electrical engineers										
Industrial engineers										
Mechanical engineers										
Aeronautical engineers										
Chemists										
Physicists										
Mathematicians										
Other scientists										

APPENDIX B

PATTERNED INTERVIEW FORM

PATTERNED INTERVIEW FORM*

Hello, my name is Dick Goodman. I am with the Graduate School of Business Administration of Washington University, St. Louis, Missouri. I am conducting a study concerning the organization of research and development projects. You have been selected as part of a sample of managers, whose position and experience are relevant to this study. I have secured the permission of your management to ask for your cooperation in answering several questions regarding this study. (HAND SUBJECT LETTER) (PAUSE) Before we start allow me to assure you that your responses will be held in the strictest confidence. The data resulting from this study will be so aggregated that the source of any particular answer will be completely disguised. No reference will be made to any specific individual or company. Do you have any questions before we go on?

With this assurance, let me proceed to define a few terms about organization so that we are using similar terminology in our discussion. These cards briefly outline the three major forms of organization: functional, project,

*A more detailed discussion of the use of this questionnaire and the results derived from its use are found in Chapter IV.

and matrix. (HAND SUBJECT CARDS) (PAUSE) In the functional organization, both the work assignments and the merit reviews are handled by the functional manager. In the project organization, both the work assignments and the merit reviews are handled by the project manager. In the matrix organization, the work assignment is handled by the project manager and the merit review is handled by the functional manager.

First, let us start with a little data about yourself.

How many years have you been in the defense industry? _____

How many years have you been with this company? _____

Of your total years in the defense industry how many have been associated with a project organization? _____
a functional organization? _____
a matrix organization? _____

What is your present title and position with this company?

_____

This second section is aimed at soliciting your advice as you might give it to an organization that you were consulting with.

How would you recommend a new R&D project be organized?
Project?_____Functional?_____Matrix?_____
Other_____Specify other_____

This third section deals with criteria.

This card has a list of the most common reasons for selecting one organizational form or another. Which, in your mind, are the three most important reasons? Which are the three least important reasons? (Place M in R column for three most important and an L for three least important.)

	R	P	F	M
1. Clear location of responsibility	___	___	___	___
2. Flexibility of staffing	___	___	___	___
3. Ease and accuracy of communication	___	___	___	___
4. Quick reaction capability to sudden changes in project	___	___	___	___
5. Effective cost control	___	___	___	___
6. Form desired by customer	___			
7. Ability to provide good technical supervision	___	___	___	___
8. Ability to provide a clear path for promotion	___	___	___	___
9. Ability to evaluate performance of technical personnel	___			
10. Complexity of project	___	___	___	___
11. Size of project relative to other work in-house	___			
12. Importance to company	___			
13. Other	___	___	___	___
14. Other	___	___	___	___

Are there any other major criteria which you would consider?

For each of the items on the card and any other reasons that you mentioned, rank for me how well the different organizational forms accomplish it? For instance, does project or functional management accomplish the best flexibility of staffing? Which one is second best? (USE THE RIGHT HAND COLUMNS OF THE ABOVE QUESTION FOR RECORDING THESE ANSWERS) (P COLUMN IS PROJECT, F IS FUNCTIONAL, M IS MATRIX) (RETRIEVE CARD) (Note: Most effective is 1, second most effective is 2, etc.)

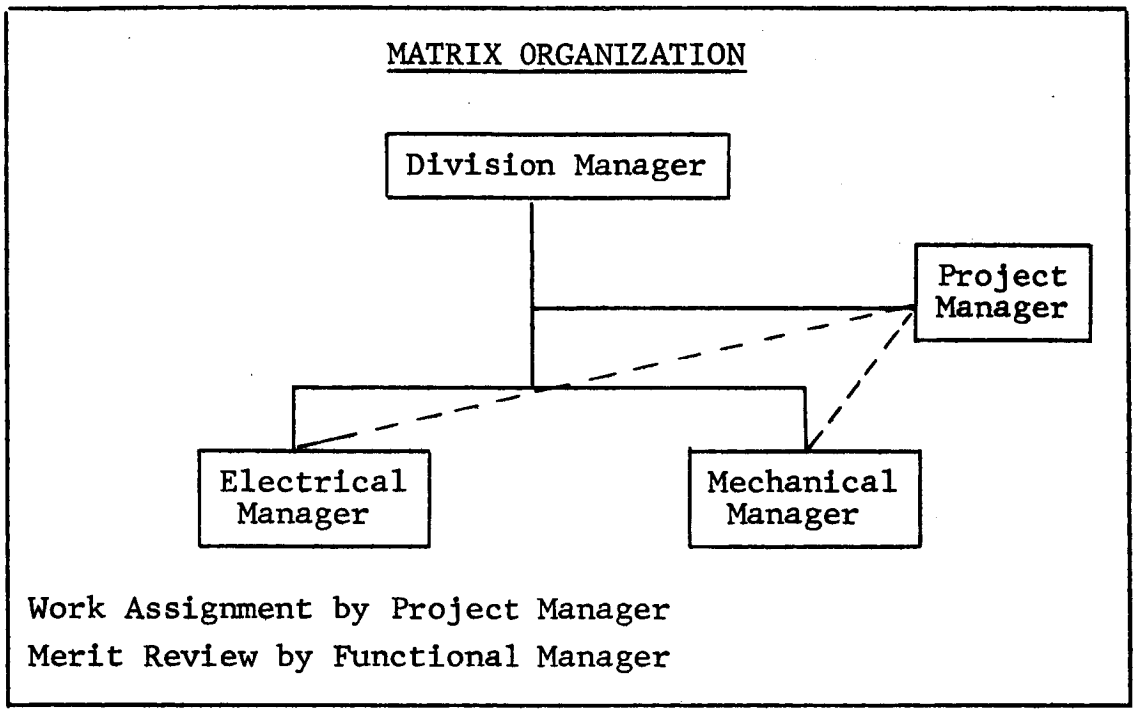
This last section deals with authority distribution.

This card has a list of important project related decisions. (HAND CARD TO SUBJECT) (PAUSE) Should the project manager have final authority on any of these or should some other area of the company have final authority?

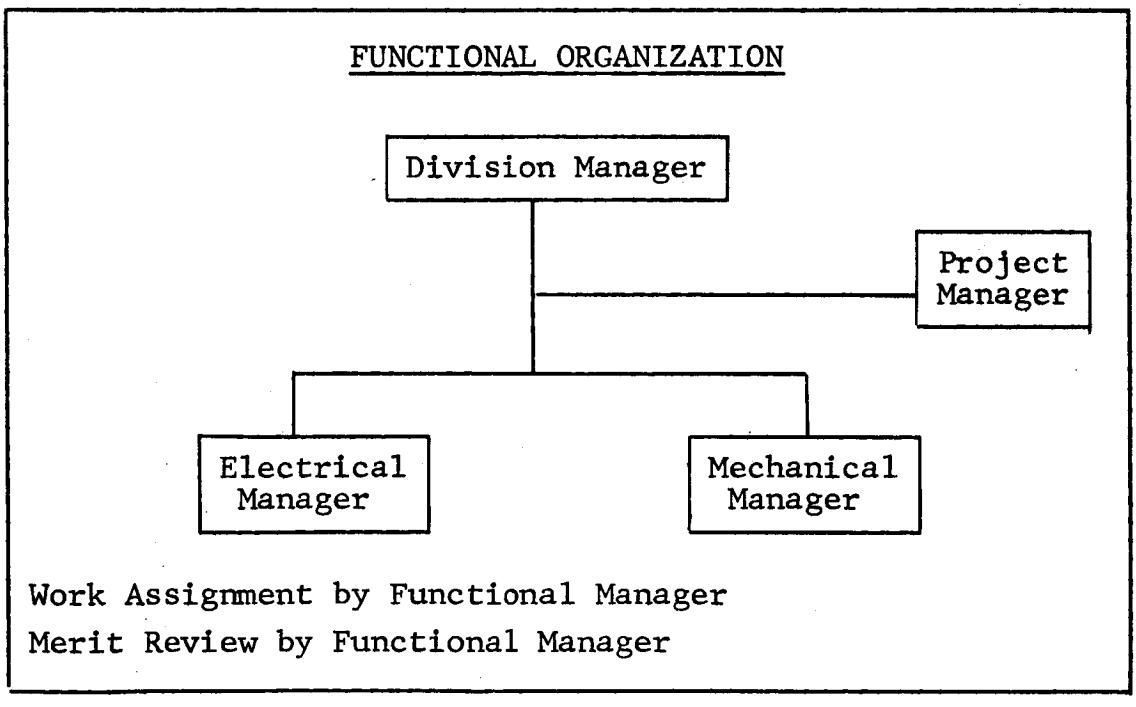
	Pref. Org.	Pres. Org.
1. Initiate work in support areas.	_____	_____
2. Assign priority of work in support areas.	_____	_____
3. Relax performance requirements (i.e., omit tests).	_____	_____
4. Authorize total overtime budget.	_____	_____
5. Authorize subcontractors to exceed, cost, scope, or schedule.	_____	_____
6. Contract change in schedule, cost or scope.	_____	_____
7. Make or buy.	_____	_____
8. Hire additional people.	_____	_____
9. Exceed personnel ceilings when crash effort is indicated.	_____	_____
10. Cancel subcontract and bring work in-house.	_____	_____
11. Select subcontractors.	_____	_____
12. Authorize exceeding of company funds allocated to project.	_____	_____
13. Determine content of original proposal.	_____	_____
14. Decide price of proposal.	_____	_____

Who has the final authority in your present organization to make these decisions? (USE RIGHT HAND SIDE OF ABOVE QUESTION TO RECORD THESE ANSWERS) (RETRIEVE CARD)

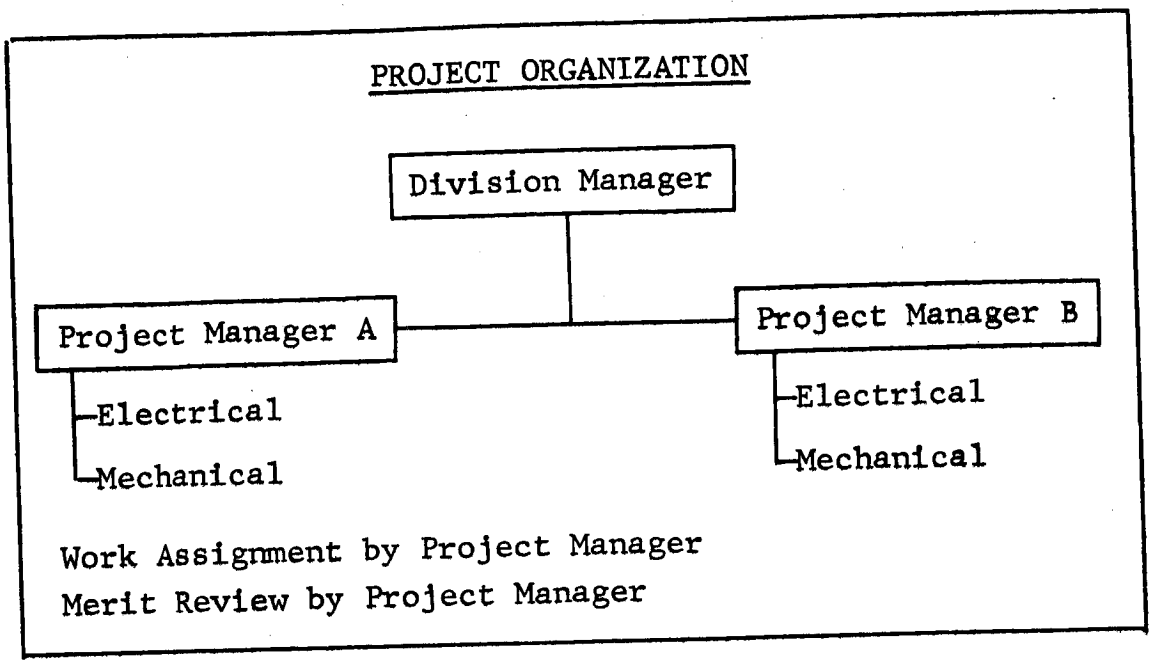
This is the end of the interview. I wish to sincerely thank you for the time and cooperation you have extended.


MATRIX ORGANIZATION
Division Manager
Project Manager
Electrical Manager
Mechanical Manager
Work Assignment by Project Manager
Merit Review by Functional Manager

CARD 1


FUNCTIONAL ORGANIZATION
Division Manager
Project Manager
Electrical Manager
Mechanical Manager
Work Assignment by Functional Manager
Merit Review by Functional Manager

CARD 2



CARD 3

1. Clear location of responsibility.
2. Flexibility of Staffing.
3. Ease and accuracy of communication
4. Quick reaction capability to sudden changes in project.
5. Effective cost control.
6. Form desired by customer.
7. Ability to provide good technical supervision.
8. Ability to provide a clear path for individual promotion.
9. Ability to evaluate the performance of technical personnel.
10. Complexity of project.
11. Size of project with relation to other work in-house.
12. Importance to the company.

CARD 4

1. Initiate in support areas.
2. Assign priority of work in support areas.
3. Relax performance requirements (i.e. omit tests).
4. Authorize total overtime budget.
5. Authorize subcontractors to exceed cost, schedule or scope.
6. Contract change in schedule, or cost, or scope.
7. Make or Buy.
8. Hire additional people.
9. Exceed personnel ceilings when a crash effort is indicated.
10. Cancel subcontracts and bring work in-house.
11. Select subcontractors.
12. Authorize exceeding of company funds allocated to project.
13. Determine content of original proposal.
14. Decide initial price of proposal.

CARD 5

PART II

THE RESEARCH FINDINGS AND ANALYSIS

CHAPTER III

FLEXIBILITY, STAFFING AND TURNOVER

Introduction

For each of the topics covered in this chapter, a similar presentational format will be used. Each topic section will consist of a development of the thought and literature leading to the particular hypothesis, a presentation and analysis of the data gathered, and a set of conclusions drawn from the data. This chapter, specifically, will contain major sections on staffing, turnover, and flexibility, as well as an integrating summary section.

Flexibility: Shifting Manpower from Project to Project

In Chapter I, a table was presented which was entitled, "Summary of Organizational Impact of Project Management versus Matrix Management." In this summary, under the concept of manpower flexibility, were the two following statements. For project management it was suggested that, "Peak manpower needs must be met by overtime while valleys in manpower needs cannot be handled in the short-run due to organizational barriers to temporary transfer." For matrix management it was suggested that,

"Personnel can be transferred for short periods of time as there is a functional manpower pool with other work which can be rearranged in the short-run." It is this comparative concept that suggested the hypothesis that an organizational effect upon manpower flexibility does exist.

Authority and Responsibility

The key to understanding the effect of organizational form lies in first understanding the authority and responsibilities of the managers involved. Smyser points out: "Whether the manager is a functional manager or a project manager, he can only be fairly evaluated as long as the principle of parity of authority and responsibility holds."[1] With regard to the concept of manpower flexibility, what are the respective authorities and responsibilities of the functional and the project manager?

A functional manager has the responsibility to perform efficiently the work of all projects which need the skills of his functional specialty. This means that the staff he assigns to each project's work should be assigned only when work is available and withdrawn as soon as the work is complete. The functional manager's authority allows him to assign his work group in any fashion that he sees fit.

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[1]Craig H. Smyser, "A Comparison of the Needs of Program and Functional Management" (unpublished Master's thesis, School of Engineering, Air Force Institute of Technology, 1965), p. 30.

The functional manager prefers that the input of work to his function will be such that he can balance the utilization of his group by shifting personnel from project to project as each individual project's need ebbs and flows.

A project manager's responsibility is to staff his project as soon as the actual tasks require staff, to reduce staffing of his project during work load valleys, and to increase on his project as the work loads increase. His authority is limited primarily to requesting staff--dependent upon their availability somewhere--and to releasing staff. He does not have other work assignments which allow him to shift staff back and forth between projects as the work demand might suggest.

It can be seen from the above that the functional manager has the authority to handle both the ups and downs of a project task assigned to him (i.e., he can transfer personnel both on and off of a project), while the project manager has the authority to handle the downs but not the ups in his project (i.e., he can release staff but he only can request additional staff). An optimum flexibility of manpower only can occur when various project work loads balance out. If this balance does not occur, there must be some differences in flexibility due to the imbalance of authority and responsibility described above.

This problem is often assumed away by some authors with statements such as the following.

> It is highly unlikely that the initial plan for manpower will fit exactly the actual requirements for input of technical skills. Hence there must be enough flexibility in the administration of the project system as a whole to deploy fruitfully the total personnel resources among the array of project and staff activities. This calls for executive ability to insure optimum distribution of workload.[2]

Aside from just assuming that good management can solve the flexibility problem, certain techniques have been proposed which similarly tend to assume away the problem. Davis suggests that the project team be conceptually drawn from a basic functional "home base."

> In this manner, each new project has a separately constituted work group drawn from their permanent or "home base" assignments within the organization. An arrangement of this type achieves a necessary measure of stability through permanent attachment to the organization, while permitting greater flexibility to adjust each work group to fit the specific manpower requirements of that one job.[3]

Some Behavioral Considerations

What is lacking in the above suggestions is a candid understanding of individual behavior. Some authors have noted that flexibility cannot really be administered but must be motivated. For example, Shepard has observed that "project teams tend to perpetuate themselves . . . , there is often strong resistance to project termination and

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[2]Lawrence W. Bass, The Management of Technical Programs (New York: Praeger, 1965), p. 95.

[3]Keith Davis, "The Role of Project Management in Scientific Manufacturing," IRE Transactions on Engineering Management, EM-9 (September, 1962), 109.

transfer to new groups."[4] Hertz observes that "the establishment of status in the limitations of flexibility makes such transfers (group to group) generally possible only for relatively inexperienced researchers."[5]

These status limitations also may be reflected in flexibility and workload considerations. A functional manager will transfer personnel from one project task to another as long as there is other work to be done. If the functional area is presently or soon to be overstaffed due to a dip in the total workload, then there may develop the well-known tendency for the manager or the group to stretch out the work, which, thereby, reduces the actual manpower flexibility.

Conversely, since a project manager's authority to add staff is negligible, he may avoid releasing staff if he feels that they will be needed in the near future. But when the entire research and development department is under heavy work pressure, a project manager probably will overcome his desire to "hoard" personnel, which means increased flexibility.

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[4]Herbert A. Shepard, "Nine Dilemmas in Industrial Research," Administrative Science Quarterly, I (December, 1956), 302.

[5]David B. Hertz, The Theory and Practice of Industrial Research (New York: McGraw-Hill Book Co., Inc., 1950), p. 182.

The Flexibility Hypotheses

These authority-responsibility concepts suggest that there is an organizational effect on manpower flexibility, while the workload concepts suggest that another major influence exists which has a contrary effect on manpower flexibility. For the purposes of this research, it was hypothesized that the workload effect is stronger than the organizational effect. Formally stated, then, two research hypotheses relating to manpower flexibility were developed:

> HYPOTHESIS ONE: Flexibility of manloading on a research and development project is a function of the workload level in the corporation.
>
> HYPOTHESIS TWO: Flexibility of manloading on a research and development project is not a function of organizational form.

Using these two hypotheses as a focus, the following discussion will present and analyze the data collected.

Flexibility Data

Before discussing the data collection and analytical methods used for testing the above hypotheses, it is necessary to define three terms used in this research: organizational unit, work pressure index, and manpower flexibility index. These are defined below:

The organizational unit includes the direct charging project management, engineering and scientific staff, and the supporting technicians, designers,

draftsmen, and checkers. It does not include any shop personnel, standards and specification writers, technical manual and technical data writers, environmental test personnel, and manufacturing personnel.

The manpower flexibility index is the ratio of the number of personnel within the organizational unit "splitting" their time between one contract and another to the total number of personnel in the company's organizational unit in a unit time period.

The work pressure index is the ratio of total direct labor time (both regular and overtime) charged by the organizational unit to the regular direct labor time charged by the organizational unit in a unit time period. For example, if each man worked forty-four hours in one week, forty regular and four overtime, this index would equal forty-four divided by forty, or 110.

The actual collection of the data to be presented below was accomplished using varying sample sizes and time periods. This variation was necessary due to the form in which the raw data were made available to the researcher. The base time period was either weekly, biweekly, or monthly. For example, if the base period was monthly and an engineer was noted to have charged time to two contracts in that month, he was considered to be a man on a flexible assignment. Conversely, using a weekly period as a base,

an engineer had to charge two contracts within the week to be counted as a flexible man. In regard to samples, either the entire population of the organizational unit was used or a sample of 225 was randomly selected from the population of the organizational unit. A third type of variation in the data collection was the selection of individual time periods. Generally, the sampling was done either in consecutive time periods for as far back as the data were available, or for randomly selected weeks out of each month for as far back as the data were available.

The availability of data leads to several problems of statistical comparison. However, these problems of statistical inconsistency did not obviate the results, which will be described below on a company-by-company basis.

Work Pressure and Flexibility in Matrix Organized Companies

In the MUNI company, the data were maintained in a biweekly form and were available for forty-eight consecutive periods, which is just short of two years. The average overtime worked during this period was rather low--just over 2 per cent. The average flexibility index during these two years was 11.0 per cent. A Spearman rank order correlation of work pressure index (overtime) with the manpower flexibility index was 0.211, which is not significant at the 5 per cent confidence level.

In the MACH company, the data were maintained in a monthly form and were available for nineteen consecutive

months. In this company the average overtime worked was 4 per cent, and the flexibility index average 41.5 per cent, which is quite high. The Spearman rank order correlation between work pressure and flexibility was -0.056, which also is not significant at the 5 per cent confidence level.

In the MEST company, the data were available in a weekly form covering random weeks selected over a three-year period. The total number of weeks in the sample was thirty-five with overtime averaging under one per cent and flexibility averaging 29.3 per cent. In the collection of the data for this company, a sample of 225 persons was selected randomly from the population of the organizational unit. A Spearman rank order correlation between flexibility and work pressure was calculated to be -0.112, which was not significant at the 5 per cent confidence level.

Work Pressure and Flexibility in Project Organized Companies

In the PUCK company the data were available in weekly form over a period of thirty-four months. A sample of 225 men was randomly selected from the organizational unit for each of the thirty-four weeks for which the data were available. The average overtime in this period was close to one per cent, and the average flexibility index was 15.1 per cent. A Spearman rank order correlation between work pressure and flexibility yielded .301, which was not significant at the 5 per cent confidence level.

The PAST company data were available in weekly form over a period of fourteen consecutive weeks. The brevity of this sample was due to the unintentional destruction of fifty-two additional weeks of data, which occurred during the process of correcting the computer program used to extract the data. A 100 per cent sample of the organizational unit was used, yielding an average overtime effort of close to one-tenth of one per cent and a flexibility average of 11.6 per cent. A Spearman rank order correlation between flexibility and work pressure yielded .387, which was not significant at the 5 per cent level.

The PAAN company data were available in weekly form over a period of twenty-one months. A random set of weeks was selected over the period, and a random sample of 225 men was selected from the organizational unit. The overtime averaged 7 per cent, and the flexibility averaged 2.8 per cent. A Spearman rank order correlation between work pressure and flexibility yielded -0.102, which was not significant at the 5 per cent level of confidence.

The data contained in the above paragraphs are summarized in Tables 4 and 5, pages 65 and 66.

Looking at the contrast between project organized flexibility and matrix organized flexibility which is evident in Table 5, there is the acknowledged problem resulting from the data inconsistency. As an approximate method of drawing conclusions, the following operations were performed on the data. First, it was assumed that the

TABLE 4

CORRELATIONS BETWEEN WORK PRESSURE INDEX
AND MANPOWER FLEXIBILITY INDEX

Company	Spearman Rank Order Correlation of Flexibility and Pressure	5% Confidence Interval	Comments
MUNI	0.211	$\pm$0.288	Biweekly data, 48 periods, 100% sample
MACH	-0.056	$\pm$0.462	Monthly data, 19 periods, 100% sample
MEST	-0.112	$\pm$0.341	Weekly data, 34 periods, random weeks, random sample, N=225
PUCK	0.301	$\pm$0.341	Weekly data, 34 periods, random weeks, random sample, N=225
PAST	0.387	$\pm$0.541	Weekly data, 14 periods, consecutive weeks, 100% sample
PAAN	-0.102	$\pm$0.438	Weekly data, 21 periods, random weeks, random sample, N=225

TABLE 5

AVERAGE FLEXIBILITY INDEX

Matrix Company	Average Flexibility Index	Project Company	Average Flexibility Index
MUNI	11.0	PUCK	15.1
MACH	41.5	PAST	11.6
MEST	29.3	PAAN	2.8
Weighted Average Flexibility Index for Matrix Companies 34.6		Weighted Average Flexibility Index for Project Companies 5.0	

A chi-squared test with one degree of freedom indicates that the difference is significant at the one per cent level of confidence.

data for each company were reasonable estimates of the average flexibility in that company. For example, in PAST a fourteen-week sample yields an average flexibility of 11.6 per cent. It was assumed that this was a fair estimate of the average flexibility over the year. Secondly, the average flexibility of the biweekly (MUNI) and monthly (MACH) data was adjusted downward by a factor which was expected to portray the situation with the least differences. (MUNI was reduced to 50 per cent of its actual value and MACH to 25 per cent of its actual value).[6] A chi-squared test was then run between the project organized average, which demonstrated that the averages were in fact different at the one per cent confidence level.

Flexibility Conclusions

The conclusions to be drawn from the above data are relatively clear: (1) Work pressure does not appear to affect manpower flexibility in a significant manner; and (2) Project organizations are significantly less flexible than matrix organizations. Both of these conclusions serve to reject the hypotheses under test and support the

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[6] If every man in the MACH company split charge only one week out of each month, the index would have calculated out to be 100. If the same data had been taken on a weekly basis, the four indexes would have been 0, 0, 0, 100, and the average would have been 25. Therefore, the lowest average flexibility on a weekly basis that could be expected from monthly collected data would be 25 per cent of the actual monthly figure. The argument is similar for biweekly collected data with the factor being 50 per cent.

generally articulated beliefs about these two factors and organizational form.

Why does flexibility not correlate with work pressure? A closer look at the forces which affect flexibility suggests that two "countervailing forces" are at work which tend to hold flexibility relatively level. In times of light work load, there may be a definite psychological pressure to "stretch out" the work available, which would suggest a lessening of flexibility as work load decreases. Conversely, as work load increases, there appears to be a different force which tends also to lessen flexibility. In the short run, it may be extremely difficult to locate personnel who are familiar enough with the design status to effectively contribute to a project. Thus, short-run work pressure generally is handled by overtime, which serves to lessen flexibility.

Further research certainly is needed for a clearer understanding of flexibility. Aside from the "countervailing forces" mentioned above, there would seem to be a need to identify what types of personnel are flexible. For example, draftsmen probably could more easily switch from project to project than could system engineers.

What is the significance of the finding that flexibility is affected by organizational form? On the surface, the data indicate that there is greater flexibility of staffing in matrix organizations than in project type organizations. But a more thorough analysis suggests that

these data could have been generated by either of two underlying processes, only one of which would be "real" flexibility.

The flexible process occurs when engineers are continually being assigned to and withdrawn from a number of projects. If this is truly what happens, then the data gathered for the flexibility index would show an increase to correspond to the increase in flexibility.

A different process occurs when engineers are assigned two or more tasks on which they are expected to work simultaneously and between which they are expected to split their time each week. In a projectized organization, these tasks are normally on the same contract and would be included in these data as non-flexible assignments. In a matrix organization, different tasks often are on different projects and would be included in these data as a flexible assignment. Thus, data under these circumstances would suggest differences in flexibility, when in reality there were no basic differences. Further research is needed to more thoroughly understand which of the two processes is predominant, and to ascertain their effect on any conclusions and recommendations made as a result of this study.

Having completed the general conclusions regarding flexibility, this report now turns to staffing.

Staffing: Manpower Planning and Authorization for Staffing

A quote from Wendell French is appropriate to introduce this section.

> The staffing process is a flow of events resulting in the continuous manning of organizational positions at all levels. This process includes the following components: manpower planning, authorization for staffing, developing sources of applicants, applicant evaluation, employment decisions and offers, induction and orientation, transfers, promotions and separations.[7]

Theoretically, under different organizational forms, manpower planning combined with authorization for staffing should lead to differences in firm, authorized staffing plans. To explore these differences, it is necessary to present an overview of the traditional manpower planning process and then suggest how such a process is implemented in the aerospace industry. This will be followed by a discussion of the impact of organizational form upon the authorization for staffing process, the conclusions of which will be the basis for hypothesis three.

Traditional Manpower Planning

The following quotations from a number of authorities in the field of personnel management describe the essence of the manpower planning process.

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[7]Wendell French, The Personnel Management Process (New York: Houghton Mifflin Co., 1964), p. 111.

Increases in personnel requirements should, if possible, be anticipated sufficiently in advance to permit effective recruitment and training of personnel for the job vacancies. . . . The sales function directly affects the performance and the personnel requirements of all other functions.[8]

In a business firm, the logical point to start the analysis of the work load to be imposed upon the firm or any part of it, is with forecasting sales. . . . The sales forecast will be translated into a work program for the various parts of the enterprise.[9]

The major steps in estimating labor requirements are as follows:

1. Forecast sales
2. Estimate master production schedule
3. Establish department production schedules
4. Convert production estimates into labor requirements
5. Tabulate present work force
6. Estimate number of employees to be separated from payroll
7. Deduct Item 6 from Item 5, to determine net working force
8. Deduct Item 7 from Item 4, to determine replacements to be made or employees to be released.[10]

Furthermore, manpower planning obviously must be integrated with over-all organizational plans pertaining to sales and production, the purchase and use of machinery and equipment, research and engineering, the financial situation of the organization, and the planning of physical facilities.[11]

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[8]Herbert J. Chruden and Arthur W. Sherman, Jr., Personnel Management (2d ed.; Cincinnati: Southwestern Publishing Co., 1963), pp. 106-107.

[9]Edwin B. Flippo, Principles of Personnel Management (New York: McGraw-Hill Book Co., Inc., 1961), p. 129.

[10]Michael J. Jucius, Personnel Management (rev. ed.; Chicago: Richard D. Irwin, Inc., 1951), p. 103.

[11]French, op. cit., p. 115.

> The analytical exercise now comes into its own. With plans available for product development objectives, market expansion, and technological progress, each technical department can prepare a plan for its anticipated needs. . . . The individual department may then forecast its manpower needs.[12]

> . . . the chief executive . . . [should] hold the personnel director and the department heads jointly accountable in this vital undertaking.[13]

Thus, it can be seen that the essential ingredients of manpower planning are (1) forecasting sales, (2) converting this forecast into overall manpower requirements, (3) considering other plans which require staff, and (4) extending the forecast into detailed manpower needs.

Manpower Planning in Aerospace

In the research and development sector of the aerospace industry, the normal sale is not for some extra units of a relatively standard product (e.g., one automobile, twenty typewriters, etc.) but for a rather large amount of a specialized product. A normal research and development contract will call for the employment of at least 5 per cent of the technical work force and a mix of technical skills that is peculiar to the specific contract. It is this "lumpiness" of sales and the particular skill mix requirement that lead to complications in the manpower

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[12]Gerd D. Wallenstein, Fundamentals of Technical Manpower Planning, Management Bulletin No. 78 (New York: American Management Association, Research and Development Division, 1966), p. 18.

[13]French, op. cit., pp. 118-119.

planning process. Manpower planning cannot be done by the relatively simplistic approach of more traditional industries (i.e., applying manpower ratios to gross sales information). The complications are compounded by the high level of uncertainty associated with the receipt of any specific contract.

To compensate for the special problems of manpower planning, the aerospace industry has adopted a combined sales forecast-manpower planning approach. A composite description of this sales/manpower forecast is presented here. First, a listing of all outstanding new business proposals is compiled along with an estimate of their receipt date and a detailed manpower plan for their completion. These data are then factored by applying a "probability of receipt" factor to each of the manpower plans. These probabilistic plans are then added to firm plans arising from business presently under contract to arrive at a detailed manpower forecast.

This is adequate for general corporate planning, but the specific needs for particular contracts make it impossible to base hiring on such a forecast. Generally, personnel departments then work to maintain access to a wide source of applicants which can be tapped when a specific contract is received. They usually actively recruit for those types of technical talent which would be interchangeable given the list of possible contracts.

Organization and Authorization for Staffing

One of the basic control systems used in conjunction with employment levels is the authorization for staffing. The decision to add an employee to any particular group is reviewed by several managers (both line and staff) to assure that the person is needed, and that the implications of his arrival are properly considered (e.g., space, budget, wage range, etc.). The formalization of this process is generally called the "authorization to staff."

Organizational form has a direct impact upon the authorization to staff. In a matrix organized research and development department, the department head has the responsibility to provide staff for any new effort. He can take advantage of the probabilistic manpower forecast and authorize the recruitment of at least some technical personnel. If the specific contracts expected do not materialize as rapidly as planned, the department head can place new hires on existing contracts which would not be adversely affected by some additional attention at this time.

However, in a project organized research and development department, there usually is no one who has: (1) the responsibility to be prepared to staff new projects, (2) the authority to authorize staff acquisition based on a probabilistic estimate of need, nor (3) a position to provide a new hire in the case that he arrives in advance of contractual coverage. A project manager assigned to an

expected contract usually cannot authorize staffing until the contract has been awarded. A project manager assigned to a current contract does not have the responsibility for new contracts, cannot authorize staffing for other than his own contract, and would be severely criticized if he absorbed new hires in an effort to keep them until an expected contract actually arrived.

The Staffing Hypothesis

The distinctions in the authorization for staffing discussed above suggest how the type of organizational form may affect the system for firm, authorized manpower planning in a research and development department of an aerospace corporation. This discussion suggests the following hypothesis which was developed for study in this investigation:

> HYPOTHESIS THREE: A research and development organization which is matrix organized will tend to have a longer definite planning horizon for staffing than will a research and development organization that is project organized.

Using this hypothesis as a focus, the discussion will now turn to the presentation of the data collected.

Staffing Data and Analysis

The data on staffing were collected from the personnel records of the various divisions under study utilizing the form presented in Appendix A, Chapter II. The form classified staff planning data in the categories used by the United States Employment Service for their system. The U.S.E.S. classification system is based on college major (i.e., electrical engineer, metallurgist, etc.); this caused some difficulty, because firms in the sample classified employees by function (i.e., development engineer, test engineer, etc.). In general, classifying personnel listed by function was accomplished by observing the specific job of the department they were in, which suggested a probable college major.

Since the concern of this research was to investigate firm, authorized planning, a screening method was employed to ascertain the confidence that various personnel departments had in the data supplied. In other words, were they authorized to actually hire the personnel their data suggested they required? For example, if a personnel manager indicated the need for a chemist in six months, and such a man was available in the first month of the plan, would he be hired? Only if a positive answer was given was the data included in the study.

Tables 6-11 included in this section represent only those periods for which data were available. For purposes

of maintaining confidence no absolute numbers are presented in the data. Except as noted, the first column of each table lists the percentage of the total present manpower level represented by the appropriate category. The remaining columns represent the percentage of additional staff needed per month per category. For example, if there are fifty chemists in a company and this is 5 per cent of the total staffing, this would be represented as five in the present staffing column. If in the third month eight new chemists were needed, this would be represented by sixteen, as an additional 16 per cent of the original fifty chemists would be needed.

Staffing Data-Project Organizations

Table 6 presents the data collected for the PUCK company. The data indicate that the company had a staffing horizon of nine months. The horizon was unusually long for this company and represented some major new projects which were 90 per cent "firm" at the time the data were gathered. (These contracts did indeed occur.)

The basic policy of PUCK is to engage in heavy recruiting efforts during times of stability as well as growth, with recruiting plans being based upon expected attrition and "firm" projects. In an interview with the personnel manager, he admitted that these data represented unusual circumstances and that PUCK's normal planning horizon was approximately three months.

TABLE 6

STAFFING PLAN OF PUCK COMPANY
(SIZE = 500 - 1000 MEN)

Category	Percentage of Total Present Manpower Level	Percentage of Present Manpower Level in Category								
		Need This Month	Need Next Month	Need 3rd Month	Need 4th Month	Need 5th Month	Need 6th Month	Need 7th Month	Need 8th Month	Need 9th Month
Chemical Engineers	4%	0	3	3	3	3	6	3	6	3
Civil Engineers	2	33	13	13	13	7	7	7	7	7
Electrical Engineers	22	21	16	18	6	3	3	2	4	3
Industrial Engineers	14	6	6	6	5	5	4	4	4	5
Mechanical Engineers	32	7	7	9	4	3	3	3	4	4
Aeronautical Engineers	3	17	9	9	4	4	0	0	4	4
Chemists	10	0	1	2	1	1	1	2	2	3
Physicists	7	11	9	5	5	6	2	2	6	8
Mathematicians	2	10	10	15	10	10	5	5	10	10
Other Scientists	4	12	15	9	6	3	3	3	3	3
Total	100%									

Note: See pages 76 and 77 for explanatory material regarding the presentation of these data.

Table 7 presents the data for the PAST company. Present manpower levels by categories were unavailable, and so the manpower need data indicate percentages of total manpower level rather than category manpower level.

TABLE 7

STAFFING PLAN OF PAST COMPANY
(SIZE = UNDER 500 MEN)

Category	Percentage of Total Present Manpower Needed This Month
Chemical Engineers	1
Electrical Engineers	4
Mechanical Engineers	1
Aeronautical Engineers	3
Physicists	1
Mathematicians	2
Other Scientists	1

The manpower planning horizon for PAST was but a single month. Definite recruiting plans were constrained by the fact that PAST usually bids only on very large projects, and it therefore engages in no probabilistic hiring. The manpower requirements shown arose solely from terminations, and the overall level of these requirements was a function of the termination rate and the hiring rate, with the hiring rate being controlled by the tightness of the labor market.

The policy of PAST is to recruit only replacement personnel, which directly implies a planning period limited to a single month.

The PAAN company is represented in Table 8. The table indicates a six-month manpower planning horizon, but this is misleading. There are two underlying policies which affected the data below. PAAN has adopted a college recruiting policy which is somewhat independent of the rise and fall of contracts. The company typically does its major college hiring in February and June, and this is what the data in the table actually represent.

TABLE 8

STAFFING PLAN OF PAAN COMPANY
(SIZE = OVER 1000 MEN)

Category	Percentage of Total Present Manpower Level	Percentage of present manpower level in category	
		Need 3rd Month	Need 6th Month
Chemical Engineers	3%	2	2
Civil Engineers	5	0	2
Electrical Engineers	23	1	1
Industrial Engineers	4	3	5
Mechanical Engineers	27	1	1
Aeronautical Engineers	19	1	3
Chemists	4	1	1
Physicists	7	3	4
Mathematicians	8	5	5
Total	100%		

At the time of this research, PAAN was facing a downturn and had no definite recruiting plans other than its college program. During normal periods, the company has a policy of establishing quarterly recruiting plans; but when facing a downturn, the planning horizon for manpower is limited to one month. Typically, the personnel department is notified one month prior to the release date that a particular engineer is available for transfer and/or separation.

Staffing Data-Matrix Organizations

The first matrix organization to be discussed is the MUNI company, whose staffing plan is presented in Table 9.

TABLE 9

STAFFING PLAN OF MUNI COMPANY
(SIZE = UNDER 500 MEN)

Category	Percentage of Total Present Manpower Level	Percentage of Present Manpower Level in Category
		Need This Month
Electrical Engineers	37%	7
Industrial Engineers	5	0
Mechanical Engineers	58	13
Total	100%	

The time horizon here is only a single month, which primarily reflected the division's policy and relatively small size. MUNI's staffing policy is not to hire until a contract is actually received, even though this policy tends to severely constrain the planning horizon. An underlying reason for this policy lies in the relatively small size of this company, which means that it cannot afford to "store" an engineer in anticipation of a contract. This size constraint has contributed directly to the policy and the policy to the time horizon.

Table 10 indicates the staffing plans of the MACH company, which is considerably larger than MUNI. The six-month plan shown in the table was available due to a policy of planning that utilizes a six-month moving forecast.[14]

The forecast was developed by the personnel department through a system of experience and participation in general planning. The personnel manager is a primary member of the general planning group and as such is kept abreast of all present and probable new business requirements. An "experience factor" is applied to the company's attrition rate and to the division's estimate of requirements from present business and expected new business. It is interesting to note that the staffing process at MACH is very close

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[14]A six-month moving forecast is a device wherein the company plans for six months into the future and updates its plans every month while maintaining a six-month time horizon.

TABLE 11

STAFFING PLAN OF MEST COMPANY
(SIZE = OVER 1000 MEN)

Category	Percentage of Total Present Manpower Level Need 2nd Month
Chemical Engineers	1
Electrical Engineers	23
Mechanical Engineers	3

The MEST company forecasts its manpower needs over a two-year time horizon. The forecast is turned into definite plans on a quarterly basis. At the time of this investigation, there were but two months left in the quarter. Therefore, the time horizon shown is only two months.

This completes the presentation of the basic data findings relating to the staffing hypothesis. The following section will further analyze the data and synthesize conclusions which appear to be supported by the data.

Conclusions Concerning the Staffing Hypothesis

In order to better compare the relationship of organization form to staffing horizon, the data of Tables 6 through 11 are summarized in Table 12.

to the process described in the development of the hypothesis (see page 75), with the significant exception that it is formally constrained to a moving six-month forecast.

TABLE 10

STAFFING PLAN OF MACH COMPANY
(SIZE = 500 - 1000 MEN)

Category	Percentage of Total Present Manpower Level	Percentage of Present Manpower Level in Category					
		Need This Month	Need Next Month	Need 3rd Month	Need 4th Month	Need 5th Month	Need 6th Month
Electrical Engineers	73%	5	3	2	2	2	1
Mechanical Engineers	10	13	9	5	5	5	5
Aeronautical Engineers	1	0	0	0	0	0	0
Chemists	1	0	0	0	0	0	0
Physicists	6	0	0	0	0	0	0
Mathematicians	9	10	5	5	5	5	5
Total	100%						

The third company in the matrix sample is MEST. Its manpower planning approach is indicated in Table 11. Availability of data was such as to preclude showing manpower needs by categories, and so the planning data are presented as a percentage of total present manpower.

Examination of Table 12 indicates that the research findings do not support the hypothesis that matrix organizations have longer staffing plans than do project organizations. Although interview data collected during the course of this study almost universally supported the logic which led to the hypothesis, the data did not.

However, there is an explanation for this lack of difference. This study has observed that formal policies rather than organizational form had the most important influence on company staffing horizons. Company policies took basically three forms:

1. The plan should be made periodically on a fixed time horizon basis (MACH, MEST, PAAN).
2. The plan should be made only on business under contract (MUNI, PAST).
3. The plan should be made on both firm and high probability business (PUCK).

It is suggested that organizational form would have had a major effect on staffing horizon, only if all of the companies in the sample had adopted policy three above. Thus, it appears that the effect of formalized planning and control systems and their resultant policies almost completely mitigate the effects of organizational form upon a company's staffing horizon.

TABLE 12

STAFFING SUMMARY

Company	Actual Staffing Horizon at Time of Study	Typical Staffing Horizon Adjusted for Abnormalities	Firm Staffing Horizon is Based upon
PUCK	9 mo.	3 mo.	Firm Business and High Probability of New Business
PAST	1 mo.	1 mo.	Firm Business Only
PAAN	6 mo.	3 mo.	Quarterly Estimate Plus College Plans
MUNI	1 mo.	1 mo.	Firm Business Only
MACH	6 mo.	6 mo.	Six-Month Moving Forecast
MEST	2 mo.	3 mo.	Quarterly Estimate

This table brings together the individual results and the major policy determinants of such results. The typical staffing horizon was estimated by removing the effects of unusual circumstances present at the time of the data collection and by relying upon the stated policies for guidelines. For example, PAAN showed an actual plan of six months which was a result of its policy to hire new college graduates regardless of the fact that the company was facing a downturn. An interview with the personnel manager revealed that PAAN normally uses a quarterly planning format; therefore, the typical staffing column shows three months for the PAAN entry.

Turnover: Organizational Effects on the Voluntary Termination Rate

To develop this hypothesis, consideration will be given to four interdependent concepts which combine to suggest an organizational effect upon the rate of voluntary terminations. These concepts are: project life cycle, sense of completion, "face," and organization. They will be treated explicitly in the following sections.

Project Life Cycle

The first concept to be discussed is the project life cycle. From a staffing point of view, a research and development project usually begins with just a few men working on it. As the research problem develops, additional skills are brought into the project and the staffing curve begins to rise. As the project moves toward the development of hardware, the staffing on the project increases and eventually peaks. At this time the major conceptual design is completed, and the effort shifts to the maintenance of design integrity in the face of minor problems which may occur. The engineering challenge follows a similar life cycle. At the outset, there are many problems to be solved. One author suggests that from 50 to 100 events (discrete, identified contributions) may be necessary to the successful completion of a typical advanced system.[15] As engineering

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[15] C. W. Sherwin and R. S. Isenson, First Interim Report on Project Hindsight (Washington, D.C.: Office of

problems are solved, the character of the engineering changes from one of conceptualization to one of integration of change into an existing design. At a different level, the process will include the creation of a drawing set and then move to the stage of continually updating an existing drawing set. From this brief discussion, one can see that the nature of the task involved will change dramatically over the life cycle of a project. With this in mind it is next necessary to add the concept of completion.

Sense of Completion

The "sense of completion" concept simply observes that man is constantly aware of the completion of the various tasks he is undertaking even though they each are part of a larger process called life. Man views life as a series of sequential sub-goals and constantly is striving for the achievement of the next sub-goal. "Gestalt psychologists speak of a 'closure tendency' which persists until the completion of a task."[16] This concept of being sensitized to any event which suggests completion has been generally developed by Gestalt psychologists such as Katz.[17]

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the Director of Defense Research and Engineering, June, 1966), p. 9.

[16]Gordon W. Allport, Pattern and Growth in Personality (New York: Holt, Rinehart and Winston, Inc., 1961), p. 233.

[17]David Katz, Gestalt Psychology (New York: The Ronald Press Co., 1960), p. 123.

To link this sense of completion to the project life cycle, it is suggested that the actual completion of a project task or the understanding that the challenging portion of the project is past tends to develop a sense of completion for the engineers involved. Such a sense of completion is often accentuated by the various actions a company might take while deciding where to reassign the engineers made available by the task's completion. Some form of manpower pool is generally used during this decision period.

> The employees enter such a pool by ceasing to charge their time to the project and by commencing work (or non-work) under any one of a number of internal billing codes at the company. These vary from obvious overhead codes referring to engineering waiting time and engineering work on closed out contracts to work of a less obvious nature.[18]

The entrance into such a pool is a clear sign of task completion, and it may become a period during which the engineer is usually not challenged by the new tasks he is assigned. This period of little challenge is affected by the concept of "face."

"Face"

The concept of "face" or self-image has been described in the work of Goffman.[19] Over time an individual

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[18] Joe Neal Nay, "Choice and Allocation in Multiple Markets; A Research and Development Systems Analysis" (unpublished Master's thesis, Department of Electrical Engineering, Massachusetts Institute of Technology, 1965), p. 32.

[19] Erving Goffman, "On Face-work," Psychiatry, XVIII (1955), 18.

develops a strong self-image, and this tends to stabilize the "face" presented to the world. The overt characteristic of this "face" is a mode of behavior which the individual believes is "correct" given his self-image. For instance, the self-image of a manager often suggests to the individual that he should appear at work in a suit and tie rather than in sports clothes. Another example of "face" is the manager who feels it is inappropriate to answer his own telephone as this would not project the correct image to his callers. This attempt to maintain a stabilized "face" to the world relates directly with the life cycle-sense of completion concepts treated above.

As the challenge of a project's work decreases, certain engineers may feel that it is not proper for them to be seen as a person who is happy about doing "lower level" work. This results in their feeling that the period of their worthwhile contribution to the project has reached an end, and in the feeling that it is an appropriate time to look for more suitable work within or outside of the company. An interesting outside offer to an engineer at such a time may result in an unwanted (by the company) voluntary termination.

Organization and Voluntary Termination

The preceding discussion has suggested that during periods close to the completion of a major project task the engineers involved may be susceptible to outside

opportunities. Therefore, voluntary terminations will be one of the dysfunctional outcomes of project task completion. This section will discuss the effect of organizational form on the tendency to terminate.

Under the project form of organization, the sense of completion is strongly accentuated. The actual end of a major project task in a project organization requires the physical movement of the engineers involved from the project area to the area where their new assignment will be undertaken. This movement means a major change in the individual's formal and informal relationships (i.e., new boss, new peer groups, etc.). Secondly, as the engineering challenge is met and overcome, the engineers who stay with the project tend to be required to perform less challenging work. Over time it may appear to these engineers that their talent is being wasted.

Conversely, in the matrix organized company the end of a major project task does not mean physical transfer and the major alteration of formal and informal relationships. The switch of an engineer from one project to another in matrix organizations tends to require some adaptation of the engineer's interaction pattern, but it does not require the wholesale changes implied in the projectized organization. Also, as the engineering challenge is met and overcome, the less challenging work is usually reassigned to another group for whom such work is challenging (i.e., from research to development engineering, or from development engineering to

production engineering, etc.). This reassignment may affect the tendency for an engineer to look for other work, since the work in a particular group will generally be challenging.

The Turnover Hypothesis

The above discussion has suggested that either a strong sense of task completion or a lack of challenging work may act as a triggering cue that sensitizes an individual to outside opportunities. The discussion also suggested that organizational form has a major impact on the strengths of the sense of completion or lack of challenge. This then leads to the following hypothesis.

> HYPOTHESIS FOUR: The turnover rate for technical personnel who terminate voluntarily with the sense of project completion as a contributory factor will be greater in project organized companies than in matrix organized companies.

It is now appropriate to turn to the data collected and to see whether the data support or reject the hypothesis.

Turnover Data and Analysis

The technique applied in the collection of turnover data was to carefully scrutinize the content of termination documents. Categories of terms were developed for use as cues in classifying the information. A termination document was scored as reflecting sense of completion if concepts similar to the following were encountered: "challenge lacking due to completion level of project"; "work assignment dropped off in the past few weeks"; "placed on transfer

status"; "would not enjoy the maintenance assignments which would have been given"; etc. All of these type quotes indicated either a sense of completion or of a change in the quality of future assignments. With the categorization scheme in mind, the actual data are described in the following sections.

The MUNI company did not keep written records of its termination interviews. Therefore, the employment manager was interviewed and actual termination records were searched. The number and identification of all the voluntary technical terminations were easily determined from the records for the three-year period of 1964, 1965, and 1966. The employment manager was asked to recall the circumstances which led to each termination, and his responses were then coded in the manner defined above. In this company, there were no terminations due to sense of completion. The MUNI company offered a great deal of security by allowing a large fluctuation in overhead rates as the work load varied. This tended to dampen the tendency to move due to a sense of completion. By far the most frequent reason for terminating in this company was for a substantial increase in salary.

In MACH the basic data were obtained by the interview method. The termination documents were not made available to the researcher. The division had implemented an extensive exit interview program, which included having a trained interviewer assigned full-time to the program. The data reported for MACH were estimates made by this trained

interviewer after a lengthy discussion about the sense of completion concept and the hypothesis under consideration. The estimate of the "sense of completion" rate by the company exit interviewer was 10 per cent.

Documentary evidence available in MEST was made available to the researcher. Included were the reports of the division personnel manager who did the termination interviews, and the opinions of each employee's supervisor regarding the reasons for his termination. The data were available for a four-year period starting in 1963 and extending through 1966. Analysis of the records revealed a "sense of completion" termination rate of 5.5 per cent.

At PUCK the data were available from post-termination questionnaires. This division did not interview at the time of separation but sent questionnaires to former employees approximately two months after termination. The questionnaires did not require identification of the respondent but did allow for an indication of job title and department. The return rate on these questionnaires was approximately 25 per cent. The questionnaire revealed a "sense of completion" termination rate of 7.2 per cent.

The PAST company was able to supply both exit interview records and supervisory evaluations with respect to the voluntary technical terminations. The interviewing in this case was handled by the personnel manager or the supervisor. The "sense of completion" rate found in this company was 13.0 per cent.

The labor relations staff at PAAN handled the termination interviews using a patterned open-ended questionnaire format. The procedure followed was part of an extensive separation review program, and the data normally were statistically analyzed for possible action. Data were available for the three-year period from 1964 through 1966 and revealed a "sense of completion" termination rate of 19.8 per cent.

The data summarized below in Table 13 were subjected to a chi-square test. This test revealed that the difference between project organized and matrix organized rates of voluntary termination due to a "sense of completion" was significant at the one per cent level of confidence.

TABLE 13

SUMMARY OF TURNOVER DATA: PERCENTAGE OF VOLUNTARY TECHNICAL QUITS REFLECTING SENSE OF COMPLETION

Company	Percentage	Source of Data	Company	Percentage	Source of Data
MUNI	0.0	Interviewer	PUCK	7.2	Documents
MACH	10.0	Interviewer	PAST	13.0	Documents
MEST	5.5	Documents	PAAN	19.8	Documents
Weighted Average Matrix Percentage 5.2			Weighted Average Project Percentage 13.3		

Turnover Conclusions

The data presented in the preceding section support the hypothesis that organizational form does have a significant effect upon the rate of voluntary terminations. Project organized companies appear to have a significantly higher rate of voluntary terminations than do matrix organized companies, when those terminations that indicate a "sense of completion" are compared.

Of course, it is recognized that the magnitude of the voluntary termination rate is a function of other factors such as the supply of other opportunities both internal to the company and in the general market place; economic considerations; the basic organizational climate of the company (i.e., is it a pleasant place to work or not?), etc. For example, the aerospace engineer in the Los Angeles area tends to live in the so-called "space corridor," which runs along the coastline from Santa Monica at the north to below Huntington Beach. Within this space corridor are several giant aerospace corporations as well as innumerable smaller aerospace-related companies. An engineer living in this area can readily switch positions, as he does not have to move his family. This increases the tendency to change jobs. Conversely, an aerospace engineer in St. Louis has very few opportunities for changing positions without relocating his family, and this may tend to reduce the tendency to terminate.

It is suggested that future research might investigate the lines of corporate market and external market impacts upon the voluntary termination rate and the effect of overall organizational climate on this rate.

Summary

The basic findings and conclusions reached from the data presented in this chapter were as follows:

1. Project organized companies exhibit less manpower flexibility than matrix organized companies.
2. Work pressure does not appear to have a significant effect upon manpower flexibility.
3. Staffing plans are not significantly affected by organizational form because of the very strong impact of planning policy.
4. Voluntary terminations of technical employees with a "sense of completion" occur at a significantly higher rate in project organized companies than in matrix organized companies.

A further evaluation of these findings and their relationship to other organizational questions will be interwoven with the findings from the following chapter and presented in Chapter V, "Summary and Recommendations."

CHAPTER IV

ORGANIZATIONAL PREFERENCE

Introduction

What are the major criteria used in the selection of a particular organizational form? Does the formal position of a man in the company hierarchy affect his organizational preferences? The material presented in this chapter is intended to suggest answers to these types of questions. The initial section discusses the explicit hypothesis tested and develops this hypothesis from the body of relevant literature. Later sections present and analyze data on organizational preference, criteria for selecting organizations, and the authority distribution question.

Organizational Preference

The basic concern of this study has been the management of research and development projects. Under any of the organizational forms considered, there are at least two relevant managerial hierarchies. A specific task in a specific project has a direct relationship with both the company hierarchy and the project hierarchy, as the following quotations suggest:

> The essence of [project] management is that it is interfunctional and is often in conflict with the normal organization structure.[1]
>
> Since the project manager's authority cuts through superior-subordinate lines of authority, he conflicts with the functional managers who must share authority in their functional areas for the particular project.[2]

It is well recognized that there is ample opportunity for conflict to occur due to the general structure and functioning of project management. In general, the project approach is considered to be effective when the work to be done has one or more of the following characteristics. These are:

- Definable in terms of specific goal.
- Infrequent, unique, or unfamiliar to the present organization.
- Complex with respect to interdependence of detail task accomplishment.
- Critical to the company because of the threat of loss or serious penalty.[3]

When the nature of the task is one of complex interdependency, there needs to be a person designated who can supervise the "trade-off" between each of the work units involved in the task accomplishment. A person so designated assumes the role, and usually the title, of project manager. Because of the complex interdependencies, the project manager

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[1]R. A. Johnson, F. E. Kast, and J. E. Rosenzweig, The Theory and Management of Systems (2d ed.; New York: McGraw-Hill Book Co., Inc., 1967), p. 146.

[2]David I. Cleland, "Why Project Management?" Business Horizons, Winter, 1964, p. 82.

[3]John M. Stewart, "Making Project Management Work," Business Horizons, Fall, 1965, p. 54.

must be vested with some authority to enable him to prevent suboptimization on the part of the work units while maximizing the optimization of the total task.

Project management is also necessary because:

> No one in a functional organization besides the company or division manager is entirely responsible for project costs and profits. Functional department executives are concerned only with doing specialized work within budget.
>
> Functional departments often are jealous of their prerogatives, and fight to promote and preserve their specialties rather than work toward a unified project objective.[4]

To overcome such problems, a project manager is appointed with responsibilities similar to the following:

> (1) Manage (plan, organize, coordinate, control, and direct) the collective actions of participating organizations in planning and executing the system [project].
>
> (2) Propose and/or prepare modification of, or changes to, the system [project] within the limits of guidance received from participating organizations or higher authority.
>
> (3) Make changes to the system program consistent with his authority as required to maintain internal balance of the [project].[5]

But, as Smyser has observed:

> "The SPD (System Program Director) must often work in close coordination with organizations outside the AFSC (Air Force Systems Command) in addition to the participating commands. . . . The amount and quality of support which the SPO (System Program Office)

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[4] C. J. Middleton, "How to Set Up a Project Organization," Harvard Business Review, March-April, 1967, p. 74.

[5] Air Force Regulation 375-3, Systems Program Director (Washington, D.C.: Department of the Air Force, June 1, 1963), p. 1.

> obtains from external agencies is probably more dependent upon the personal attitudes and abilities displayed by the SPO personnel than due to legal authority." However, no matter what methods he uses to obtain his authority, obtain it he must, for "He stands in a position to receive credit for successful accomplishments or to accept responsibility for failure."[6]

In other words, the essence of the project management technique is the designation of an individual to coordinate and control complex interdependencies by delegating to him a second authority network which becomes an overlay to the otherwise purely functional organization.

The superimposition of a secondary authority network leads directly to a violation of the principle of unity of command and thus to an inherent conflict situation. There is either conflict between the project manager and the functional manager over what the workers should do, or the project manager and the functional manager ignore this conflict and the worker himself is faced with a conflict between the various requirements placed on him by his two bosses. This dual authority problem is very uncomfortable to the people working under it and must be resolved by some form of secondary adaptation to the manifest system.

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[6]Craig H. Smyser, "A Comparison of the Needs of Program and Functional Management" (unpublished Master's thesis, School of Engineering, Air Force Institute of Technology, 1965), p. 33. Internal quotes are pages 14 and 11, respectively, from Air Force System Command Manual 375-3, Systems Program Office Manual (Washington, D.C.: U.S. Air Force Systems Command, June 15, 1964).

> Since the authority and responsibility patterns represent a "web of relationships" rather than a discrete hierarchial flow, there is conflict between the project manager and the functional managers. Functional managers find themselves sharing their authority with the project manager. The result is the emergence of "project authority," a concept of authority which departs radically from the line-staff organizational dichotomy that has been the mainstream of management theory.[7]

As a corollary to the conflict in authority, there is the organizational problem referred to as "projectitis."

> "Projectitis" is a seeing of all things as though a particular project were the center of the corporate universe--the alpha and the omega of the development effort. This phenomenon of organizational beings as observed in World War II was called "theateritis." The late General Henry H. Arnold, in his autobiography "Global Mission," remarked that the disease of theateritis--the inability of an Air Force commander to be cognizant of the problems of war in any theater other than his own--caused him great concern and trouble in his personal dealings with his top field commanders. However, General Arnold noted at the same time that he would not have under his command any general who did not suffer from this disease.[8]

The underlying factors here are the different objectives of the two levels of management. The major objective of project management is the solution of the technical problem in a fashion which will produce the greatest project profit. The major objective of general management is the

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[7]David I. Cleland, "Contemporary Military Program Management," California Management Review, Winter, 1966, p. 67.

[8]Paul O. Gaddis, "The Project Manager," in C. Heyel (ed.), The Handbook of Industrial Research Management (New York: Reinhold Publishing Co., 1959), p. 96. The full reference for Global Mission is Henry H. Arnold, Global Mission (New York: Harper and Brothers, 1949).

allocation of company resources so as to maximize progress on all projects within the company and produce the greatest possible company profit. As the maximization of company profit must occasionally be accomplished at the expense of a particular project's profit, a basic conflict may arise between general management and project management. Thus, each level of management would probably prefer an organizational form which would minimize the other level's ability to frustrate its objective. This leads to the following hypothesis:

> HYPOTHESIS FIVE: Project management will tend to prefer the project form of organization, while general management will tend to prefer the matrix form of organization.

It is now appropriate to turn to the data collected in an attempt to support or reject this hypothesis.

Survey of Executive Opinion: Data and Analysis

The interview form constructed for the survey of executive opinion contained sections on organizational preference, the criteria for organizational design, and authority distribution. The following presentation will treat each of these topics in order but will be prefaced by a section detailing the nature of the sample of executives interviewed.

The Sample

The sample was evenly divided between general managers and project managers. Forty-six managers were interviewed--twenty-three general managers and twenty-three project managers. Within the general management category there were six vice-presidents and general managers, five contracts managers, six controllers, one personnel manager, two engineering managers, one business manager, one marketing manager and one manufacturing manager. Each of these men was selected because he was considered to be a key individual in the company top management team by the vice-president and general manager of the particular company. The twenty-three project managers represented about 80 per cent of the project managers in the companies studied. The project managers not interviewed were either involved in highly classified projects or were on extended travel and could not be reached.

The sample included twenty-four managers from matrix organized companies and twenty-two managers from project organized companies. The managers in the matrix organized companies averaged 16.0 years of experience in the defense industry--13.5 years with matrix companies and 2.5 years with project companies. By contrast, the managers of the project organized companies averaged 17.1 years of experience in the defense industry--12.5 years with matrix companies and 4.6 years with project companies. It can be seen from the above that the experiential base of both

groups of managers was approximately the same.

As an aside, the above data suggest that the project form of management is not widespread in the defense industry. This conclusion is supported further by the difficulty the researcher encountered in locating enough project companies to balance the sample. Of the nineteen companies contacted in the course of this study, only four companies were project organized. This finding deserves formal research in the future and a recommendation to that effect will be included in the concluding chapter. With this general information about the sample, it is appropriate to discuss the data gathered in the research interviews.

Organizational Preferences

The first major question in the questionnaire asked each manager to state the form of organization he would recommend for a $5 million to $10 million new project that was from 5 to 10 per cent of a company's business. Of the general managers, five preferred the project form and eighteen preferred the matrix or functional form.[9] Of the project managers sixteen preferred the project form and seven preferred the functional or matrix form. The data are in Table 14 below.

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[9]See Appendix B, Chapter II, for brief descriptions of each of these forms.

TABLE 14

ORGANIZATION PREFERENCE

Prefer	General Managers		Project Managers	
	Per Cent	Number	Per Cent	Number
Project organizational form	19.2	5	69.6	16
Functional or matrix organizational form	80.8	18	30.4	7
Total	100.0	23	100.0	23

A chi-squared test indicates that the differences in organizational preference between general managers and project managers is significant at the one per cent level of confidence.

On the surface these data are strongly supportive of the preference hypothesis, but it is of interest to look a bit deeper into the data to explore relationships which might be of importance. For instance, of the twelve general managers who operated under the project form of organization only five preferred such a form. Why, then, were these companies project organized?

The apparent reasons for the use of the project organizational form by each of the project organized companies were quite different. In the PAAN company, the projects were so large that to organize in any other fashion

was viewed as impractical. These projects were of an order of magnitude considerably larger than the typical projects being handled by the other companies in the sample. In the PAST company, the customers had demanded by contract the use of the project form of organization. In the PUCK company, the vice-president felt that clear location of responsibility was extremely important, and it appeared that this consideration led him to the use of the project form of organization. Further study is needed to determine when these criteria--size of project, form desired by the customer, and clear location of responsibility--become significant factors in the decision of how to organize a company.

Looking at the data in Table 14 in a similar fashion, it is to be noted that seven of the project managers in matrix organized companies preferred the matrix form. The only consistent comment made by these project managers seemed to be that they were willing to "tolerate the frustrations of the matrix form," since they viewed this form as beneficial to the company as a whole. Further elaboration of the summary data presented above is contained in the following section of descriptive elaborations to the formal organizational preference question asked in the interview.

Interview Elaborations on Organizational Preferences

Most of the comments included in this section were made by respondents as an elaboration of their statements concerning organizational preference. These elaborations tended to supply their pro and con sentiments about the various organizational forms. The following statements reflect the comments regarding the matrix, project, and functional organizational forms.

Matrix Organizational Form

1. Project Manager MACH--"Matrix is best as a diversity of product prevents the effective use of the project form."
2. General Manager PAAN--"Matrix must be used for a myriad of middle-sized projects."
3. Project Manager MEST--"Matrix is best for company objectives."
4. Project Manager MEST--"Matrix is best for company objectives, in my opinion."
5. General Manager MUNI--"Matrix is best for small projects."
6. Project Manager MACH--"Matrix will give you the best technical solution but at a greater cost than other forms."
7. General Manager PAST--"Multi-product lines imply much interdependence, and this requires a matrix organization."
8. General Manager MACH--"Matrix is best, but it will only work when project managers really have delegated authority from general manager."
9. Project Manager PAST--"Matrix is best to provide a mix of skills."

10. Project Manager MUNI--"Matrix is best if the company has a mixed product line."

11. General Manager MEST--"Matrix is best because it fosters expertise and does not duplicate functions."

12. General Manager MACH--"Matrix is bad as it implies that each man has two bosses."

13. Project Manager PAST--"Matrix is best but it requires considerable coordination time."

Project Organizational Form

1. General Manager PAAN--"The structure of the customer's organization, a large project, and/or a product which is in the development or production stage all suggest the use of a project organization."

2. Project Manager MEST--"The project form is best from the project viewpoint, in my opinion."

3. Project Manager MEST--"The project form is best from the project viewpoint."

4. Project Manager PUCK--"Anything over $3 million should be projectized."

5. Project Manager MACH--"The projectized form gives minimum cost and maximum efficiency."

6. Project Manager MACH--"I prefer the projectized form, but it is difficult to get people in and out of the project fast enough."

7. Project Manager PAST--"A drawback to the project form is that it leaves behind only a few people with experience [in the functional department] and cycles out the rest."

8. General Manager MACH--"The project form adds many more managerial positions."

9. Project Manager MUNI--"Large projects call for a project form."

10. Project Manager PUCK--"The project form is beneficial vis-à-vis team spirit and it allows me to promote personnel, and it is the most useful form if upper management is poor."

11. General Manager PAAN--"Over the long run the use of the project form results in higher overhead but lower total cost."

12. General Manager MEST--"Under the project form, it is difficult to motivate engineers during the middle and end of a project, it provides for only a very narrow engineering challenge, thus resulting in a less than optimum assignment of talent and a feeling in the engineer that the [technical] world is passing me by."

13. General Manager PAST--"The project form leads to too much duplication of resources."

Functional Organizational Form

1. General Manager MEST--"The functional form is amorphous, results in poor coordination and leaves the engineer feeling powerless."

2. Project Manager PUCK--"There are enough tasks in a $5 million project to prevent the project manager from being best in all areas. Therefore, the functional form is best, as the day-to-day comprehension of progress must be through the functional managers and not around them."

3. Project Manager PUCK--"The functional form is the best if the top management is very good."

4. Project Manager MUNI--"If the company is a single-product company, then the functional form is best."

5. General Manager MACH--"The key to the superiority of the functional form is the ability to train engineers."

6. General Manager PAST--"A single-product company should be organized in the functional form."

7. Project Manager PUCK--"Small projects, under $3 million, should be functionally organized."

8. General Manager MUNI--"A large project should be functionally organized."

Summary of Preference Elaborations

The quotations reported above are of a subjective nature, which cannot be extensively analyzed in a quantitative sense. But certain common threads are apparent in the list of comments, and these briefly summarized are as follows:

1. A single product-line company should be functionally organized.
2. A multiple-product-line company should be matrix organized.
3. Very large projects should be project organized.
4. The matrix or functional form is best for the company, as it does a better job of using resources more fully and training and challenging engineers.
5. The project form is best for the project, as it leads to more control, efficiency and lower costs.

It should again be observed that these are merely stated opinions and preferences of the managers interviewed, but these statements serve to support the quantitative data of the preceding section and the sections to follow.

Criteria for Organizational Design

The second major section of the interview questionnaire asked the various managers to select from a list of criteria which they felt were the three "most important" and the three "least important" criteria which should be considered in designing an organization. Table 15 presents a weighted summary of the judgments in a rank order format (i.e., most important to least important) for both general and project managers.

With one exception--flexibility of staffing--there are only minor differences between the two rank orderings by project and general management. The two rank orderings when correlated yield a coefficient of 0.811, which is significant at the one per cent level of confidence.

The differential ranking of the flexibility of staffing criteria by the two groups is of particular interest. This criterion is the only one in the list which is related to the allocation of scarce resources, namely, staff. General management's concern for flexibility is supportive of the concern of this group for control of the allocation of resources in order to maximize company profit. The lack of concern for flexibility on the part of project management can be interpreted as an indication that they feel flexibility is not important and, therefore, that they should control the staff working on their particular projects. This interpretation would support the desire on the part of

TABLE 15

IMPORTANCE OF CRITERIA FOR ORGANIZATIONAL DESIGN

Criteria	Rank Orderings by	
	General Management	Project Management
Clear location of responsibility	1	2
Ease and accuracy of communication	2	1
Effective cost control	3	3
Ability to provide good technical supervision	4	4
Flexibility of staffing	5	11
Importance to the company	6	6
Quick reaction capability to sudden changes in the project	7	5
Ability to evaluate the performance of technical personnel	8	9
Complexity of the project	9	8
Size of project with relation to other work in-house	10	7
Form desired by the customer	11	10
Ability to provide a clear path for individual promotion	12	12

project managers to control the allocation of resources within their project such that they can maximize project profit or project completion.

A second interesting observation about this set of rankings is concerned with three of the criteria at the "least important" end: complexity of the project, size of the project, and form desired by the customer. It appears that most of the projects being worked on by the companies in this sample were complex enough to require the use of a project manager but this complexity did not have an important effect upon organizational form. Size appears to be an organizational design criterion only in extremes--the very small project and the very large project. The vast majority of projects being accomplished by the companies in this sample were in a "mid-range" with regard to size. Therefore, size as a criterion was much less important. The organizational form desired by the customer is a criterion that is widely discussed when a company is considering what strategy to use in competing for new business. Managers in the interviews generally discounted this criterion as "only a marketing stand and not what is really done." It is the opinion of this researcher that the customer has far less effect upon organizational design than the proposals submitted to him might suggest. But it is also the opinion of this researcher that the customer has far more effect upon organizational design than the managers interviewed would admit. To substantiate this opinion, some quite

sophisticated research would be required.

"Preferred" Organizational Form

> For each of the [criteria for organizational design] rank for me how well the different organizational forms accomplish it? For instance, does project or functional management accomplish the best flexibility of staffing? Which one is second best?[10]

The above question was scored by assigning a value of one to the "best" form, a value of two to the second "best" form, and a value of three to the third "best" form. These data were gathered for the following criteria: responsibility, flexibility, communications, cost control, quick reaction capability, supervision, promotion, and evaluation.[11]

One way of analyzing these data is to assume that the summation of all the scores that indicate how well a particular organizational form satisfies the criteria would be an index of how "good" the form is in the judgment of the executives sampled. Looking at the data this way, a second assumption must be made: Should the criteria be equally weighted or not? Initially an equal weighting was assumed, and the results are shown in Table 16 for both general and project management. A chi-squared test shows the differences in the general management's opinions are not significant,

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[10]This quote is from the interview questionnaire form presented in Appendix B to Chapter II.

[11]These are the key words from the criteria statements found in the preceding tables and are used for convenience for the rest of this chapter.

TABLE 16

"PREFERRED" ORGANIZATIONAL FORM

Criteria	Organizational Form		
	Project	Functional	Matrix
Unweighted general management opinion	368.5	351.0	384.5
Unweighted project management opinion**	327.0	409.5	367.5
Weighted general management opinion	351.7	359.9	392.4
Weighted project management opinion*	307.5	425.5	371.0

Note: The upper set of scores for each organizational form were calculated by summing the score on each criterion for all of the project or general managers, assuming equal weights for each criterion. For the lower set of scores the individual criterion scores were weighted by the importance scores shown in Table 17.

Using a chi-squared test with two degrees of freedom these values are significantly different at (*) the one per cent level of confidence, and at (**) the 2 per cent level of confidence.

but the project management's opinions are significant at the 2 per cent level.

Another way of looking at the "preferred" organization is to assign weights to each of the criteria based upon the judgment of the executives interviewed. The rank-ordered criteria ratings presented in Table 15 were analyzed by assigning a score of three for each criterion rated most important, two for each criterion rated neither most nor least important, and one for each criterion rated least important. Table 17 presents the resulting scores for the criteria used in this "preferred" organization discussion.

TABLE 17

WEIGHTED IMPORTANCE OF CRITERIA
FOR ORGANIZATIONAL DESIGN

Criteria	Composite	General Management	Project Management
Responsibility	126	65	61
Communication	120	58	62
Cost Control	111	57	54
Supervision	100	51	49
Quick Reaction Capability	92	45	47
Flexibility	85	48	57
Evaluation	84	44	40
Promotion	62	31	31

Except for the flexibility rating, the weighted scores for general management and project management were so close--within four--that the composite ratings were selected to be used as weightings for the criteria. The results of weighting the criteria scores with the importance scores are also included in Table 16.

A chi-squared test used on the weighted scores shows that there are significant differences at the one per cent level of confidence for the project management data, but that the general management data continue to show no significant differences.

When the data are considered from this "preferred" organization vantage, an apparent dichotomy in the earlier findings is noticeable. The project managers preferred the project form of organization both by their articulated preferences and by the summarized criteria scores, but the general managers showed no such consistency. The general managers' articulated preferences for the matrix or functional form were not supported statistically when summarized criteria scores were analyzed. Two possible reasons for this inconsistency are: (1) Some important criteria which might sway the preferences of general management were not explicitly covered; or (2) the general management perceived that the performance of the various organizational forms in meeting the several criteria listed was considerably more equal than the project managers thought they were. The first reason probably can be rejected in favor of the second,

since the general managers did not suggest additional criteria when they were asked explicitly whether any important criteria had been omitted.

In addition to the data presented above, some of the explanatory comments made during the criteria section of the interviews will now be presented.

Interview Elaborations on Design Criteria

The interview commentary which developed in the criteria section of the questionnaire are grouped under three topic areas: customer relationships, adaptations to personnel and a miscellaneous category.

Customer Relationships

1. Project Manager PAST--"The organizational design should provide the ability to perform contractual requirements.
2. Project Manager MACH--"The organization is affected by the details of the customer interface."
3. General Manager MUNI--"The importance of the form desired by the customer increases with the size of the project."
4. Project Manager MUNI--"The organization must be able to satisfy special contractual commitments and to effectively attain new business in a selected field."
5. Project Manager MUNI--"The organization must provide a single voice to the customer."
6. General Manager MUNI--"The organization must have the ability to guide the customer and to administer the control."

Adaptations to Personnel

1. Project Manager PUCK--"The organization must be adapted to the specific individuals involved, by name and talent."

2. General Manager PUCK--"The characteristic of available personnel is a primary criterion to the design of the organization."

3. Project Manager MACH--"The capabilities of the people affect the appropriate organization."

4. Project Manager MEST--"The organization should suit the personnel available."

5. Project Manager PAST--"The ideal project must be adjusted to the personnel."

6. General Manager MEST--"The level of competency of the people is important in organizational design."

7. Project Manager PAST--"A major design consideration is the background and the personalities of the people."

8. Project Manager PUCK--"The organization should aid morale and motivation."

9. General Manager PAST--"The organization should provide identification of people with the project (personal involvement, a sense of it's my project or idea)."

10. General Manager PAAN--"It is important that the organization maintain a mix of skills and salary levels in order to perpetuate the enterprise."

11. General Manager PAST--"The organization should help create a sense of commitment."

12. Project Manager PAST--"The organization must assist in the match of the motivation on incumbent projects with that on new projects."

Miscellaneous

1. General Manager MEST--"With regard to project information, the project form gives the best communication, but with regard to learning, the matrix form is best."

2. General Manager MEST--"Best cost control and least expensive approach are not necessarily the same."

3. Project Manager MACH--"Another important criterion for design is company policy."

4. General Manager MACH--"The organization must conform to company standards."

5. General Manager MUNI--"The organization should implement organizational objectives."

6. Project Manager MEST--"Other important criteria for design are clear definition of authority and cross fertilization."

7. General Manager MACH--"Clear location of authority is extremely important."

8. Project Manager MEST--"The viability of the functional organization must be maintained under any organizational design."

Summary of Criteria Elaborations

The interview commentary of the managers point primarily to two major areas of interest in relation to organizational design: (1) The details of working with the customer, especially one as complex as the federal government, often require organizational adaptation; and (2) the organization generally must alter its "ideal" organizational form in order to accommodate the personalities and capabilities of the personnel. Both of these findings are not at all surprising and are generally consistent with research findings concerning many other organizations.

Authority Distribution

Each manager interviewed was asked the following question: "In your company does the project management have the final authority to make the crucial project decisions listed on this card?" (See Chapter II, page 53.) A project manager was considered to have final authority if: (1) in a case of conflict between the interested parties regarding a particular decision, the project manager determined the final decision; or (2) if the project manager's decision was not subject to formal review by his superior. The list of the types of decisions under consideration is as follows:

1. Initiate work in support areas.
2. Assign priority of work in support areas.
3. Relax performance requirements (i.e., omit tests).
4. Authorize total overtime budget.
5. Authorize subcontractors to exceed cost, schedule, or scope.
6. Contract change in schedule or cost or scope.
7. Make or buy.
8. Hire additional people.
9. Exceed personnel ceilings when a crash effort is indicated.
10. Cancel subcontract and bring work in-house.
11. Select subcontractors.
12. Authorize exceeding of company funds allocated to project.
13. Determine content of original proposal.
14. Decide initial price of proposal.[12]

Before discussing the data generated from the questionnaire, it is meaningful to identify the underlying

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[12]Adapted from D. G. Marquis and D. M. Straight, Jr., Organizational Factors in Project Performance, Working Paper No. 133-65 (Cambridge: Massachusetts Institute of Technology, School of Management, August, 1965).

assumptions regarding the decision process. The decisions chosen for inclusion in the questionnaire were considered to be a list of the important types of decisions a project manager typically faces in his relations with the company, suppliers, and customers. If these types and decisions generally are the important project-related decisions, then it is reasonable to expect considerable agreement within the company regarding who has the authority to make each of the decisions. However, a significant lack of agreement would indicate a serious ambiguity of authority definition.

The actual data derived from the questionnaires are presented in Table 18. A few samples of ambiguity taken from this table demonstrate the type of phenomena which are discussed here. In the PUCK company, for instance, the entire general management believes that project managers cannot authorize subcontractors to exceed cost, schedule, or scope; yet all the project managers interviewed feel that they can. In the same company, with the exception of the financial manager, none of the managers believes the project manager can set the initial price of a proposal. In the MUNI company the vice-president, the financial manager, and two project managers believe that the project manager can initiate work in support areas, whereas the personnel manager and two other project managers do not believe that this is true. In the PAAN company the vice-president, the financial manager, and the two project managers believe that they can determine the content of the original proposal, whereas the

TABLE 18

ANSWERS TO QUESTION: "DOES THE PROJECT MANAGER HAVE THE FINAL AUTHORITY ON THE CRUCIAL PROJECT DECISIONS?" (Y = Yes, N = No)

Company Code	Title	Number of decision item from list on page 122													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
PAAN	Vice President	Y	Y	Y	N	Y	N	N	N	Y	N	N	N	Y	N
PAAN	Contracts Mgr.	Y	Y	N	Y	Y	N	N	N	N	N	Y	N	N	N
PAAN	Financial Mgr.	Y	Y	N	Y	Y	N	N	N	Y	Y	N	N	Y	N
PAAN	Engineering Mgr.	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	N	N
PAAN	Project Manager	Y	Y	Y	Y	Y	N	Y	N	Y	N	N	N	Y	N
PAAN	Project Manager	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	Y	N
PAST	Vice President	Y	Y	Y	Y	Y	Y	N	N	Y	N	N	N	Y	N
PAST	Contracts Mgr.	Y	Y	N	Y	N	Y	N	N	Y	N	N	N	Y	N
PAST	Marketing Mgr.	Y	N	Y	N	Y	Y	N	Y	N	N	Y	N	Y	N
PAST	Financial Mgr.	N	N	Y	Y	Y	Y	N	N	Y	Y	N	Y	Y	N
PAST	Business Mgr.	Y	Y	Y	Y	N	Y	N	N	Y	N	N	N	Y	N
PAST	Project Manager	Y	Y	N	Y	N	N	N	N	N	N	N	N	Y	N
PAST	Project Manager	Y	Y	Y	Y	N	N	N	N	Y	N	Y	N	Y	N
PAST	Project Manager	Y	Y	Y	Y	Y	Y	Y	N	Y	N	Y	N	Y	N
PAST	Project Manager	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	N	Y	Y
PUCK	Vice President	N	Y	Y	Y	N	N	N	N	N	N	N	N	Y	N
PUCK	Contracts Mgr.	Y	Y	Y	N	N	N	N	N	N	N	N	N	Y	N
PUCK	Financial Mgr.	Y	Y	Y	Y	N	N	N	Y	N	N	N	N	Y	Y
PUCK	Project Manager	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N
PUCK	Project Manager	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N
PUCK	Project Manager	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N
PUCK	Project Manager	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	Y	N
MUNI	Vice President	Y	Y	Y	N	Y	Y	N	N	N	N	N	N	Y	N
MUNI	Financial Mgr.	Y	N	N	N	N	N	N	N	N	N	Y	N	Y	N
MUNI	Personnel Mgr.	N	Y	N	Y	Y	Y	N	N	N	N	N	N	N	N
MUNI	Project Manager	Y	Y	Y	Y	Y	Y	N	N	Y	N	N	N	Y	Y
MUNI	Project Manager	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	N	Y	Y
MUNI	Project Manager	N	Y	Y	N	Y	Y	N	N	N	Y	Y	N	Y	N
MUNI	Project Manager	N	Y	Y	Y	Y	Y	N	N	Y	Y	N	Y	Y	N

TABLE 18 (continued)

ANSWERS TO QUESTION: "DOES THE PROJECT MANAGER HAVE THE FINAL AUTHORITY ON THE CRUCIAL PROJECT DECISIONS?" (Y = Yes, N = No)

Company Code	Title	Number of decision item from list on page 122													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
MACH	Vice President	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	N	Y	N
MACH	Contracts Mgr.	Y	Y	N	Y	N	N	Y	N	Y	Y	Y	N	Y	Y
MACH	Financial Mgr.	Y	Y	Y	Y	Y	Y	N	N	Y	N	N	Y	Y	N
MACH	Engineering Mgr.	Y	Y	Y	Y	Y	Y	Y	N	Y	N	Y	N	Y	N
MACH	Project Manager	Y	Y	N	Y	Y	N	N	N	Y	N	N	N	Y	N
MACH	Project Manager	Y	Y	N	Y	Y	Y	N	N	Y	N	N	N	Y	N
MACH	Project Manager	Y	Y	Y	N	Y	Y	N	N	Y	N	Y	N	Y	N
MACH	Project Manager	Y	Y	Y	Y	N	N	N	N	Y	N	N	N	Y	N
MACH	Project Manager	Y	N	Y	Y	Y	Y	N	N	Y	N	N	N	N	N
MEST	Vice President	Y	Y	Y	N	Y	Y	N	N	N	N	N	N	Y	N
MEST	Contracts Mgr.	Y	Y	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	N
MEST	Financial Mgr.	Y	N	N	Y	N	N	N	N	Y	N	N	N	N	N
MEST	Production Mgr.	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y	N
MEST	Project Manager	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
MEST	Project Manager	Y	Y	Y	N	Y	Y	N	N	Y	N	N	N	N	N
MEST	Project Manager	Y	Y	Y	Y	N	N	N	N	Y	N	N	N	Y	N
MEST	Project Manager	N	Y	Y	Y	Y	N	N	N	Y	N	N	N	Y	N

Note: The first letter in the Company Code identifies that the company is organized in a project (p) or matrix (m) organizational form.

contracts manager and the engineering manager believe the project managers cannot. These few samples reveal the apparent ambiguity shown in detail in Table 18.

A summary view of the data from Table 18 is presented in Table 19 entitled, "Percentage of Agreement on Crucial Project Decisions." One can see that the percentage of agreement on crucial project decisions varies from 75 per cent to 84 per cent with an average of 80 per cent.

TABLE 19

PERCENTAGE OF AGREEMENT ON CRUCIAL PROJECT DECISIONS

Company	Organizational Structure	Percentage Agreement
PAAN	Project	83
PAST	Project	81
PUCK	Project	76
MUNI	Matrix	76
MACH	Matrix	84
MEST	Matrix	80
AVERAGE		80

For each manager interviewed, the preceding question was asked regarding what decisions he felt the project manager should have the final authority to make. The raw data from the interviews are shown in Table 20.

TABLE 20

ANSWERS TO QUESTION: "SHOULD THE PROJECT MANAGER HAVE THE FINAL AUTHORITY ON THE CRUCIAL PROJECT DECISIONS?" (Y = Yes, N = No)

Company Code	Title	Number of decision item from list on page 122													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
PAAN	Vice President	Y	Y	Y	N	Y	Y	N	N	Y	N	Y	N	Y	N
PAAN	Contracts Mgr.	Y	Y	N	Y	Y	N	N	N	N	N	Y	N	N	N
PAAN	Financial Mgr.	Y	Y	N	Y	Y	N	N	N	Y	Y	N	N	Y	N
PAAN	Engineering Mgr.	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	N
PAAN	Project Manager	Y	Y	Y	Y	Y	N	Y	N	Y	N	N	N	Y	N
PAAN	Project Manager	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	Y	N
PAST	Vice President	Y	Y	Y	Y	Y	Y	N	N	Y	N	N	N	Y	N
PAST	Contracts Mgr.	Y	Y	N	N	N	N	N	N	Y	N	N	N	Y	N
PAST	Marketing Mgr.	Y	Y	Y	N	Y	Y	N	Y	N	N	Y	N	Y	N
PAST	Financial Mgr.	N	N	Y	Y	Y	Y	N	N	Y	Y	N	Y	Y	N
PAST	Business Mgr.	Y	Y	Y	Y	Y	Y	Y	N	Y	N	N	N	Y	N
PAST	Project Manager	Y	Y	N	Y	N	N	N	N	N	N	N	N	Y	N
PAST	Project Manager	Y	Y	Y	N	Y	N	N	N	Y	Y	Y	N	Y	N
PAST	Project Manager	Y	Y	Y	Y	Y	N	Y	N	Y	Y	Y	N	Y	N
PAST	Project Manager	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	Y	Y
PUCK	Vice President	N	Y	Y	Y	N	N	N	N	N	N	N	N	Y	N
PUCK	Contracts Mgr.	N	N	N	Y	Y	N	N	Y	N	Y	N	N	Y	N
PUCK	Financial Mgr.	Y	Y	Y	N	Y	N	N	N	N	N	N	N	Y	N
PUCK	Project Manager	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	N	Y	N
PUCK	Project Manager	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N
PUCK	Project Manager	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N
PUCK	Project Manager	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	N	Y	Y
MUNI	Vice President	Y	Y	Y	N	Y	Y	N	N	N	N	N	N	Y	N
MUNI	Financial Mgr.	N	Y	Y	N	N	N	N	Y	N	N	Y	N	Y	N
MUNI	Personnel Mgr.	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y	N
MUNI	Project Manager	Y	Y	Y	Y	Y	Y	N	N	Y	N	N	Y	Y	N
MUNI	Project Manager	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y
MUNI	Project Manager	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y
MUNI	Project Manager	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	Y	Y	Y

Taking both questions together, it is interesting to see the differences between the "should have" and the "does have" questions when compared between the general and project managers. Table 20 summarizes these data. With few exceptions, the data show that (1) project managers believe they have more authority than their general managers think they have; (2) project managers believe they should have more authority than their general managers believe they should have; and (3) project managers believe they should have more authority than they do have. The single exception to this is MACH, where the general managers believe they have delegated more than the project managers appear to have realized. From a statistical viewpoint, only the items blocked in on the table are significantly different using a chi-squared test.

A few interesting comments were made during the authority distribution section of the interviews, and these are reported below.

Interview Elaborations on Authority Distribution

There were only four comments made in elaboration of the authority question, but each has a distinctive impact on the whole question of authority.

1. General Manager MEST--"A man can have the power but not the authority. That is, a man who exercises the authority of others and is then not contradicted by those with whom the authority formally rests is

TABLE 20 (continued)

ANSWERS TO QUESTION: "SHOULD THE PROJECT MANAGER HAVE THE FINAL AUTHORITY ON THE CRUCIAL PROJECT DECISIONS?" (Y = Yes, N = No)

Company Code	Title	Number of decision item from list on page 122													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
MACH	Vice President	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	N	Y	N
MACH	Contracts Mgr.	Y	Y	N	Y	N	N	Y	N	N	Y	Y	N	N	N
MACH	Financial Mgr.	Y	Y	Y	Y	Y	Y	N	N	N	Y	N	N	Y	N
MACH	Engineering Mgr.	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	N	Y	N
MACH	Project Manager	Y	Y	N	Y	Y	N	N	N	Y	N	N	N	Y	N
MACH	Project Manager	Y	Y	N	Y	Y	Y	N	N	Y	N	N	N	Y	N
MACH	Project Manager	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	N	Y	N
MACH	Project Manager	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N
MACH	Project Manager	Y	Y	Y	Y	Y	Y	N	N	Y	N	Y	N	N	N
MEST	Vice President	Y	Y	Y	N	Y	Y	N	N	N	N	N	N	Y	N
MEST	Contracts Mgr.	Y	Y	Y	Y	Y	N	N	N	Y	N	N	N	N	N
MEST	Financial Mgr.	Y	Y	N	Y	Y	N	N	N	Y	N	N	N	N	N
MEST	Production Mgr.	Y	Y	Y	Y	Y	Y	N	N	N	Y	N	N	Y	N
MEST	Project Manager	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
MEST	Project Manager	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	N	N
MEST	Project Manager	Y	Y	Y	Y	Y	N	N	N	Y	N	N	N	Y	N
MEST	Project Manager	N	N	Y	N	Y	N	N	N	Y	N	N	N	Y	N

Note: The first letter in the Company Code identifies that the company is organized in a project (p) or matrix (m) organizational form.

TABLE 21

FINAL DECISIONS OF PROJECT MANAGEMENT

Company	Average number of final decisions that project management			
	Does have As reported by		Should have As reported by	
	General Management	Project Management	General Management	Project Management
MUNI*	5.0	8.5	6.0	11.0
MACH	9.3	6.6	8.3	8.6
MEST	6.3	7.5	6.5	8.8
PAAN	6.8	8.5	7.8	8.8
PUCK*	5.0	10.5	4.6	11.0
PAST	7.0	7.8	7.4	8.3

*Blocked-in pairs are significantly different at the one per cent level of confidence using a chi-squared test.

legally considered to have the authority he has exercised. He has gained this authority by abdication.

2. General Manager MEST--"Several managers should have the responsibility but not necessarily the authority. Authority and responsibility are not necessarily related."

3. Project Manager MUNI--"With regard to authority, I will tell you what I can do, what I can't do, and what is not specified, and therefore, I assume I can do."

Random Elaborations

This section contains four comments which do not fit neatly into formal categories, but they merit inclusion on the basis of their potential significance.

1. Project Manager PAST--"I didn't think that authority was a topic used in business schools anymore. The president of our company explicitly spells out responsibilities and lets the authority be distributed according to the specific problems of the moment.

2. Project Manager PAST--"There is a 'critical mass' phenomenon such that there is a minimum and a maximum number of personnel on a project, so that the whole is greater than the sum of the parts. Outside of this range, at either end, major inefficiencies set in."

3. Project Manager PAAN--"I have seen projects in this company which were functionally organized do extremely well and extremely poorly. In the former case, the project manager later became president. That is, the personality of the project manager was such that he could work a functional organization well, or in the second case, he could not work a functional organization well."

4. General Manager MEST--"Aside from the three organizational forms you mention [project, functional, matrix], there is another type of organization which we sometimes use. This form is a matrix with the project personnel all co-located. That is, all the personnel on the project are physically located in a

single area, even though they report to their functional managers for merit review purposes.

Summary

This chapter has presented data derived from a series of interviews with general and project managers of the six companies in the sample. The material presented represents the opinions and attitudes of executives who, on the average, had 16.5 years of experience in the management of research and development. The data indicate the following conclusions:

1. In support of Hypothesis Five, project managers do prefer the project form of organization, while general managers prefer a functional or matrix form of organization. Statistically, this preference tested significantly at the one per cent level of confidence.
2. The three most important criteria for organizational design are (a) clear location of responsibility, (b) ease and accuracy of communication, and (c) effective cost control. The three least important criteria are (a) ability to provide a clear path for individual promotion, (b) organizational form desired by the customer, and (c) the size of project with relation to other work "in-house."
3. By ranking the ability of each organizational

form to satisfy the criteria for design, it was shown that the opinions of the general managers did not develop a "best" organizational form. However, in the opinions of the project managers, the project form was significantly "better" (statistically at the 2 per cent level of confidence).

4. When the criteria were weighted by use of an importance index, the findings of (3) above remained true and the confidence level increased (one per cent level of confidence).
5. There was a considerable ambiguity concerning definition of authority within each company, as evidenced by the fact that agreement between company project and general managers concerning what decisions the project manager could make averaged only 80 per cent.
6. The project managers believed they did and should have more authority than their respective general managers believed they did and should have. However, this finding was not statistically significant.

This concludes the presentation of the research findings of this chapter. Additional conclusions and their interpretation will be brought together in the final chapter.

PART III

SUMMARY AND RECOMMENDATIONS

CHAPTER V

SUMMARY AND RECOMMENDATIONS

Introduction

This study investigated the effect of two basic types of organizational form on the stability and flexibility of manpower in companies engaged in research and development for the United States government. Important criteria for selecting one organizational form rather than another were investigated in order to ascertain which criteria provide the rationale for choosing specific organizational forms.

Specifically, the project management and the matrix management forms of organization were investigated within the context of the defense/aerospace sector of the United States economy. Six defense/aerospace contractors were selected for study through the use of a multiple case study technique. A series of hypotheses were developed and tested concerning the influence of these forms of organization on manpower flexibility, turnover, staff planning, and organizational choice.

Organizational forms typically are identified by work assignment and merit review considerations. For the

purposes of this research, a project management form of organization was defined as one in which a project manager had the authority to supervise the work of engineers working on his project and also to perform the annual merit review of these engineers. A matrix management form of organization was defined as one where a project manager supervised the work of the engineers assigned to his project, but merit review was handled by a functional manager (e.g., the mechanical design manager). These definitions were used as the basis for categorizing the sample studied. (Additional details concerning these definitions are included on pages 6 through 11 of Chapter I.)

The Research Problem and Approach

A multiple case study technique was selected as the appropriate method of research. In the course of the research, six companies were studied in some detail. The sample (see Table 3, Chapter II, page 40, for a general summary) included companies ranging in sales from under $50 million to over $100 million, and in size of technical staff from under 500 to over 1,000. The companies supplied such products as technical services, ordnance, space systems, support equipment, and electronics to the Department of Defense and the National Aeronautics and Space Administration.

Three of the companies studied were essentially project organized, and three were essentially matrix

organized. It was recognized at the outset that: (a) it would be unlikely for the research to find companies which would represent a "pure" organizational form; and (b) selection of companies would have to be made on the basis of "predominance of form" criteria. In the course of the study, this expectation was verified. Fortunately, in each of the companies investigated, it was clear that each company was predominantly one organizational form or the other. This fact made the classification of the companies straightforward. Details concerning these classifications are included in Chapter II.

Quantitative indices were constructed from data available in payroll records, termination interview reports, employee requisition forms and manpower forecasts. These indices were subjected to several statistical techniques, such as rank-order correlation and chi-square tests in order to ascertain the possible effects of organizational form.

In addition, forty-six executives were interviewed concerning their organizational preferences and the criteria which influenced these preferences. Twenty-three of these executives were project managers. The other twenty-three were managers with responsibilities relating to many projects (e.g., a financial manager or a contracts manager). This latter group was referred to as general management.

The Findings

Six specific topics were investigated during the course of this study. These will be reviewed here in order of their appearance earlier in this report. The topics are: manpower flexibility, staffing, turnover, organizational preference, organizational criteria, and authority distribution.

Manpower Flexibility

Among the major variables which have an impact upon manpower flexibility are organizational form and the level of work load. Organizational literature has usually suggested that there is an administrative barrier to flexibility in the project management form of organization. In the project form, there typically is no manager who has the direct responsibility for locating temporary, short-run assignments for personnel who are available due to a reduction in a particular project's workload. This may frustrate a company's ability to shift its personnel during project lulls and thus contribute to limited manpower flexibility.

Conversely, in the matrix organization an engineering manager usually does have the authority and responsibility to reassign temporarily available engineers. This generally results in the engineering force being moved rather easily from project to project and back again. This ease in reassignment would contribute to increasing a company's exhibited manpower flexibility.

A second variable affecting flexibility is the level of work load. This variable would appear to influence greater manpower flexibility when the work load is heavy than when the work load is light. If a peak work load demand occurs on a project--and sufficient time is not available for hiring additional staff--the demand must be met by drawing people from another project which thereby would mean increasing flexibility. On the other hand, when the work load in a company is low, there would tend to be few or perhaps no other projects available for the engineers. Therefore, the engineers probably would stay on whatever project they had been recently working, even though the work requirements were limited. This tendency would imply a lessening of manpower flexibility.

For this research study, it was hypothesized that the work load effect upon flexibility would be more significant than the organizational effect. Therefore, the following hypotheses were developed for investigation in this research.

> HYPOTHESIS ONE: Flexibility of manloading on a research and development project is a function of the work load level in the corporation.
>
> HYPOTHESIS TWO: Flexibility of manloading on a research and development project is not a function of organizational form.

A flexibility of manloading index was developed which measured the percentage of direct charging engineers who charged their time to two or more contracts during a particular time period. A work load index was developed

which measured the overtime rate during the same time period. There was no significant correlation between the flexibility indices and the workload indices. Analysis of the data indicated the correlation coefficient between the work load index and the flexibility index was near zero for each of the companies studied. Therefore, the tentative conclusion was that the indices were independent of each other. Thus, the first hypothesis was rejected.

This finding must be qualified, since it relied upon the entire engineering staff as a unit of analysis. One executive estimated that most defense companies maintain only a 5 per cent surplus of engineers over and above their current workload. If true, the effect of work load upon manpower flexibility is quite likely to be masked by other factors such as project completions, summer employment, and the like. If a different unit of analysis were used, such as a department or labor grade, it could well be that work load and flexibility would be found to have a significant correlation.

Using the same flexibility index and dividing the sample into project organized and matrix organized companies, it was found that the average flexibility index for the matrix organized companies was 34.6 per cent; for the project organized companies, the flexibility index was 5.0 per cent. Since this difference was statistically significant, the second hypothesis, too, was rejected. Stating this conversely, the research findings would support the

hypothesis that flexibility of manloading is a function of organizational form.

It was relatively clear from this part of the study that personnel in a matrix organization have many more opportunities to work on multiple projects than do personnel in a project organization. It is quite probable that multiple project opportunities could contribute to multiple levels of challenge and a broader learning experience for the engineer. This factor could be of critical importance when companies consider what manpower capabilities they have to offer as future projects are "put out to bid." It seems likely that the matrix organization is better suited than a project organization to support a broader and perhaps a higher general level of technical capability among engineers. This particular thought will be discussed more thoroughly in a later section of this chapter.

Staffing

The uncertainty of future manpower needs and the official authorization to hire manpower are two of the major considerations in the staffing and recruiting plans of a research and development company. In some companies the uncertainty of the future is hedged by the use of a probabilistic approach applied to the pending new business proposals. Manpower implications of potential new business are calculated and then factored by the probability of winning each proposal. The result of such a process is an

estimate of future manpower requirements. Personnel departments then mount their recruiting efforts to attract personnel who could fit relatively well into any of the likely new business efforts.

This planning procedure is complicated by the requirement for an official authorization to hire. In a matrix organization, the responsibility for hiring personnel for new business usually lies with the functional manager, who officially must notify the personnel department before the personnel department can actually hire new manpower. However, in a project organization there usually is no single individual who has the direct responsibility to plan staff for potential new business. Therefore, no person officially is designated who can issue formal authorizations to hire in anticipation of new business. With these considerations in mind, the following hypothesis was developed for research and analysis.

> HYPOTHESIS THREE: A research and development organization which is matrix organized will tend to have a longer definite planning horizon for staffing than will a research and development organization that is project organized.

The findings of this research study were such that this hypothesis was rejected. Interviews with personnel executives tended to support the logic behind this hypothesis, but specific practices of the companies definitely did not. In actual practice, two companies had a one-month planning period: three companies used a quarterly planning

period; and one company had a six-month planning period.

A logical conclusion that can be derived from these data is that the staffing process is a complex set of policies which develop from numerous unique and significant company problems. Consequently, the staffing horizon of companies is not significantly affected by the biases inherent in organizational form.

At most of the companies studied, the staffing process appeared to be an integral part of the overall master plan and control system of the company. These systems tended to have regular calendar cycles which were judged to be optimum by each particular company. In order to build a complex master set of interrelated company plans, subsidiary plans such as staffing are developed in terms of the optimum forecast period for the company master plan, rather than for the optimum forecast period for the subsidiary plan. Thus, staff planning horizons in general were constrained by the demands of the company planning system, rather than by organizational form.

Turnover

The fourth hypothesis of this research was concerned with the impact of organizational form on personnel turnover rates. Several studies were cited concerning the "sense of completion" that typically arises at the end of a project in the minds of the personnel working on the project. Personnel working on a project may view the completion of a

project as an appropriate time in which to search for new challenges both inside and outside the company. It is quite likely that the completion of a project would be more strongly "felt" in a project organized company than in a matrix organized company, since typically there would be a requirement to physically transfer personnel from one project area to another. This, in turn, would disturb both existing formal and informal behavior patterns. Due to this accentuated "sense of completion," it was hypothesized that turnover rates reflecting the "sense of completion" phenomenon would be higher in project organized companies than in matrix organized companies. Formally stated, the hypothesis developed was as follows:

> HYPOTHESIS FOUR: The turnover rate for technical personnel who terminate voluntarily with a sense of project completion as a contributory factor will be greater in project organized companies than in matrix organized companies.

Termination interview reports were extensively studied in this phase of the research. Voluntary terminations of engineers were analyzed for statements or indications that the engineers considered the project they had been working on as essentially "complete." The findings revealed that the turnover rate of voluntary engineering terminations who exhibited such a "sense of completion" was significantly higher in project organized companies (13.3 per cent of voluntary terminations) than in matrix organized companies (5.2 per cent of voluntary terminations). Thus, the research findings supported the fourth hypothesis.

This finding suggests that there exists a distinct disadvantage to the project form of organization in terms of technical personnel who leave companies because of the organizational impact on their employment decisions. This may represent wastage of human assets in a project organized firm of sufficient magnitude to be of concern. Classical personnel management approaches to studying termination interview reports, which look generally for malpractices of management and data on competitive offers, provide little insight into organizational effects upon decisions to terminate. Project organized companies particularly would be well advised to study in detail their voluntary terminations in order to better understand the dynamics of organizational considerations upon such terminations. It could well be that such study might influence the choice of organizational form, if the findings of this investigation are replicated.

Organizational Preference

Attributes of various organizational forms are manifold. Table 2 of Chapter I (see pages 9-10) identified several of the major attributes relating to the choice of organizational form for a research and development project. Management of a research and development company must "trade-off" the effects of these attributes in terms of the overall objectives of the company in order to select what they consider to be the most appropriate organizational

form. It was hypothesized that the general management of a company (i.e., the general manager, the controller, the contracts manager, etc.) and the project management of a company would weigh these attributes differently and thus have different preferences regarding organizational form.

The underlying factors here are the different objectives of the two levels of management. A major objective of project management is the solution of a project's technical problems in a fashion which will produce maximum (optimum) project profit and expedite the project. A major objective of general management is the allocation of company resources so as to maximize progress on all projects within the company and produce the maximum (optimum) overall company profit. If the maximization of company profit must be accomplished at the expense of a particular project's progress and/or profit, a conflict situation may arise between general management and project management. Thus, each level of management would probably prefer an organizational form which will minimize the other level's ability to frustrate its own parochial objectives. These considerations were used to develop the fifth hypothesis for research and analysis.

> HYPOTHESIS FIVE: Project management will tend to prefer the project form of organization, while general management will tend to prefer the matrix form of organization.

In order to test this hypothesis and related topics, forty-six project and general management personnel were

interviewed using a partially structured interview format. Project managers expressed a significantly greater preference for the project organizational form (69.6 per cent) than did the general managers (19.2 per cent). Thus, the research findings supported the fifth hypothesis.

In order to gain further insight into why these preferences were stated, a section on organizational design criteria was included in the interviews.

Organizational Criteria

To determine what might be the major considerations used in the selection of a particular organizational form, a list of organizational design criteria was included in the interview form. (These criteria are listed in Chapter IV, page 113.) Each manager was asked to indicate what he considered to be the "three most important" and the "three least important" of these criteria in the selection of an organizational form. The managers' answers were then used to construct a rank ordering of the criteria for the group of project managers and for the group of general managers. There was a very high agreement between the two rankings. A rank-order correlation coefficient of .811 was calculated, which was significant at the one per cent level.

In the opinion of the executives interviewed, the "three most important" criteria for organizational design were: clear location of responsibility, ease and accuracy of communication, and effective cost control. The "three

least important" criteria indicated were: size of project, form desired by the customer, and ability to provide a clear path for promotion.

The relatively close agreement between project managers and general managers as to important organizational design criteria did not explain their disagreement as to organizational preference. To understand this dichotomy further, data from another interview question was analyzed. Each manager was asked which form of organization "best" satisfied the individual organizational design criteria. The answers of the managers showed that the general managers were of the opinion that the benefits of the project form as compared to the matrix form with regard to these criteria were about equally divided. However, the project managers indicated that the benefits of the project organizational form with regard to the organizational design criteria were significantly superior (at the one per cent level) as compared to the matrix form of organization.

These findings demonstrated a difference in viewpoint that differentiated the two groups. General management must concern itself both with the problems of effectively organizing for the overall company benefit and effectively organizing for the benefit of individual projects. On the other hand, the project manager is primarily concerned with the effective management of a single project. Although this is not to be unexpected, these are important differences. This concept will be

restated in later sections of this chapter, and the importance of these differences will be treated more fully.

Authority Distribution

The final portion of the interview form asked the managers to review a list of important project-related decisions and to indicate which decisions the project managers in their company had the "final" authority to make (see Chapter IV, page 122). The two major findings here were: (a) The agreement between general managers and project managers within a company concerning which decisions had been delegated to project managers averaged only about 80 per cent; this level agreement was viewed as a sign of considerable ambiguity. (b) Project managers felt that they had considerably more authority than the general management group felt had been delegated to the project managers. This second finding was not statistically significant, but it was a consistent tendency.

These two findings serve to demonstrate the complexity of the authority question. There was a considerable degree of ambiguity in the perceived authority distribution between project managers and general managers. This ambiguity seemed related to many factors such as abdication of authority on the part of some general managers, poor communications, poor enforcement of standard practices, and/or individual differences in regard to the abilities of various project managers to make certain decisions. Since

formal organization charts and written authority delegations do not necessarily predict the perceived authority which individuals have and/or exercise, additional research is needed in order to understand the complexities of the authority issue more fully.

At this point it may be well to ask: What are the major overall implications of this investigation? The next section will synthesize some of the specific findings into a general commentary concerning organizational form.

Contributions of This Study

This research study has attempted to add to the state of knowledge in the field of management of research and development. It is suggested that the following concepts have been developed which may prove fruitful for further research and be applied to the problems of research managers.

Summary of Organizational Effects

Concisely stated, the benefits of each organizational form as they were tentatively demonstrated in this investigation were as follows: The project management form of organization was shown to be less flexible, preferred by project managers, and was commonly agreed to have a clearer location of responsibility, more effective cost control, better "quick reaction" capability, and facilitated ease and accuracy of communications. The matrix management form

of organization was shown to be more flexible, to have a lower rate of voluntary terminations with a "sense of completion," to be preferred by general managers, and was commonly agreed to have better flexibility, a better perspective for supervising and evaluating technical personnel, and offered a clearer promotion ladder for technical personnel. Using this summary as a basis, it is important to clarify some basic issues related to the question of organizational choice.

Two Questions in One

It is the opinion of this author that much of the managerial confusion regarding the selection of an appropriate organizational form for research and development companies arises from not clearly comprehending that this question tends to have different answers depending upon the time orientation. When asked about organizational form, managers tended to mix both short-run and long-run considerations into their replies, such as: "The organization must exhibit quick reaction capability" (generally a short-run problem) "and still contribute to improving the technical capability of the company" (generally a long-run problem).

In the short-run, management is normally faced with this question, "How do we most effectively satisfy our present customers with regard to technical performance, schedule, and budget on the projects we have under

contract?" The answer to this question revolves around the technical staff's ability to solve current technical problems and management's ability to coordinate various elements of the company in developing technical solutions. This requires concentration on the technical problem at hand, ease of communication of project status and changes, quick reaction capability to sudden changes, and some assurance that key personnel will not be removed from the project too early (less flexibility). All of these attributes probably are better handled in a project management form of organization as indicated in the research findings of this study. In other words, the author would tentatively conclude that in answer to the numerous short-run problems normally found in research and development projects, a project management form of organization would more likely be appropriate than a matrix organizational form.

But in the long run, management is always faced with this type of question, "How can we best prepare our company to meet the challenges and to be competitive in the future, say the next five to ten years?" In research and development companies, a critical factor in this question resides in each company's ability to establish and maintain a superior technical capability. This can be accomplished by successfully improving and upgrading the technical knowledge and capacity of the present technical staff and by attracting high caliber new personnel. Organizational form may have an important effect upon a company's ability to broaden

the learning experience and technical capacities of key personnel. These can be enhanced by exposure to a broad range of technical problems, by face-to-face contact with members of a particular technical or scientific discipline, by project-to-project communication, by good technical supervision, and by maintaining as much of the existing technical staff as possible over the long-run. All these attributes appear to be more conducive with the matrix management form of organization than with project organizational form as indicated in the research findings of this study. In other words, the author would also tentatively conclude that, in answer to the numerous long-run problems normally found in research and development companies, a matrix management form of organization likely would be more appropriate than a project organizational form.

Thus, the dilemma of organizational choice faced by each company engaged in research and development probably should be dependent primarily upon the priorities the company places upon its particular short-run or long-run time dimensions, and the perceived benefits each company anticipates in the short run versus the long run. The choice of which organizational form to utilize becomes one of considerable subjective forecasting and weighting of anticipated short-run and long-run benefits--obviously a most difficult problem to face. But companies would be well advised to systematically study these types of benefits before making their choice as to a project or matrix

organizational form.

Problem Areas for Future Research

This section will discuss three areas of investigation which seem to have a particularly fruitful potential for contributing to the actual practice of managing research and development.

Manpower Flexibility

The findings of this research demonstrated that the manpower flexibility exhibited by the companies studied varied over a wide range (see Chapter III). Since there appears to be a clear organizational effect upon the flexibility of manpower (i.e., matrix organizations appear to be more flexible), it becomes important to ask what are the implications of increasing manpower flexibility. Such an understanding would provide data for consideration when the choice of organizational forms come under discussion. One pair of hypotheses that might be tested by future research is that increased flexibility leads to a higher level of shared knowledge, and that a higher level of shared knowledge enables an organization to be more effective. To expand upon this briefly, it seems probable that the most effective response an organization can make to a new research and development problem is to bring to bear its most appropriately trained and skilled human resources to tackle the problem. It is therefore suggested that any increase

in the knowledge of the detailed skills of an organization's staff would enable an organization to respond more effectively to new problems in research and development. The question of whether a matrix organizational form's increased flexibility implies increased shared knowledge of detailed skills and if increased shared knowledge in turn facilitates increased organizational effectiveness deserves serious further consideration by future researchers.

Ambiguous Authority

Another interesting problem area uncovered in this research was that of the ambiguous managerial authority definition by project and general managers (see Chapter IV). A fruitful further study would be to delve much deeper into the project manager's definition of his authority. The realities of such a manager's perceived authority and his written authority should reveal significant data on organizational adaptations to the strengths and weaknesses of individual project managers. This might contribute to greater understanding of organizational adaptations to individual managerial differences, which possibly could lead to a theory of organizations based upon individual differences rather than one based upon organizational and/or individual similarities.

Organizational Preferences

The difference in organizational preferences between project managers and general managers (see Chapter IV)

points to an apparent conflict situation. This conflict is an outgrowth of the dual authority problem which is typical of virtually every project organization approach. Since this conflict is well recognized by most project organizations, it would seem appropriate that further research be directed upon the problem of whether and how project management can become a more constructive conflict situation. A detailed study of the benefits inherent in this conflict would be applicable to the design of project organizational systems in research and development.

Organizational Form: Past is Prologue

It is the opinion of this author that for the foreseeable future, the time orientation of the defense/aerospace industry in the United States generally will be directed toward the present and immediate future. This orientation will continue to put pressure on the industry toward selective and adaptive use of the project management form of organization, although (as suggested in Chapter IV) the matrix form of organization is likely to be predominant in general. This further suggests a continued dynamic interaction between short-run project problems and long-run organizational problems.

It also is the author's opinion, based on the findings of this report, that continued concentration on the short-run may be detrimental to the optimum development of human resources in the industry. Since this research

tentatively is indicative of long-run human resource advantages of the matrix form of organization, the author would strongly recommend that the industry and the Federal Government undertake extensive research in order to gain a deeper and clearer understanding of the preferred long-run organizational strategy. Such an understanding perhaps could have direct application to public policy as it relates to the design of organizational forms and to the defense/aerospace industry's organizational choices.

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