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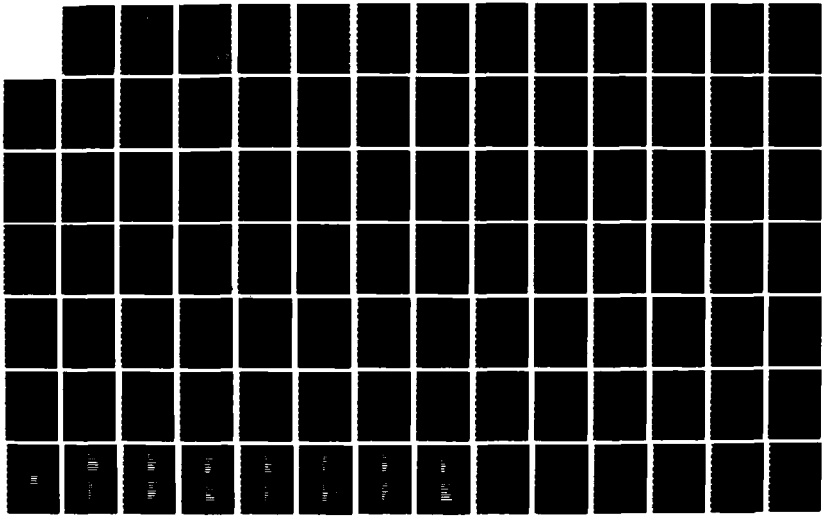

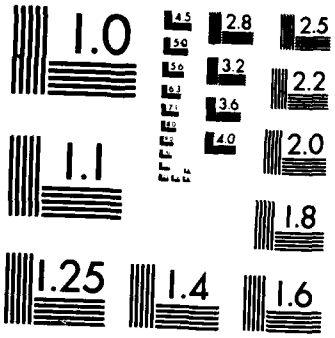

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PROJECT EFFECTIVENESS AND THE BALANCE OF POWER IN MATRIX ORGANIZATIONS: AN EXPLORATORY STUDY

THESIS

Connie Fairchild Peterson
GS-12

AFIT/GLM/LSY/86S-56

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PROJECT EFFECTIVENESS AND THE BALANCE OF POWER IN MATRIX ORGANIZATIONS: AN EXPLORATORY ~~RESEARCH DESIGN~~ STUDY

THESIS

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In partial Fulfillment of the

Requirements for the Degree of

Master of Science in Logistics Management

Connie Fairchild Peterson, B. S.

GS-12

September 1986

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Preface

This research effort was motivated by an awareness of the problems and conflicts that often manifest in matrixed organizations. Specifically, it is my opinion (and one supported by a preponderance of the literature) that the competing and often conflicting roles of the project and functional managers can degenerate into embittered power struggles. Subsequently, these power struggles can hamper the effectiveness of specialists who must attempt to support both managers. Unfortunately, such conflicts can result in dilution of the overall effectiveness of the project office.

Certain portions of the literature suggest that the balance of power between the functional and project managers should be equal; other portions suggest that in certain situations it should be shifted toward one manager or the other based on the goals of the project at various phases. However, nowhere in the literature could I find where this relationship was actually tested. Thus, the intent of this study was to develop a design to test this possible relationship. Specifially, I hypothesized that in the early research phases of project developement, the majority of influence over the specialist should rest with the functional manager. Conversely, I hypothesized that in the later phases of a project's life cycle (development phases), the majority of influence over the specialist should rest with the project manager. The survey instrument developed in this exploratory effort was designed to test these possible relationships.

It is my belief that the continuation of this project is both worthwhile and of significant importance to the effective implementation of matrixed organizations.

In support of this effort, I would like to express my appreciation and gratitude for the assistance of a number of people. Foremost, I wish to express my heartfelt appreciation for the infinite patience, guidance and wisdom of my thesis advisor, Capt Thomas Triscari. Also, I would like to express my appreciation to Dr. Robert P. Steel for his help with factor analyses and to Dr. Charles R. Fenno for his assistance on technical matters. And, finally, I would like to express a particularly warm thanks to Major Daniel W. Reyen for his patience and support in evaluating possible research designs and statistical alternatives.

Connie Fairchild Peterson

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Abstract

The purpose of this ~~study~~ was to develop a research design for measuring the relationship between project effectiveness and the balance of power between the functional and project managers in matrixed organizations during different project phases. Specifically, it was proposed that dominant functional manager influence relates positively to organizational effectiveness in early research phases of project or technology development. Conversely, it was proposed that dominant project manager influence relates positively to organizational effectiveness in later phases of project development. A survey instrument was developed to test these possible relationships. Actual testing of these hypotheses, however, is a subject for follow-on research effort.

Interviews with Air Force Wright Aeronautical Laboratory (AFWAL) and Aeronautical System Division (ASD) deputate level managers provided information on the weighting of organizational indicators across the various phases of a project's life cycle. This was accomplished to verify assertions advanced in the literature review that the importance of different effectiveness indicators may vary with the phase of the project. Interview findings tended to support the literature; i.e., certain effectiveness indicators do vary in importance based on the phase of the project.

The interviews also revealed that such a study would be generally well received by the ASD organizations. Conversely, the AFWAL organizations were cooperative but relatively uninterested in possible findings of such a study. This lack of interest may be attributable to the fact that the

laboratories are working within a structure that already supports project effectiveness in early project phases (i.e., one in which the functional manager is dominant).

PROJECT EFFECTIVENESS

AND THE BALANCE OF POWER IN MATRIX ORGANIZATIONS:

AN EXPLORATORY RESEARCH DESIGN

I. Introduction

Background.

Matrix management has only evolved over the last two decades. With the massive technological boom in the early 60's, many companies set up internal teams of experts from contributing functional areas in an effort to respond to increasingly competitive market situations. These teams, often called project or product teams, focused on individual product development while emphasizing cost and schedule parameters. The initial intent was that these teams would be temporary, but technological growth and transition continued to escalate and the teams became permanent fixtures in most successful companies. (11:30; 19:37; 38:21-22)

Sometimes the teams were based in specific functional areas. However, it soon became apparent that functional managers did not have the necessary "total systems" outlook required to coordinate complete product development (38:22). In an effort to compensate for this weakness, some companies set up teams as completely separate entities, i.e., independent product divisions with personnel from each functional area assigned permanently. This approach, on the other hand, tended to underutilize manpower resources and sacrifice specialty expertise which is readily nurtured in the functional arrangement (11:30; 32:23). The matrix organization evolved as an outflow of subsequent

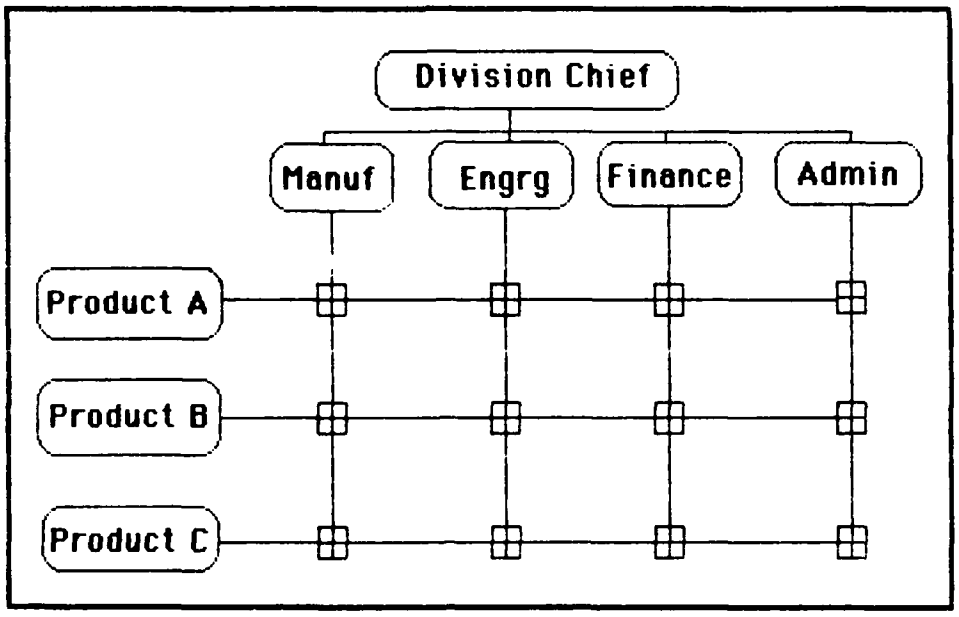

Figure 1. Matrixed Organization (adapted from Rowen et. al.--32:24)

efforts to draw on the strengths of both forms of management while attempting to minimize the weaknesses of each (11:30).

Struckenbruck (38:21) defines the matrix organization as "one in which there is dual or multiple managerial accountability and responsibility." Or, more succinctly, there are two bosses--a functional manager and a project manager. The project manager is normally responsible for managing those activities associated with the product, i.e., assuring the product design is integrated and that cost, performance, and schedule goals are met. The functional manager, in contrast, is normally responsible for his area of expertise as applied across all product lines. He is also responsible for assuring efficient utilization of resources and for development and maintenance of speciality expertise. (19:37; 32:23; 37:309-310)

This concept results in an organizational chart in which the project organization is horizontally overlayed across the functional organization as depicted in Figure 1.

The intersections indicate personnel assigned to each product division from supporting functional organizations. The assignments to the product divisions are generally considered temporary; once the project is completed, the resources return to their respective functional organizations for reassignment to new projects or to workload within the functional organization itself. (19:37; 38:24)

The matrix organization can be an effective means of supporting multiple projects with limited assets. When the proper balance is struck between functional and project managers, it can be an excellent way to facilitate rapid product development while maintaining functional integrity (11:30; 38:32; 43:10). Proponents of the matrix organizational form also state that it can be conducive to innovative problem solving, efficient employee utilization, and, more effective cost management (38:25; 19:38). However, the matrix is a complex system to manage. Organizations operating inside the matrix arrangement are often characterized by goal conflicts, power struggles between functional and project managers, bottlenecks, delays, and employee confusion over goals and organizational loyalties. These problems can manifest in poor program continuity, reduced morale, cost and schedule overruns and overall decreased organizational effectiveness (13:8; 19:40; 38:26).

General Problem.

The problem then is how do managers capitalize on the benefits of matrix management while avoiding the pitfalls? If management could become aware of the variables that are evident in effective matrix

organizations, then perhaps they could manipulate these variables during the organizational design process to assure optimum design implementation.

One of the major and most often referred to problems of the matrixed organization is the ambiguous and often competing roles of the project and functional managers (19:40; 32:23; 38:26). This conflict regarding the dual responsibilities of these managers can be debilitating to the progress of a program office. As stated earlier, project and functional goals can often conflict. The project manager's role is that of "integrator" and "coordinator" of project tasks (12:15). In turn, it is his job to assure that multi-disciplinary inputs are effectively integrated into product development and that cost and schedule goals are met. Sometimes this means that he must induce support from specialists that he has little formal authority over (12:15). In contrast, the functional manager's job is to assure efficient utilization of specialty resources and to insure product integrity in his particular area of concentration. In turn, the functional manager will tend to slow down movement of the product to the market as he strives to make it just "a little bit better" (15:68). These conflicting roles and tasks can lead to embittered power struggles between the two competing managers. Constructive resolution of such conflicts is essential to the effective performance of the matrixed organization. (19:40; 21:142-143, 151; 38:22)

When such conflicts are not resolved, the specialist who works for both managers can get caught in the middle of the power struggle. For him this can be an extremely stressful arrangement in that he stands to displease one or the other manager whichever way he goes. In such situations, the specialist will tend to side with the manager who he perceives to have the most power and influence (15:70; 19:40). Unfortunately, this is not always in the best interest of the project.

Specific Problem.

This study concentrates on the conflicting roles of the functional and project managers. Specifically, it examines the issue of "balance of power" between project and functional managers in the matrixed organization. Katz and Allen (15:69) recognized the criticality of the "balance of power" issue and stated that:

> "The degree to which each side of the matrix is successful in building power and influence within the R&D organization will have a strong bearing on the outcome that emerges from the many interdependent engineering activities." (15:69)

The matrix after all is a device for promoting integration (41:26). In turn, the project manager's role is that of integrator. Then perhaps if we can determine what the degree of integration required is, we can ascertain how much power the project manager (as well as the functional manager) needs to do his job effectively. Lorsch (41:26) suggests that the more complex and differentiated the new porduct needs are, the more important the integrator role becomes. He further suggests that the frequency of communication necessary between employees and departments to coordinate efforts is a measure of need for integration. Other experts (15:68; 37:31) supports Lorsch's contention and also suggest that the integrator role is key when the task requires timely completion and when technology is rapidly changing.

It intuitively appears then, that the need for a strong integrator role would vary with the actual phase of the project. For example, it appears that in the early phases of research, when the technology is being developed, efforts are very specialized. That is, scientists and engineers work quite independently with little focus on how the technology will integrate into a specific product (2:135-136). In turn, strong functional management is

appropriate since maintenance of functional expertise is more readily facilitated under a purely functional orientation (32:23). However, at some point, the major research questions regarding technology development have been answered--the technology hardens, and is ready for integration into some product or weapon system. At this point, then, the integrator (i.e., project manager) role becomes increasingly important as other disciplines (such as marketing, logistics, manufacturing, etc) are drawn into the development effort (15:68). In turn, the need for project manager influence increasingly intensifies as the design moves toward production. Cost and schedule issues become paramount as the pressure to get a product on the market ahead of ones competitors intensifies. No longer can the functional manager be allowed to hold the product back (i.e., make it "just a little bit better") without affecting the company (or the military service's) competitive edge.

Summary. Since the need for integration increases as the product moves from research towards production, it appears that the balance of power or authority over the specialist in a matrix situation must shift toward the project manager from the functional manager. This proposed relationship is summarized in the following hypotheses.

Research Hypotheses.

1. A weak matrix (one characterized by a dominant functional manager will correlate with organizational effectiveness in the early research phases of project (or technology) development.

2. Conversely, as the program advance to the later phases of project development, a strong matrix (one characterized by a dominant project manager) will be positively related to organizational effectiveness.

In other words, which manager should have the power is a function of the degree of integration required to meet mission needs. In turn, the degree of integration required is dependent on the phase of the project.

Support for the Hypotheses.

Support for this possible relationship is inferred in Galbraith's article (11:37-38) in which he suggests that there is a broad range of possible organizational styles from pure functional on one end of the spectrum to pure project on the other end of the spectrum, with the matrixed organization monopolizing a fuzzy area in the middle. This area can range from very strong to very weak. Strong referring to a tendency toward project manager dominance, and weak referring to a tendency toward functional manager dominance. In turn, both Galbraith (11:39-40) and Salancik (41:238) suggest that organizations naturally respond to the changing demands of the environment by restructuring their power bases. That is, as cost and schedule become more important, power naturally shifts to the hands of the project manager; when functional integrity issues are of more import, power remains in the hands of the functional manager. However, Salancik (41:235) contends that this shift is normally slower than what might be optimal. He argues that this is because "power tends to take on institutionalized forms that enable it to endure well beyond its usefulness to an organization" (41:235). More simply stated: The manager (be it a project or a functional manager) which has been in the organization the longest and has, therefore, had the greatest opportunity to develop a power base will have the greater opportunity to develop official policies supporting his position in the organization and a political support system (network)--i.e., his existance and the existance of the organization he manages becomes embedded in the formal organizational structure--"institutionalized" in the organization. In

the matrixed organization, this institutionalization of power may enable the dominant manager to exert influence and retain control of resources even when the environment dictates change and a relinquishing of that power (41:235). Subsequently, we might expect to find power in the hands of functional managers when it rightfully ought to be in the hands of project managers (in the later research phases, such as later phases of demonstration/validation and in full-scale development). Furthermore, we should expect these projects to be among the lower performers.

Investigative Questions.

To address the above hypothesis, the following research questions were addressed:

1. What characteristics differentiate the various phases of research and development (R&D)?

   a. What are the various stages/phases of R&D?

   b. What are the differences between the various phases?

   c. What degree of integrative effort is required in the different phases?

2. What differentiates a strong (project manager dominant) matrix from a weak (functional manager dominant) matrix?

   a. What constitutes a strong/weak matrix?

   b. What are potential sources of power that influence the "balance of power" between the functional and project managers?

3. What constitutes an effective organization in both early project development and later stages of engineering development?

a. What are appropriate measures of effectiveness in R&D settings?

b. Are they constant throughout the R&D process?

c. Are there any common measures of effectiveness?

Scope of Study. Due to the limitation of time imposed by the 15-month AFIT program, and the fact that this research is of an exploratory nature, this study was limited to the development of a research design to adequately test the hypotheses proposed in the foregoing section. In turn, the literature review and survey instrument design constitutes a major proportion of this study.

II. Literature Review

The purpose of this literature review is to address the investigative questions proposed in Section I of this study and to provide background, understanding and foundation for this study.

Phases of Research and Development (R&D).

Five Phases of R&D. Pappas (29:15) identified five basic phases of the R&D process as:

1. Basic Research - that research directed toward the quest for "fundamental knowledge."

2. Exploratory Research - directed toward identifying the potential useful application of a scientific concept."

3. Applied Research - directed toward "improvement of the practical application of a scientific concept."

4. Development - concerned with "engineering improvement of a particular product or process."

5. Product Improvement - directed toward modifying a product to reduce its cost or enhance its consumer appeal.

Five Phases of Project Life Cycle. In the Air Force, phases of project development are divided into four categories to include: (1) concept exploration, (2) demonstration and validation, (3) full-scale development, and (4) production/deployment. Definitions of each phase are adapted from Peschke (30:7-56 - 7-69) as follows:

1. Concept Exp[illegible]tion Phase. During this phase alternative solutions are being explored. The emphasis is on innovation and competition between contractors. Each contractor is free to propose his own technical approach, main design features, and alternatives. Tests are limited to determining technical feasibility of concepts, defined subsystems, and key components. The program manager is assigned and his responsibilities, authority and accountability are stated in an official charter. This phase is complete when alternative concepts have been selected for system demonstration (30:7-57 - 7-59)

2. Demonstration and Validation Phase. During this phase, full-scale prototypes are developed if deemed financially feasible. If not, paper studies are expanded and definitized and prototypes of high risk subsystems are assembled and tested. Long lead-time parts are ordered. The goal during this phase is to reduce both technical and economic risk, thereby assuring that the design(s) selected for full-scale development is (are) feasible within given time and resource limitations. (30:7-67 - 7-69)

3. Full-Scale Development Phase. During this phase, the entire system is "designed, developed, fabricated, and tested" (30:7-69). Preliminary and critical design reviews are conducted in an effort to clean up any design problems prior to commitment of the item to production (30:7-69). After many evaluative iterations, the project moves into the production/deployment phase.

4. Production/Deployment Phase. During this phase, the entire system is produced for operational use. In turn, training and support equipment are produced along with system spares. Also, at some point in this phase, the program transitions from the program manager to the supporting command (in the Air Force the supporting command is the Air Logistics Center). (30:7-69)

Summary. It appears that the stages of R&D as identified by Pappas (29:15) can be effectively related to the phases of project development. That is, the conceptual phase seems to align quite nicely with

the exploratory research phase in which the useful applications of scientific concepts are being developed and integrated into a product; the demonstration and validation phase with the applied research stage in which the practical application of scientific concepts are "improved;" the full-scale development phase with the development stage of research in which the emphasis is on engineering improvement; and, finally, the production/deployment phase with the product improvement phase of R&D when the emphasis is on maintenance, modification, and product improvement.

Invention/Innovation. Two key concepts which help to diffentiate the phases of R&D are "invention" and "innovation." Invention relates to the combining of old or "pre-existing knowledge" in such a way that new knowledge is generated, and innovation relates to the turning of such inventions into profitable products or "innovations" (41:42). The implication here is that invention ties to the early phases of research which is involved with the generation of knowledge for knowledge sake. Conversely, innovation relates to later project phases in which efforts are directed toward integration of the new knowledge into a useful product. Quinn and Mueller (41:75) suggest that the effective transfer of new knowledge (or new technology) into a successful product is a key management concern today which requires a "strong coordinating authority" who has the responsibility, power, and resources to facilitate the integrative process (41:60,76).

Degree of Integration. As discussed in Chapter I, the degree of integration should increase as we progress from research to development stages. Integration is defined by Lawrence (21:142) as "the achievement of unity of effort among the major functional specialists in a business." He further suggests that if schedule and integration are important to the

business organization, then a formal integrator role needs to be established (21:145). He defines the integrator's role as that of fascilitating resolution of non-routine, unprogrammed type problems between multi-disciplinary functional areas (21:142).

Lorsch (41:485) recognizes that the matrix itself is actually a device for promoting integration, so the establishment of the project office and the assignment of a project manager can be considered formal recognition of the need for increased integrative effort.

Strong Versus Weak Matrix.

Define Strong/Weak Matrix. Earlier a strong matrix was defined as one characterized by a dominant project manager, and a weak matrix as one characterized by a dominant functional manager. A dominant functional manager can be either a manager who has the majority of influence over an employee who is assigned to a project, or it can mean that the project is actually based in his functional organization (11:32).

Galbraith (11:37) expands this definition by describing the matrix as the middle range of a continuum from the pure functionally managed organization at one extreme and the pure project managed organization at the other extreme. This conceptualization is illustrated in Figure2.

The more the organization tends toward the left side of the matrix, as diagramed in Figure 2, the "weaker" the matrix; conversely, the more it tends to the right, the "stronger" the matrix. He suggests that the choice of management style (matrix, project, or functional) is contingent upon the amount of integrative effort required, the state of technological development, the rate of technological change, and economies of scale. He further suggests that project manager influence is necessary when tight schedules and integrative effort are of primary importance. On the other

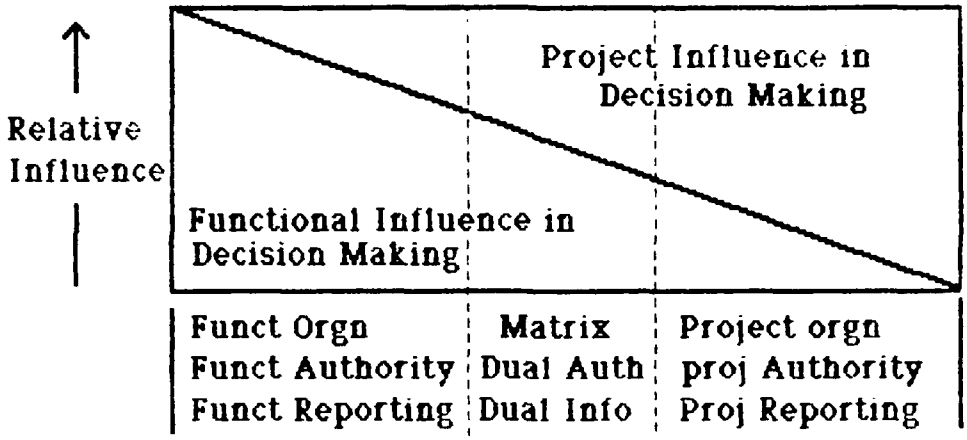

Figure 2. The Range of Structure Alternatives (adapted from Galbraith--gal71:37)

hand, when economies of scale, preservation of functional expertise, and efficient employee utilization of expertise are of primary importance, heavy functional manager influence may be more appropriate. (11:37)

Support for this relationship was developed even earlier by the findings of Lawrence and Lorsch (21) in a comparative study of ten organizations in the plastics, consumer foods, and container industries. Their findings revealed that strong integrator roles relate to organizational effectiveness during periods of rapid technological change. However, when the environment is technologically stable, they suggest that the integrator role can effectively be performed from within the traditional hierarchical structure.

Sources of Distribution and Power. Various studies refer to certain power bases that are major indicants of whether the majority of the power is in the hands of the project manager or, conversely, in the hands of the functional managers. Gemmill gives a good definition of these five power bases which are quoted in Table I.

TABLE I

Sources of Power

Formal Authority:

The ability to induce or influence others to meet his request because they perceive him as being officially empowered to issue orders.

Reward Power:

The ability to induce others to meet his requests because they value the rewards they believe he is cable of administering.

Punishment Power:

The ability to induce others to meet his requests because they wish to avoid punishments they believe he is cable of administering.

Expert Power:

The ability to induce others to meet his requests because of their respect for his technical or managerial expertise.

Referent Power:

The ability to induce others to meet his requests because of theif feelings of identification with him, with the project, or with the position of project manager.

(Adapted from Gemmill--12:16)

Formal Authority is tied to a project manager's ability to direct employees and workload without having to go through superiors or the functional manager; reward authority can be either direct (the actual ability to increase salary or give promotions) or indirect (perceived ability to

"influence" promotions or salary increases); and referent power can take the form of actual friendship, simple "personal attraction," mentorship, or simply common technical background (12:20).

In the previously referenced Lawrence and Lorsch (21) study involving the plastics, consumer foods, and container industries, findings also revealed that effective "integrators" (program managers) use persuasive arguments based on expertise versus formal authority to induce support from personnel.

Their findings are supported by those of Thamhain and Wilemon (39) who conducted a study utilizing French and Raven's typology to determine which sources of power were the strongest determinants of employee satisfaction and performance. They surveyed 22 project managers and 66 project personnel in various project offices in a large electronic company. They utilized both questionnaires and interviews to collect the required data on the five specific variables quoted as follows:

> "(1) project personnel perceptions of influence methods used by their project managers; (2) degree of support provided by project personnel, (3) willingness of project personnel to disagree with their project manager, (4) degree of project involvement among project personnel, and (5) management's rating of the performance of the project managers." (39:218)

The employees ranked formal authority, work challenge (a type of reward power), expertise (a type of expert power), future work assignments (reward), salary (reward), promotion (reward), friendship (referent), and coercion (punishment) from most preferred to least preferred motivators. From his study, one would expect formal authority, work challenge (reward power), and expertise (expert power) to be the strongest indicants of

satisfaction and motivation. However on his overall project performance index, only work challenge and expertise correlated positively with project performance. Formal authority seemed to lower overall project performance and coercive power correlated negatively with degree of support (39:219-220).

Vasconcellos recognized the five common power sources referenced above and also identified two additional variables that influence the power bases. The first was "communications patterns;" i.e., if the project manager gives directions directly to the specialists without going through the functional manager, then the project manager's power is increased (42:60). He found that two organizations which might basically have the same power distribution, might still be considerably different due to the communication patterns in effect.

The second variable identified by Vasconcellos was used to differentiate matrix structures. He felt that it was necessary to differentiate those matrix structures in which the project manager is also a functional manager from those in which the project manager is exclusively a project manager (42:60). Intuitively, if the particular project manager also serves a functional manager role to some of the project personnel, this should sway the matrix toward the weak (functional manager dominant) side of the spectrum.

Another major factor contributing to the project manager's ability to induce support from both functional managers and specialists was isolated by Might and Fischer (25) in a study involving 103 development projects in 30 different firms. They found that high levels of authority correlated positively with all measures of project success. Other factors which are not directly under the control of the project manager but which can impact the success of

the project were also analyzed. These included organizational structure (matrix, functional, or project) and size of project. The matrix format correlated highly with project success (indicating that matrix management was conducive to effective projects). Size, on the other hand, yielded ambiguous results; however, overall, large projects which receive managerial attention tend to enjoy greater success.

Organizational Effectiveness.

Different Indicators for Different Phases. The phase of the program calls for different types of skills and talent--different types of people The needs, personalitities, and personal goals of these idividuals vary significantly. In turn, one might expect that different effectiveness indicators would be necessary to deal with these differences as well as different organizational structures and management styles. For example, scientists normally are deeply involved in the early phases of research and initial phases of project development, engineers in the later phases. In turn, one must look at the roles and norms of scientists versus engineers when differentiating the project phases.

A well documented study conducted by Badawy (2:135-136), revealed that the scientist is normally concerned with the advancement of knowledge for knowledge sake and not necessarily for the sake of the organization. His ideas of success tie closely to the submisssion of quality publications, the recognition of achievement from peers working in his specialized area, and assignment to group research leader positions. He is not normally concerned with positions that have administrative responsibilities or that allow him to participate in the decision making of the organization.

The engineer, on the other hand, is interested in team work and integrating inventions into the product line. He is concerned with "technical

application" and with troubleshooting urgent problems. The engineer seeks recognition and advancement through the organization. Unlike the scientist, his goals are more in line with those of the company (2:136).

Ford (9:41-43) traces the basic differences between scientists and engineers back to their childhood inclinations. Specifically, he suggests that research scientists tended to be "isolationary" and autonomous even as children. They tended to pursue reading, music and intellectual activities (such as involvement in science clubs, etc) rather than social activities. The scientist then carries these characteristics into adulthood; that is, he maintains an air of distance or detachment and tends to be very self-sufficient and autonomous. He is not particularly interested in group activities nor team efforts.

The development scientist or engineer, on the other hand, tends to be much more sociable and talkative relative to the research scientist. He tends to be more oriented toward the goals of the group or company (9:42).

Delbecq et. al. (6) developed a model that helps to ascertain role differences at different phases. In their study, scientists involved in early research fall into the "creative" and/or "professional" category in which tasks are "unique" and/or "nonrepetitive." The group leader in such a situation acts as a facilitator toward group creativity. Individual analysis and identification of solution coupled with group evaluation and decision making is the norm. The emphasis is on quality; time is not a limiting factor except within vague parameters as defined in organization guidelines or regulations. The scientific group works fairly independent of the company's management or administrative system. Originality, eccentricty, and open communication are fostered. Performance evaluation is normally subjective and group oriented (i.e., the research group is evaluated versus each individual in the group).

Productivity measures (such as cost and schedule) are given little weight since they are hard to obtain.

In contrast, the engineer falls into the "specialist" and/or "provencial" category in which tasks are "similar" and/or "nonrepetitive." The engineer's goals, like the scientists, also relate to quality, but now "quantity" is also a consideration. Time constraints in the form of milestones prevail and the emphasis is on "interdependent" decision making and "independent implementation." The management or administrative system now defines the end product. The method of reaching the end product is negotiated between the engineering group and the administrative system. Cost parameters become a factor since an end product is the goal. Performance evaluation is based on resource utilization and productivity goals. (6:213-214)

Implicitly, then, one would not expect management to utilize the same management style or the same performance evaluation criteria for the scientist that they use for the engineer. For example, the research scientist might be quite insensitive to schedule constraints since one certainly cannot dictate when a knowledge breakthrough must occur. Rather management might put more emphasis on qualitative type indicators such as peer evaluation.

Also, the management structure that facilitates a group of engineers toward organizational success might be quite different from the structure that moves a group of basic research scientists toward success. It appears that the more the specialist's functions tend toward the basic research side (i.e., expanding the knowledge base), the more specialized and autonomous his efforts are. Cost and schedule issues are not as central as perhaps quality and functional integrity issues. However, the more the specialist's talents

tend toward the engineering development side, the more it appears he must integrate his efforts with marking and manufacturing concerns as well as with different disciplines. In turn, the role of the project manager as an integrator might become more important as cost and schedule issues surface as paramount considerations.

Quinn and Cameron (31) conducted a study in which they correlated the stage of project development (phase of the project) and organizational effectiveness. They organized criteria of effectiveness into four models: rational goal, open system, human relations, and internal process models. The different models were correlated with effectiveness in organizations depending on their stage in the life cycle. A state agency development was analyzed for a five-year period to provide support for these hypothesized relationships. They concluded that effectiveness criteria does in fact change depending on the phase of the project.

Specifically, they found that during the entrepreneurial phase when the thrust is innovation and "niche formation", the open systems model with its emphasis on flexibility, growth, and resource acquisition is the most appropriate management style (31:34,43).

However, in the formalization stage when the organization stabalizes and becomes "institutionalized," the internal process and rational goal models proved most effective. The emphasis of these models is on "goal setting," productivity, efficiency and the establishment of formal communications channels and control mechanisms (31:34,44).

And finally, in the "elaboration of structure phase," when the organization once again begins to expand and innovate, the open system model again proved more effective (31:34,44).

Common Indicators Across All Phases. As indicated by the discussion above, one might expect that criteria which indicate organizational effectiveness in early research phases might be different from criteria that indicate organizational effectiveness in the later phases of research, particularly since scientists and engineers have different goals and roles. However, Moser (27) conducted a study to try to isolate some performance measures which could be used in basic research, applied research, and design and development phases. He queried 40 industries (124 questionnaires) as to which indicators were used most frequently to rate performance measures in work settings. He isolated three primary variables. They were quality of output or performance, degree of goal attainment, and amount of work completed on schedule. The next three most often used indicators included unit level of efficiency, percentage of projects completed, and percentage of results adopted by the company (27:31).

Along the same lines, Stahl (36) used peer ratings to measure innovation and productivity in research and development settings. He found in his study that innovation and productivity are highly correlated. Essentially this means that research and development personnel who are innovative also tend to be productive. He defined productivity as the "quantity of output in the form of publications, patents, products, materials, written reports, and proposals." He defined innovation as a subset of productivity; i.e., it is an output which is both "useful and original." Therefore, innovation was considered a measure of "quality" and productivity a measure of "quantity." "Useful" meant that it supplemented the "fund of knowledge or inventions" that had some application or "value" to the scientific or engineering community. The bottom line: Innovation is not found without productivity.

Weighted Indicators of Effectiveness. Some studies have been conducted to try and weight indicators for use across all phases. For example, in a study conducted by Mahoney (22) measures of R&D effectiveness were ranked from high to low as follows:

1. High order critera (measures of ouptut):

    a. Cooperative behavior
    b. Staff development
    c. Reliable performance

2. Low order critera (measures of organizational climate, supervisory style, and capacity for performance):

    a. Efficiency
    b. Productivity
    c. Output behavior

Interestingly, for regular business organizations, he found this criteria to be reversed. This hierarchy exists because there is no standardized production cycle in R&D (i.e., producible products may never be developed and projects may simply be scraped; i.e., it is difficult to predict output in R&D settings) (22:360-374).

Brabson (3) recognized that the more abstract and creative the work (and it is most abstract and creative in the basic research phase), the more emphasis needs to be placed on qualitative indicators of performance. On the other hand, as research progresses into the engineering development phases, the work effort becomes better defined allowing for more emphasis on quantitative indicators of performance. In turn, he developed a performance evaluation model (reference Figure 3) which combines both "quantitative measures of performance" with qualitative estimates of worth of work" (3:73).

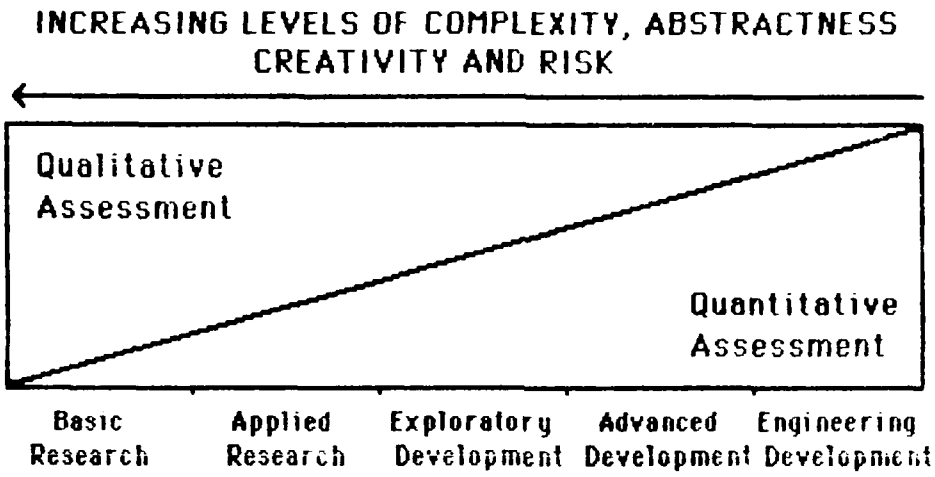

Figure 3. Spectrum of R&D activities
(adapted from Brabson--3:71)

Brabson (3:73) identified two quantitative measures which he considerd common to all stages of research and development--schedule and cost. Schedule is simply the ratio of trageted schedule to actual schedule, and cost is simply the ratio of targeted cost to actual cost. He also identified three qualitative measures of "estimate of worth or work;" these were "relevance" (a relative measure of contribution to organizational goals), "peer group evaluation" (a relative measure of the "quality of the science and technology"), and "preparation of the future" (a relative measure of the adequacy of resources committed to the expansion of the technology base) (3:75).

The quantitative measures of performance were then combined with the qualitative measure of worth to provide a "single index" for the organizational unit (3:75).

Brabson's technique has an intuitive appeal because it allows for the use of several basic measures for evaluating all phases of research and

development. Also, the measures are weighted appropriately according to the emphasis given to them in the particular phase in question.

Summary. Based on the above literature review, one might expect that that some organizational/project effectiveness indicators will be consistently important throughout all phases of a project's life cycle. However, due to varying goals during different phases and the varying skill compositions required to meet these goals, some indicators may be important in one phase and relatively uniportant in another phase. The literature appears to be contradictory as to which indicators vary in importance and which indicators remain constant across all project phases. It appear that the majority of the contradiction is definitional. That is "schedule" might be considered important in both research and development if defined as: (a) the "accomplishment of a specified number of experiments" for research phases and (b) the "production of a marketable end item" for development phases. However, if schedule is defined only as "production of a marketable end Item," then it might be weighted increasingly more heavily as the phases advance toward production.

In turn, a research design (such as the one being developed in this study) which seeks to compare organizational effectiveness in different project phases must: (1) utilize effectiveness indicators which account for changing goals and skills, and (2) assure that indicator importance is weighted appropriately according to the project phase.

III. Methodology

In Chapter 1, the conflicting roles of functional and project managers were identified as a primary source of contention in matrix organizations. Furthermore, it was hypothesized that, rather than an equal balance of power between project and functional manager, perhaps the preponderance of power (or influence over the specialists) should shift with the phase of the project based on changing project demands. In Chapter 2, the literature was explored to address the investigative questions formulated in Chapter 1, and thereby determine what research was already in existence relative to these hypotheses. Although much of the literature suggested that an equal balance of power between project and functional managers was ideal, another portion furthered the hypotheses advanced in Chapter 1, i.e., that the balance of power should shift with the phase of the project. However, nowhere in the literature reviewed had this relationship actually been tested. The goal of this study, then, was to develop a methodology to test these hypothesized relationships. In turn, this chapter identifies the steps which were involved in development of a research design which would focus on examining the relationship between balance of power and organizational effectiveness across various phases of a project's life.

Methodology Steps:

1. Conceptualization of a research design which would capture: (a) balance of power between functional and project managers, (b) organizational effectiveness of the project office, and (c) changing project phases.

2. Determination of how the data would be gathered (historical data, interview data, survey data, etc).

3. Development of a methodology to differentiate the phases of the project. The literature review was the primary source of information for this portion of the design development.

4. Development of measures for the balance of power. The literature review also provided the primary source of information for development of the measures for balance of power. Questions which had already been tested for internal validity were utilized to the maximum extent possible.

5. Development of preliminary measures for organizational effectiveness. The literature review was used to develop preliminary measure of organizational effectiveness. However, input from managers familiar with the projects was considered crucial for development of realistic measures of effectiveness. In turn, interviews were arranged with key personnel in both AFWAL and ASD to evaluate and rank the measures of project effectiveness based on the phase of the project and to identify any additional or inapplicable measures.

6. Development of the preliminary measurement instrument.

Scope of Research.

This study is limited to the development of an experimental design methodology. Actual data collection and analysis through administration of the survey instrument will be a subject for further thesis research. This limitation is imposed due to the time constraints imposed by the AFIT graduate program. However, some data was collected in support of development of the project effectiveness indicators. Specifically, data was collected to assess the importance of project effectiveness indicators at various phases in a projects lifecycle. To minimize travel costs, only managers at Wright-Patterson AFB were interviewed (i.e., AFWAL and ASD managers which are one heirarical level above project and functional managers).

This study primarily concentrates on the conceptual, demonstration/validation, and full-scale development phases of project development. It is during these phases that matrix management is most often employed.

This methodology was developed to analyze current, on-going projects only (versus development of systems already fielded, etc).

Furthermore, this research was directed toward development of a design which would evaluate project effectiveness from the perspectives of people closely linked to the project (such as project specialists, functional and project managers, and managers one heirarchical level above the project and functional managers). This will allow for cross-validation of organizational effectiveness criteria in the follow-on survey effort while minimizing the population which must be sampled.

IV. Research Design

The Basic Research Design.

The research design developed in this chapter is an ex post facto design aimed at assessing possible correlational relationships between the distribution of power (authority) between functional and project managers and the effectiveness of specific projects at various phases in their life cycle. The short range goal for the survey instrument developed in this study is for cross-sectional use. It is anticipated that the first couple of "snap-shot" uses of this design could reveal substantial flaws in the instrument design. However, a long range goal of follow-on research might be to refine this instrument for longitudinal use. The longitudinal study is preferred in that it would allow for observation of the same projects through various phases of their life cycles. Ideally, projects would be tracked from early phases of research through production and deployment phases.

However, for present purposes, the cross-sectional study is seen as more realistic--particularly for follow-on AFIT graduate application due to the 9 to12 month time allotment for thesis study.

Survey was selected as the method of data collection primarily because it provides a relatively easy method for collecting and statistically analyzing a large volume of uniform data.

Proposed Statistical Analysis.

The Hypotheses formulated in the Chapter I of this study are reiterated below:

1. A weak matrix (one characterized by a dominant functional manager) will be positively related to organizational effectiveness in the early research phases of project (or technology) development.

2. A strong matrix (one characterized by a dominant project manager) will be positively related to organizational effectiveness in the later phases of project development.

To allow for each hypothesis to be tested separately, the data was split into two categories. Since a natural break seems to exist between Research (the laboratory environment) and Development (the SPO environment), it was decided that these two categories would be treated as mutually exclusive in the research design. In turn, for the follow-on study, data collected in the laboratories would be directed toward assessing the relationship described in hypothesis one; conversely, the data collected in the SPO's would be directed toward assessing the relationship described in hypothesis two.

With the above categories defined, each hypothesis can now be broken into two variables: the dependent variable, project effectiveness, and an independent variable, matrix strength. Both variables can be measured on interval scales and can be mathematically depicted as follows:

Data Set 1 (Research): $Y = \beta_0 + B_1X + E$

Data Set 2 (Development): $Y' = \beta_0' + B_1X' + E'$

Where,

Y = project effectiveness β_1 = slope of the line

X = strength of matrix β_0 = the Y intercept

E = the random error

Linear regression analysis can then be used to determine if there is a relationship between the X variable, matrix strength, and the Y variable, project effectiveness, in the two separate categories (24:396-414). In turn, the strength and direction of the relationship can be examined by observing

the correlation coefficient "r" and the coefficient of determination "r^2" (24:418-425).

It is conceivably possible that research and development are not separate subgroups but rather that they represent the same population. The Chow test can be used to test whether the coefficients of each subgroup differ significantly (14:195).

Development of the Survey Instrument.

Development of the preliminary survey instrument required addressing each of the following questions.

1. How will organizations (projects) be selected for measurement?

2. What factors will be used to measure the strength/weakness of the matrix?

3. What factors will be used to measure organizational effectiveness?

The remainder of this chapter is directed towards answering the above questions.

Selection of Projects for Measurement.

Project selection criteria were adapted from studies by Thamhain and Gemmill (39) and Vasconcellos (42) as follows:

Population. The Aeronautical System Division (ASD) and Air Force Wright Aeronautical Laboratories (AFWAL) would provide a convenient and appropriate potential population--particularly since the managers in those organizations have already been queried and were involved in the ranking of the organizational effectiveness criteria. Also, it might be appropriate to limit the population to basket SPO's (SPO'S that have multiple projects within them) to increase the probability of obtaining comparable projects.

Grouping Projects for Comparison. Since both effectively performing projects and less effectively performing projects are required to support the follow-on survey analysis, managers at least one hierarchical level above the project and functional manager level should be queried to identify the projects for study (39:220). Their intuitive selections could then be verified by having them rank each project utilizing the project effectiveness criteria developed for the survey instrument (reference questions 14-20, Appendix C).

Project Duration. Suggest the projects be of a minimum duration of six months and involve at least two functional areas (42:56).

Sample Size. Ideally, one would conduct a pilot study; then, based on the findings, a sample size would be computed reflecting the degree of confidence and the interval of estimate desired for specific parameters (24:316-318). Unfortunately, in this instance, the collection of data will probably be limited to the availability of projects for examination and the cooperativeness of the managers of the projects. In turn, the sample will have to be delimited to what is possible to obtain (versus what is preferred). The researcher/analyst will have to make the the best possible use of the data obtained recognizing the weaknesses of statements that can be made about the findings based on the limited sample size.

Measures of Strong/Weak Matrix.

There are primarily four variables which were incorporated into the survey instrument for measurement of matrix strength/weakness. These variables are:

1. Power.
2. Communications patterns.

Table II

Questions to Ascertain Project Manager Influence

	Construct Measured
1. He has the authority over my appraisal or, if military, over my Officer Effectiveness Rating (OER).	Formal
2. He has the authority to direct my activities on project related tasks.	Formal
3. He has the authority to affect my future work assignments.	Reward
4. He has the influence over my future work assignments.	Reward
5. I feel he has the most potential to penalize me in some way.	Punishment
6. Between the two, I would seek him out for advice on technical matters.	Expertise
7. Between the two, I draw on his knowledge more to resolve project related problems	Expertise
8. Between the two, I would prefer to be identified with him or with the project or functional area he represents.	Referent
9. Between the two, I feel he is more of a friend to me	Referent

3. Role differentiation.

4. Number of personnel committed to the project full-time.

Power. Power refers to the respective manager's authority or ability to influence the specialist to support him. It is the specialist's "perception" of which manager has authority over him which will determine how the power is distributed between functional and project managers (15:70). Therefore,

when utilizing this methodology, specialists working each project will be asked questions to determine which manager has the bulk of the authority as defined by Gemmill (12:16-17). Again, the primary sources of authority are formal, reward, punishment, expert, and referent (12:16-17). Utilizing ideas operationalized in both the Vasconcellos (42:57) and Thamhain and Gemmill (39:218-219) studies, questions were developed to measure each source of power. These questions are summarized in Table II. In the follow-on survey, each of the project specialists would be directed to address the questions listed in Table II utilizing the following scale:

A. Project manager only.
B. Mostly project manager.
C. Project manager somewhat more than functional manager.
D. About the same for both the functional and project managers
E. Functional manager somewhat more than project manager.
F. Mostly functional manager.
G. Functional manager only.

Communication Patterns. The second measure is communications patterns. As pointed out in the Vasconcellos study (42:57), the more direct the project manager's communication is with the employee, the more the matrix will tend to the strong (project manager dominance) side of the spectrum. The result is that at first glance two organizations might mistakenly be identified as very similar based on their power structures when, in fact, they may be very dissimilar when their communications patterns are taken into account (42:59). To account for this variable, specialists in follow-on studies would be asked to indicate which of items listed in Table III best describes their communication pattern. These criteria will be reverse weighted; i.e., 4 = 0, 3 = 1, 2 = 2, 1 = 3. Item five will be

Table III

Qeustions to Ascertain Communications Patterns

_____ 1. The project manager communicates directly with team members on project related matters.

_____ 2. Again, the project manager communicates directly with team members on work related matters, but later, either he or the team member keep the functional manager informed.

_____ 3. The project manager communicates with team members on work related matters by going through the functional manager. He communicates with the team members informally only. (Informally means that he may discuss project related issues with team members, but all formal communications or decisions must come from, or be coordinated through the functional manager).

_____ 4. The project manager communciates with the team members on work related matters only through the functional manager.

_____ 5. Other (specify):_____

(Adapted from Vasconcellos--42:57)

independently assessed based on the individualized answers and, if appropriate, ranked and accounted for (described) in the evaluation findings.

Role Differentiation. If the particular project manager also serves a functional manager role to some of the project personnel, this could sway the matrix toward the weak (functional manager dominant) side of the spectrum (42:59). This situation is likely to occur in early stages of project development when team members primarily consist of scientists and engineers. To assure that this variable is taken into consideration in ascertaining the strength or weakeness of the matrix structure, a question

was designed which directs the specialist to indicate whether his project manager also serves a functional manager role. Specifically, project personnel would be asked to specify one of the following:

1. The project manager also serves a functional role speciality (i.e., he is either a unit, section, branch, or division chief in a functional area).

2. The project manager serves no other functional role.

If the specialist ascertains that item one describes his situation, the researcher would expect that the matrix would be stronger (indicating project manager dominance) than if item two were selected. In turn, the items would be weighted such that 1 = 1, and 2 = 0.

Number of Personnel Committed to the Project Full-Time. Intuitively, the more employees assigned to the project manager full-time, the more the matrix will tend toward a strong matrix. This can be measured by asking the specialists to indicate whether they are officially assigned to the project manager or the functional manager. Specifically, the specialist would be asked to select one of the following:

1. I am assigned to this project full time and am officially assigned to the project manager. ("Officially" indicating that the project manager is responsible for related administrative duties over your position such as maintenance of time and attendance records as well as development and coordination of your effectiveness rating).

2. I am assigned to this project full time. However, I am officially assigned to the functional manager.

3. I am assigned to this project only part time and am officially assigned to the functional manager.

4. Other (please specify):

Again these questions would be reverse weighted, i.e., 1 = 3, 2 = 2, and 3 = 0. If item four was selected, the researcher would have to make an independent assessment as to the appropriate category, and then would account for the assessment in the research findings.

Matrix Strength. Matrix strength is then computed by adding all five variables together as follows:

MS = matrix strength
PO = power (or authority)
CP = communications patterns
RD = role differentiaion
PC = Number of personnel committed to the project full tim

Then,

$$MS = PO + CP + RD + PC$$

Measures of Project Effectiveness.

Factor Analysis of Project Effectiveness Indicators. A factor analysis should be conducted on the project effectiveness indicators. Factor analysis allows for examination of the interrelatedness of the variables developed to measure organizational effectiveness. This examination is aimed at identifying a smaller set of effectiveness indicator variables which are principally accountable for the major proportion of the observed variance in the data (28:469).

Factor analysis involves: (1) development of a correlation matrix, (2) indentification of a new set of variables for analysis of "data reduction" possibilities, and (3) a rotation procedure aimed at simplifying the interpretability of the factors (28:469).

There are both R-type (variable) and Q-type (unit) factor analyses. An R-type factor analysis is envisioned for this study because we are focusing on correlations between variables versus units; that is, we are looking at

correlations between project effectiveness indicators (variables) versus looking at correlations between between the individuals (units) that actually fill out the questionnaires (28:470). The factors are "inferred" factors meaning that it is "assumed that the observed variable is influenced by various determinants, some of which are shared by other variables [common] in the set while others are not shared by any other variable [unique]" (28:471). The assumption is that the common portion of the variance will account for all of the observed relations in the data.

The planned procedure for this study is a SPSS Principal Factor with Iteration (PA2) analysis with a VARIMAX (orthogonal) rotation (28:468-514). PA2 was selected both because it is an acceptable method for use with the design described in the above paragraphs and also because it is the most widely accepted method of factor analysis (28:480). Also this method is recommend for those with a limited understanding of factor analysis methods (28:480).

The goals of rotation are: (1) to simplify interpretability of the data, (2) to obtain "theoretically meaningful factors" and, (3) "to simplify the factor structure" (28:483-484). There are primarily two types of rotation: orthogonal and oblique. Orthogonal assumes that the factors are independent which simplifies the mathematics of the rotation procedure (28:473). Oblique assumes that they are dependent (correlated) which is more empirically realistic but more complex to evaluate mathematically (28:472-473). In the final analysis, the literature offers no particular reason to favor one method over the other. However, the VARIMAX (orthogonal) rotation is noted as the most widely used method of factor rotation; subsequently VARIMAX rotation is recommend for use with this research design (28:485).

Selection of Project Effectiveness Indicators. Project effectiveness measures were selected from the literature and include the following measures (10, 15, 16, 22, 27, 29, 34, 36, 40):

1. mission
2. quality
3. schedule
4. resource utilization
5. planning
6. Cooperation
7. technical excellence
8. adaptability
9. flexibility
10. budget
11. integration
12. training
13. innovation

The primary source for the questions to measure each construct of project effectiveness were drawn from a study by Triscari (40:278-281). The Triscari study also sought to measure organizational effectiveness in R&D settings within the Unites States Air Force. Consequently, although the Triscari study focused on information processing, the questions utilized in that study were well suited for use in this one as well. These questions (with only slight modifications) are provided in Appendix A. The specialists in each project will be asked to answer each question utilizing a scale of one (strongly agree) to seven (strongly disagree). The scores (1 - 0, 2 - 1, 3 - 2, 4 - 3, 5 - 4, 6 - 5, and 7 - 6) will then be summed up taking care to assure that questions are reverse coded when applicable. For example, for most of the

questions, a "1" means that the project is effective. However for other questions, a "1" means that the project is not effective (reference question number 15). In this case the scores must be reversed (1 = 6, 2 = 5, 3 = 4, 4 = 3, 5 = 2, 6 = 1, and 7 =0) before they are summed for each individual survey. Consequently, if all 14 indicators were used in the follow-on survey, then the results could range between 0 and 84 (14 times 6); zero indicating that the project is exremely effective, and 84 indicating that it is extremely ineffective.

Although effectiveness is operationalized on a multi-dimensional basis, a ranking of these indicators by a group of experts was performed. This ranking was necessary because it was anticipated that the importance of individual effectiveness indicators would vary with the phase of the project. That is, in the early phases (or research phase), it was anticipated that the emphasis would be on qualitative measures such as innovation and cooperation. However, as the project transitions to later phases (development), it was anticipated that increasing emphasis would be on quantitative measures such as cost and schedule. In turn, interviews were scheduled with the chiefs (or their representatives) of each of the following organizations to rank the indicators from "1" (most important) to "14" (least important:

1. Air Force Wright Aeronautical Laboratories:

Aero Propulsion Laboratory	AFWAL/PO
Avionics Laboratory	AFWAL/AA
Flight Dynamics Laboratory	AFWAL/FI
Materials Laboratory	AFWAL/ML

2. Aeronautical Systems Divisions:

Strategic Systems	ASD/YY
Airlift/Trainer Systems	ASD/AF
Tactical Systems	ASD/TA
Reconn Stk/Elec Warfare Systems	ASD/RW
Engines	ASD/YZ

The group of experts consisted of managers in positions one hierarchical level above both project and functional managers. In turn, these managers will be the ones to select both effective and less effective projects for measurement for the follow-on study.

Data Collection for Weighted Indicators. The abstract and questionnaire presented in Appendix A were developed for the interview process. However, after the first two interviews were complete, it was evident that this document had several weaknesses.

For one thing, there were two indicators for "schedule" (questions 3 and 5). This was obviously confusing to the managers since it appeared they were supposed to rank it twice. Also, one indicator (question 14) which measured "overall project effectiveness" did not really fit the format as an indicator of project effectiveness.

Also, since the intent was to break the data into research and development, the AFWAL chiefs were to rank the data for the research phases, and the ASD chiefs were to rank the data for the development phases. However, some managers on the development side had projects in concept exploration through production while other managers had projects which were only in full-scale development and production (or some other limited combination). The same situation was manifest on the research side. Furthermore, on the research side, the managers did not want to discuss the project in relation to concept exploration through production, but rather in

terms of types of funds--6.1, 6.2, and 6.3 (6.1 is basic research funds, 6.2 is exploratory development funds, and 6.3 is advanced development funds). It became apparant that the phases would need to be broken out if a comparison of rankings was to be meaningful.

Along with the above there was some problem with the abstract. It was too long, too detailed, and somewhat confusing to the managers.

To correct these faults, a new interview package (Appendix B) was developed which corrected these weakness. Note that the new abstract is more concise and that the directions are more clear. Also, two new indicators, autonomy and credibility, were added along with questions designed to address each one (items 14 and 15). These two indicators were identified by one of the managers in the original two interviews (1).

The support of the remaining six managers was then solicited to rank each indicator using the form provided on the second page of Appendix B. Their evaluation of each question for measuring organizational effectiveness was also solicited (pages three and four of Appendix B). During the interview, each manager selected the phases that were appropriate for his respective organization and the appropriate columns (page two of Appendix B) were titled at that time. The research effort was then discussed in limited detail (indicating that sufficient detail was presented to satisfy each managers interest and questions). The forms were then left with the managers for them to fill out at their leisure, and a date was identified for a return visit to collect the forms.

Analysis of Project Effectiveness Indicators.

For purposes of this study, "research" refers to the first three phases (basic research through advanced development--or 6.1, 6.2, or 6.3 funds), conversely, the term "development refers to the last four phases (concept

Table IV

Project Effectiveness Indicator Rankings

Effectiveness Indicator	Basic Res	Explore Develop	Adv Develop	Concept	Dem/Val	FSD	Production
Mission	11.5	4.0	2.5	5.0	5.2	3.2	2.5
Quality	3.0	3.0	3.5	7.67	6.75	5.75	5.5
schedule	13.0	9.0	3.5	8.0	4.8	4.6	3.0
Resource Util	7.5	8.5	8.0	7.0	7.6	6.4	6.0
planning	8.0	7.5	6.0	2.33	3.25	3.5	1.0
Cooperation	9.0	9.0	9.0	11.33	8.2	10.8	9.5
Technical	2.0	1.5	7.5	6.5	7.4	6.0	6.5
Adaptability	6.5	9.0	12.5	10.33	9.8	8.75	10.5
Flexibility	5.5	14.0	11.5	8.0	9.4	9.0	7.0
Budget Goals	7.5	9.0	13.0	4.0	4.2	4.2	3.0
Integration	12.5	7.5	5.5	9.67	5.75	7.75	9.5
Training	15.0	6.0	11.5	9.0	13.75	12.25	15.0
Innovation	1.0	6.0	12.0	2.33	7.6	12.0	12.0
Autonomy	10.5	11.0	14.5	14.0	14.5	14.5	13.0
Credibility	13.0	10.0	8.0	12.0	12.0	10.0	6.5

exploration through production). The numerical rankings that each manager assigned to the specific indicators were then summed and averaged. This data is summarized in Table IV.

In reiteration, this portion of the research was conducted to assess the importance of the individual effectiveness indicators at various phases of research and development [reference Brabson's (3) methodology which is physically described in Figure 3]. In turn, it was expected that some indicators would be rated important in all phases of project development; others might be important in early phases but not in later phases (and vice

versa); and still others might prove to be relatively insignificant across all phases.

There was not sufficient data to accomplish statistical tests, however, general trends can be noted. These trends are pictorally displayed in Figures 4 through 19 (Appendix D). When viewing these figures, it should be noted that the closer the ranking is to 1, the more important the indicator is perceived as being; conversely, the closer it is to 15, the less important it is perceived as being. It is also important to realize that the AFWAL group ranked the 15 indicators for the first three phases (basic research through applied research); the ASD group for the last four phases (concept exploration through production). The
indicators with rankings closest to the number "1" received the bulk of the attention in this analysis based on the fact that they are defined as more important.

Overall, indicators which appear to be important across all phases of R&D included "Mission," "Planning," and "Quality." Note, however, that "Mission" (Figure 12, Appendix D) does not appear to be important in the basic research phase. This might be explained by the fact that in this phase efforts are primarily directed toward the quest for fundamental knowledge. Subsequently, efforts are usually extremely specialized and rarely is any type of matrix arrangement appropriate.

"Planning," (Figure 13) on the other hand appears to be somewhat more important in the development phases than in the research phases. This could be due to the increased coordination required to integrate the multiple disciplines (i.e, engineering, logistics, manufacturing, configuration and data management, etc).

A reversed relationship is noted for "quality" (Figure 14). That is,

However, it appears to have slightly declined in importance in the development phases. This could be attributable to the off-setting increased importance of cost (budget) and schedule during the development phases.

As anticipated, "budget" goals (Figure 6) appear to be considerably more important in the development phases than in the research phases. This might be expected, since in the later phases the product tends to become increasingly more defined; in turn, costs can be harnessed to productive effort much more readily.

At first glance, the trend for "schedule" (Figure 16) appears to indicate that schedule becomes increasingly more important as you move from basic research to applied research; at which point, it appears to fall back down in importance during concept exploration, then again increases in importance through the production phase. This is contrary to what one might expect, since the literature review (as well as one's intuition) consistently suggests that schedule becomes increasingly important as a project moves toward production. This could have resulted from the division of the data (i.e., the AFWAL managers ranked only the first three phases; the ASD managers all other). It appears quite likely that had each manager on both the ASD and AFWAL sides been able to rank each indicator across all possible phases in both research and development, this trend may have indicated a gradual decline across all phases combined.

The indicator "innovation" (Figure 10) can be analyzed in much the same respect as was the indicator "schedule." However in this case the relationship is inverse. Again, it appears probable that there is agreement between both ASD and AFWAL managers--that agreement being that innovation gradually decreases in importance from basic research through production. Intuitively, one would expect that the bulk of innovative effort

Table V

Suggested Rankings of Effectiveness Indicators

INDICATOR	RESEARCH	DEVELOPMENT
Mission	High	High
Planning	Medium	High
Quality	High	Medium
Schedule	Low	High
Budget	Low	High
Innovation	High	Low
Technical Excellence	High	Medium
Resource Utilization	Medium	Medium
Cooperation	Medium	Medium
Flexibility	Medium	Medium
Adaptability	Low	Low
Autonomy	Low	Low
Credibility	Low	Low
Training	Low	Low

would take place in the earlier phases of a product's life. As a product matures toward production, however, the design hardens and efforts become directed toward keeping costs down and production on schedule. During these later phases innovation would be avoided if possible since innovation might involve major design changes that could result in cost overruns and slipped schedules.

The remaining indicators either had low rankings of importance or the patterns of the rankings did not lend themselves to clear indications of importance. A summary table is provided, Table V. This table attempts to

importance. A summary table is provided, Table V. This table attempts to synopsize the general importance (high, medium, or low) of the individual indicators when split into the two categories, research and development. This table provides a subjective evaluation by this researcher based on the above analysis and a visiual analysis of Figures 4 through 18.

This data suggests that the individual indicators do vary in importance based on the phase of the project. Thus, these differences should be taken into consideration when measuring project effectiveness.

Evaluation of Individual Questions. As stated earlier, the managers were also asked to assess the usefulness of the questions developed to measure project effectiveness. A summary of their comments follow:

General Comments. For one, the laboratory managers tend to refer to their groups as "teams" rather than projects (1, 4). In turn, a questionnaire directed toward the research groups should address "team effectiveness" rather than "project effectiveness," and all reference to "project" should be changed to "team."

Along the same lines, one manager pointed out that team effectiveness and project effectiveness can be two very different things (4). A team can be very effective, i.e., they can work well together, and be extremely productive. However, if the project they are working on has a specification which is extremely tight, or if the project incorporates new technology that is not yet well-defined and still has many problems (or some other similar problem is encountered), then the team may do very well, but the project may fall behind schedule and overrun costs. This is an important point. The goal of this study, however, is to access both "team" and "project" effectiveness (reference the questionnaire--some questions refer to "the people in this project . . ." and other questions refer to simply " this project . . .").

One manager suggested that schedule, budget, and technical excellence be tied to the project baseline to assure that there is no doubt as to the frame of reference when the questionnaire is administered (20). Another manager noted that these same words were vague, which gives support to the suggestion of tieing these factors to baseline figures (35).

One manager noted that the data collected regarding the indicator "mission" may have been misinterpreted with other missions such as those of TAC, SAC, etc, rather than the mission of the team. He felt it should be called "ability to meet 'team' goals rather than "ability to meet 'mission' goals." This may have distorted the ranking of this indicator by the managers if they did not refer to the specific question which was developed to measure this indicator.

Comments Regarding Specific Questions. On question two the point was made that project teams rarely turn out "products" (hardware), but rather they turn out documents or services.

On question 4 "money" was seen as already being measured by question 10 (budget indicator). It was suggested that this term be changed to specialists.

On question 5, it was noted that conflict is often conductive to constructive resolution of problems in the project office. In turn, perhaps the goals should be to "cooperate" to resolve conflict.

Question 11 on the integration of state-of-the-art technology into the product received a couple of comments. One manager noted that integrating state of the art technology is not always good; he suggests that sometimes you want to integrate "cost effective" technology instead. Also, there was some problem with the word "integration." For example, the systems developed in the Reconnaissance Strike/Electronic Warfare systems Deputate are

integrated into other systems. In turn, the manager representing this organization was not certain if he should use the systems developed in his deputate or the systems in which they are integrated into as a reference point for the project. This concern was supported by another manager who stated that normally the word "integration" in the SPO environment refers to how the project/program is incoporated in an overall system.

Summary and Demographics.

All of the above suggested changes were integrated into a proposed survey instrument which is presented in this study as Appendix C. Questions 1 of the survey instrument is a demographic question directed toward assessing the percentage of time that each respondent works on the project in question. It is believed that some specialists work on several projects at one time. In turn, percentage of time working on the project in question could be a confounding variable affecting matrix strength.

Question 2 is also a demographic question which asks the respondent to indicate which of the following best describes his/her position on the project in question:

1. Research Scientist
2. Applied Science Scientist
3. Developmental Engineer
4. Budget/Cost Specialist
5. Logistics Specialist
6. Manufacturing/Production Specialist
7. Configuration/Data Management
8. Other (Specify):

This question might allow for explanation of contradictory research findings. That is, perhaps certain people rank the project as "effective" and

others rank the same project as "ineffective." Perhaps this contradiction is due to the different perspectives of these people and the different weights that they put on various effectiveness indicators (i.e. reference the literature review regarding the differences in the perspectives of engineers versus scientists). Questions 3 through13 measure matrix strength, and questions 14 through 27 measure organizational effectiveness.

V. Conclusions and Recommendations

Review of the Experimental Design.

Design Feasibility.

Comparability of Laboratory and SPO Projects. The laboratory managers consistently brought up the point that laboratories do not truely have a matrix arrangement (1, 20, 23, 33). Instead, they have teams which normally consist of from 5 to 12 people (17, 20). Conversely, in development (i.e., SPO's) a project may employ 20 to 1,000 or more people depending on the size of the project. Also, the laboratory teams normally work for just one manager--there is no "two-boss" arrangement which normally characterizes a true matrix. In turn, there was some question as to whether the two should, and honestly could, be compared (1, 17, 20, 23, 33). Further research effort is required to to assess this feasibility.

Divisibility of Projects into Laboratory and SPO Categories. There appeared to be no doubt on the part of laboratory or SPO managers that projects are divisible into laboratory projects and SPO projects. However, when researching Air Force regulations for a clearer interpretation of the types of funds (6.1, 6.2, and 6.3), it appeared that some overlap might exist between the phases. Specifically, AFR 80-1 (7:2) indicates that basic research (6.1 funds) and exploratory development (6.2 funds) are pre-concept exploration phase efforts. However, advanced development (6.3 funds) can be either pre-concept exploration or concurrent with either concept exploration or demonstration validation (7:2). Further research effort is required to assure that those projects coded "research" are clearly not from the same population as those coded "development."

Field Support for This Research. The laboratory managers showed less concern for the importance of this research than did the SPO managers. Specifically, the laboratory managers felt that such an effort might be more appropriate if focused only on the development (SPO) side (1, 17, 20, 23). This could be because the laboratories do not have formal matrix structures; in turn, they do not have to deal with the conflicts that the formal matrix can entail. The indication is that there might be some resistence if this research is imposed on the laboratories. Perhaps if the questions and abstract (Appendix B) had been developed with laboratory terminology (ie., "team" versus "project," etc) in mind, this resistence would not have been as strong. One solution might be to develop a modified instrument for use in gathering information for the research phases. Regardless, because of the lack of formal matrixing in laboratories, it is expected that the research environment would not be as interested in the results of such a study.

The development managers' general concensus was that the matrix is an extremely frustrating form of management structure, and that most managers feel they can do a better job when they have total control of their assets (1, 4, 13, 35). However, one manager did come to the defense of the matrix structure pointing out that although the matrix is rather cumbersome, it does provide a method of balancing the divergent goals of the functional and project manager (35). All SPO managers had strong feelings about matrixing in general and the overall impression was they would be supportive of such a research project.

Research Design Validity.

Instrument Testing. The survey instrument as a whole has never been pre-tested. Prior to conducting an official survey, further effort needs to be directed toward testing the instrument. This might be

needs to be directed toward testing the instrument. This might be accomplished in two parts. First the instrument might be reviewed in-house by knowledgeable and interested parties (8:206). This is necessary to reduce ambiguity, assure understanding of all research questions, and gage the sensitivity of surveyee's to the questions; ie., will the questions be offensive and/or excessively controversial, etc. This cycle might be repeated until the researcher has confidence in the survey instrument. Then the survey instrument might be field tested in both the laboratory and SPO environments. This should clear up any further problems with the survey instrument as well as provide an opportunity to conduct a factor analysis pilot study on the project effectiveness indicators.

Validity of the Measures for Matrix Strength. Only the specialists within the matrix organization can answer the questions on project/functional manager *influence* (*questions 3 through* 10, Appendix C). In turn, to assure the measures were reliable, two questions were developed to measure each source of power (formal, reward, punishment, expertise, and referent). If both questions on each source of power yield consistent answers, this would indicate that the measures are reliable.

The measure for "number of personnel committed to the project full time" (question 11, Appendix C) is actually another measure of formal authority. Consequently, formal authority is receiving three-way verification of reliability.

The measures for communciations patterns and role differentiation (questions 12 and 13, Appendix C) will also receive a three-way verification by having managers one hierarchical leveal above project and functional managers, project and functional managers, and specialists address these questions. Compatible answers would promote the validity of these

Validity of the Measures for Project Effectiveness. Only one question was developed to measure each effectiveness construct (budget, schedule, flexibility, etc). However, the proposed factor analysis will help to identify those groups of constructs which account for the primary source of interrelatedness in the data. Often, this allows for a decrease in the number of factors which are important for further analysis. This would be particularly true if the same constructs which did not load on the major factors were those that the managers ranked as unimportant. Therefore, the factor analysis and the effectiveness indicator rankings are complimentary and, taken both independently and together, promote the reliability of the effectiveness measures.

The validity of the effectiveness measures will be assured five ways: (1) First, the managers of the laboratories and SPO organizations will intuitively select both effective and less effective projects to be included in the study; (2) then, they will then use the effectiveness portion of the survey instrument to actually assess each project's effectiveness; (3) both project and (4) functional managers will also rate the project utilizing the same organizational effectiveness measures; and (5) the specialist will rank the project on organizational effectiveness.

Recommendations/Areas for Future Research.

Focus the Study on the Development Side Only. The major issue surfaced by this research was that the laboratory environment does not utilize the formal matrix structure. In turn, an alternative approach to this study which might warrant consideration would be to concentrate on only the development (SPO) side of the R&D spectrum. One method of addressing such a study would be to divide the projects into four phases: concept exploration, demonstration/validation, full-scale development, and production/

deployment. Or a more simplified design might compare early phase projects (perhaps those in concept exploration and demonstration/validation) with later phase projects (perhaps full-scale development and production).

Improve Project Effectiveness Indicator Rankings. This study revealed that there does appear to be a difference in the importance of the various indicator rankings based on the phase of the project. However, due to the limited amount of data collected, no specific statements could be made about the apparent trends. The ability of the effectiveness indicators to actually measure project effectiveness could have been strengthend by clearing up contraditions in the data. Perhaps such contradictions could have been minimized by utilizing the Delphi method. Utilizing the Delphi method would have involved having the managers re-rank the indicators after discussing, as a group, reasons for divergent opinions. Also, the findings could have been strengthened by obtaining a larger sample (perhaps by expanding research efforts to other SPO/laboratory organizations in Air Force Systems Command). In turn, statistical inferences could have been quantified. Further effort in this area would be appropriate prior to administering the follow-on survey.

Summary.

Overall, it is the opinion of this researcher, that the proposed research is both feasible and worthwhile. As noted in the literature review, the functional manager may actually retain control of the specialist well beyond a point which is conducive to healthy project management. However, the literature also suggests that an equal balance of power is optimal in the project office (though I uncovered no literature which had tested this assumption). This study goes one step further, and suggests that this balance of power changes depending on the phase of the program. If such a hypothesis bears out, then managers can utilize such information to

manipulate the balance of power according to the needs of the program and based on the phase of the project.

The major obstacle to accomplishing this study, as assessed by this researcher, is the view of laboratory managers that their input is not relevant to a study on matrix effectiveness; i.e., they do not view themselves as operating in a matrix environment. If the laboratories are included in a follow-on research effort, then care must be taken to solicit their support of the effort.

APPENDIX A. INTERVIEW PACKAGE (FIRST CUT)

Connie F. Peterson
25 June 86

INTERVIEW ABSTRACT
MATRIX MANAGEMENT IN R&D SETTINGS

I am doing my thesis on matrix management. I know that the matrix arrangement is complex to manage. However, I also know that, at present, it appears to be the best approach we have to managing multiple projects with limited assets. Even if it were not, in the Air Force it is the only way we manage projects, so we need to make the best possible use of it. In turn, we need to pinpoint the inherent problems in matrix management and find feasible solutions or ways to minimize these problems.

Therefore, I feel it is important to determine just what differentiates an effective project office from a less effective project office. My research to date has lead me to believe that the balance of power (authority) between the project and the functional manager is an extremely important determinant in project effectiveness. My research has further lead me to speculate that in the early stages of project development (concept exploration and perhaps demonstration/validation), the effective project offices will be those which have a dominant functional manager (this is called a "weak" matrix, i.e., the majority of the power or influence over the specialist rests with the functional manager). On the other hand, I further suspect, that in the later phases of R&D (particularly in FSD), the more effective projects will be those which have a dominant project manager (conversely called a "strong matrix, i.e., the majority of power and influence over the individual specialist rests with the project manager).

To test these hypotheses, I have developed a methodology to measure both the balance of power between the two managers and also to measure organizational effectiveness in the project offices.

This leads me to the reason I am here. I need you help to evaluate the survey instrument I have developed. In particular, I need your help both in ranking and in evaluating the organizational effectiveness indicators I have developed (i.e., are the indicators good ones; are there some I missed or some which should be excluded or rewritten; are some important in one phase and others important in another phase, etc).

Once completed, this research could be instrumental in helping managers such as yourself to design more effective project offices. Specifically, it will provide insight into how to manipulate the balance of power during the various stages of the project's life cycle to facilitate organizational effectiveness.

SECTION III. PROJECT EFFECTIVENESS

1	2	3	4	5	6	7
Strongly Agree			Neutral			Strongly Disagree

_____ 1. In comparison with similar groups, the efforts made by people on this project contribute very effectively to the overall goals of the project.

_____ 2. The people working this project turn out high quality products or services.

_____ 3. In the past 12 months, this program office has been able to complete, on time, its planned milestones and activities.

_____ 4. The people working this project do NOT seem to get maximum output from the resources (money, time, and equipment) that they have available. That is, they do NOT plan for the future better than do similar organizations.

_____ 5. In the past 12 months, this program office has been able to meet its planned milestones and activities as well as other program offices.

_____ 6. The people working on this project anticipate problems that may come up in the future and prevent them from occurring or minimize their effects. That is, they plan for the future better than do similar organizations.

_____ 7. For the most part, people assigned to this project are cooperativ with and helpful to other people who, through their work, they come in contact with.

_____ 8. The work performed by this project group meets or exceeds the technical objectives or standards set for it.

SECTION III. PROJECT EFFECTIVENESS (Cont'd)

1	2	3	4	5	6	7
Strongly Agree			Neutral			Strongly Disagree

_____ 9. When changes are made in the routines or procedures, people assigned to this project accept and adjust to these changes more readily than do personnel assigned to similar projects.

_____ 10. When emergencies arise, such as a schedule being moved up, overloads are often caused for many people. This project group copes with these emergencies more readily and successfully than do other project groups.

_____ 11. Over the past year, this project office (unit) has been able to meet its budget limitations or cost constraints.

_____ 12. State-of-the-art technology is being effectively integrated into the product on this project.

_____ 13. Specialists on this project are afforded more opportunities to enhance their specialty expertise then do those on other projects through seminars, symposiums, or opportunitites to attend schools, etc.

_____ 14. Overall, this project is extremely successful (top notch) when compared to other similar projects.

_____ 15. This project group has been instrumental in adding to the fund of knowledge that can be applied usefully by the scientific or engineering community. That is, new technologies have been successfully integrated for the first time into this product, or there have been major breakthroughs in understanding how this technology can be integrated into some future product.

APPENDIX B. INTERVIEW PACKAGE (SECOND CUT)

Connie F. Peterson
AFIT/LGM
30 June 1986

Home Phone: 237-7411
Advisor (Capt Tom Triscari): 255-3355

AFIT THESIS ABSTRACT
MATRIX MANAGEMENT IN R&D SETTINGS

My thesis research is centered on the conflicting roles of the functional and project managers in the matrix arrangement. Specifically, I believe that the balance of power (authority) between the project and functional manager is an extremely important determinant in project effectiveness. My research to date has lead me to speculate that in the early stages of project development (concept exploration and perhaps demonstration/validation), the effective project offices will be those which have a dominant functional manager (the majority of the power or influence over the specialist rests with the functional manager). On the other hand, I further suspect, that in the later phases of R&D, particularly in FSD), the more effective projects will be those which have a dominant project manager (the majority of power and influence over the individual specialist rests with the project manager).

To test these hypothesis, I have developed a methodology to measure both the balance of power between the two managers and also to measure organizational effectiveness in the project offices.

I need your help in ranking and in evaluating the organizational effectiveness indicators I have developed (i.e., are the indicators good ones; are there some I missed or some which should be excluded or rewritten; are some important in one phase and others important in another phase, etc).

Your support and feedback regarding my efforts will be greatly appreciated.

DIRECTIONS: Please review the attached questions designed to measure project effectiveness. Are they good measures? Have I missed any? Is the wording clear? Then please rank them from most important to least important based on the phase of the project. The questions are designed to measure the following indicators of project effectiveness (i.e., question 1 is designed to measure the groups ability to meet mission goals):

Ability to:

1. meet mission goals
2. product quality products
3. meet schedule goals
4. utilize resources effectively
5. plan effectively
6. work cooperatively
7. produce technical excellence
8. adapt
9. be flexible
10. meet budget goals
11. integrate
12. obtain required training
13. innovate
14. be autonomous
15. be perceived as credible

1. _____ _____ _____
2. _____ _____ _____
3. _____ _____ _____
4. _____ _____ _____
5. _____ _____ _____
6. _____ _____ _____
7. _____ _____ _____
8. _____ _____ _____
9. _____ _____ _____
10. _____ _____ _____
11. _____ _____ _____
12. _____ _____ _____
13. _____ _____ _____
14. _____ _____ _____
15. _____ _____ _____

SECTION III. PROJECT EFFECTIVENESS

1	2	3	4	5	6	7
Strongly Agree			Neutral			Strongly Disagree

Mission	1. In comparison with similar groups, the efforts made by people on this project contribute very effectively to the overall goals of the project.
quality	2. The people working this project turn out high quality products or services.
schedule	3. In the past 12 months, this program office has been able to complete, on time, its planned milestones and activities.
resource util	4. The people working this project do NOT seem to get maximum output from the resources (money, time, and equipment) that they have available. That is, they do NOT plan for the future better than do similar organizations.
planning	5. The people working on this project anticipate problems that may come up in the future and prevent them from occurring or minimize their effects. That is, they plan for the future better than do similar organizations.
cooperation	6. For the most part, people assigned to this project are cooperative with and helpful to other people whom, through their work, they come in contact with.
technical	7. The work performed by this project group meets or exceeds the technical objectives or standards set for it.
adaptability	8. When changes are made in the routines or procedures, people assigned to this project accept and adjust to these changes more readily than do personnel assigned to similar groups.

SECTION III. PROJECT EFFECTIVENESS (Cont'd)

1	2	3	4	5	6	7
Strongly Agree			Neutral			Strongly Disagree

flexibility. 9. When emergencies arise, such as a schedule being moved up, overloads are often caused for many people. This project group copes with these emergencies more readily and successfully than do other project groups.

budget. 10. Over the past year, this project office (unit) has been able to meet its budget limitations or cost constraints.

integration 11. State-of-the-art technology is being effectively integrated into the product on this project.

training 12. Specialists on this project are afforded more opportunities to enhance their specialty expertise than do those on other projects through seminars, symposiums, or opportunities to attend schools, etc.

innovation 13. This project group has been instrumental in adding to the fund of knowledge that can be applied usefully by the scientific or engineering community. That is, new technologies have been successfully integrated for the first time into this product, or there have been major breakthroughs in understanding how this technology can be integrated into some future product.

autonomy 14. The people working in this group feel that they can succeed or fail without suffering undo consequences or repercussions.

credibility 15. The people working this project have the respect of their peers, i.e., team members are qualified and respected for their ability to produce quality efforts/products.

APPENDIX C. PROPOSED SURVEY INSTRUMENT

SURVEY ON MATRIX EFFECTIVENESS

BACKGROUND: This survey is being conducted in an effort to isolate some of the elements which may promote organizational effectiveness in R&D matrix settings. Your support of this effort is completely voluntary. However, each surveyee's input is extremely important to assure an accurate assessment of each project office. In turn, your response to the survey is urgently solicited and will be greatly appreciated.

DIRECTIONS: Please answer each of the following questions as accurately as possible. If none of the answers appear appropriate, simply choose the answer that is closest and then explain your concern under Section IV, Comments (last page of this survey). Please read each question carefully before answering.

Name of Project: _____ .

1. Some specialists are assigned to more than one project at a time. If you are one of those specialists, please indicate the amount of time you spend working on this particular project.

   _____ 0-20% of my time is spent working on this project.
   _____ 21-40% of my time is spent working on this project.
   _____ 41-60 % of my time is spent working on this project.
   _____ 61-80 % of my time is spent working on this project.
   _____ 81-100% of my time is spent working on this project.

2. Please indicate which of the following best describes your position on this project.

   _____ Research Scientist
   _____ Applied Science Scientist
   _____ Developmental Engineer
   _____ Budget Specialist/Cost Specialist
   _____ Manufacturing/Production Specialist
   _____ Configuration/Data Management
   _____ Other (Please Specify): _____

.SECTION I. MATRIX STRENGTH

DIRECTIONS: Please use the scale below to respond to each of the following items. Place the appropriate alphabetic letter in the space provided.

A. Project manager only.
B. Mostly project manager.
C. Project manager somewhat more than functional manager.
D. About the same for both the functional and project managers.
E. Functional manager somewhat more than project manager.
F. Mostly functional manager.
G. Functional Manager only

To what extent does the functional/project manager have influence or authority over each of the following?

_____ 3. He has the authority over my appraisal or, if military, over my Officer Effectiveness Rating (OER).

_____ 4. He has the authority to affect my future work assignments.

_____ 5. I feel he has the most potential to penalize me in some way.

_____ 6. Between the two, I would seek him out for advice on technical matters.

_____ 7. Between the two, I would prefer to be identified with him or with the project and/or functional area he represents.

_____ 8. He has the authority to direct my activities on project related tasks.

_____ 9. Between the two, I feel he is more of a friend to me.

_____ 10. Between the two, I draw on his knowledge more to resolve project related problems.

SECTION II. MATRIX STRENGTH (Cont'd)

11. Indicate which of the following best describes the project manager for this program.

_____ The project manager also serves a functional role (i.e., he is either a unit, section, branch, or division chief in a functional area, or he is a work leader in a specific functional area).

_____ The project manager serves no other functional role.

12. Which of the following descriptions best describes how you are assigned to this project.

_____ I am assigned to this project full time and am officially assigned to the project manager ("officially" indicating that the project manager is responsible for related administrative duties over the position such as maintenance of time and attendance records as well as development and coordination of effectiveness ratings).

_____ I am assigned to this project full time. However, I am officially assigned to the functional manager.

_____ I am assigned to this project only part time and am officially assigned to the functional manager.

_____ Other (please specify):

13. Which one of the following descriptions best represents the flow of communications on this project. Please place an "X" in the space provided.

_____ A. The project manager communicates directly with team members on project related matters.

_____ B. Again, the project manager communicates directly with team members on work related matters, but later, either he or the team member keeps the functional manager informed.

_____ C. The project manager communicates with team members on work related matters by going through the functional manager. He communicates with the team members informally only. (Informally means that he may discuss project related issues with team members, but all formal communications or decisions must come from, or be coordinated through the functional manager.)

_____ D. The project manager communicates with team members on work related matters only through the functional manager.

(Please go to next page.)

SECTION III. PROJECT EFFECTIVENESS

DIRECTIONS: Please use the scale below to respond to each of the following items. Place the appropriate numeric letter in the space provided.

1	2	3	4	5	6	7
Strongly Agree			Neutral			Strongly Disagree

_____ 14. In comparison with similar groups, the efforts made by people on this project contribute very effectively to the overall goals of the project.

_____ 15. The people working this project turn out high quality products, documents, or services.

_____ 16. In the past 12 months, this program office has been able to complete, on time, its baselined milestones and activities.

_____ 17. The people working this project do NOT seem to get maximum output from the resources (money, time, and equipment) that they have available. That is, they do NOT plan for the future better than do similar organizations.

_____ 18. The people working on this project anticipate problems that may come up in the future and prevent them from occurring or minimize their effects.

_____ 19. For the most part, people assigned to this project cooperate to constructively resolve conflicts.

_____ 20. The work performed by this project group meets or exceeds the baselined technical objectives or standards set for it.

SECTION III. PROJECT EFFECTIVENESS (Cont'd)

1	2	3	4	5	6	7
Strongly Agree			Neutral			Strongly Disagree

_____ 21. When changes are made in the routines or procedures, people assigned to this project accept and adjust to these changes more readily than do personnel assigned to similar projects.

_____ 22. When emergencies arise, such as a schedule being moved up, overloads are often caused for many people. This project group copes with these emergencies more readily and successfully than do other project groups.

_____ 23. Over the past year, this project office has been able to meet its baselined budget limitations or cost constraints.

_____ 24. Specialists on this project are afforded more opportunities to enhance their specialty expertise then do those on other projects. That is they are afforded more opportunities to attend seminars, symposiums, or opportunitites to attend schools, etc.

_____ 25. This project group has been instrumental in adding to the fund of knowledge that can be applied usefully by the scientific or engineering community. That is, new technologies have been successfully integrated for the first time into this product, or there have been major breakthroughs in understanding how this technology can be integrated into some future product.

_____ 26. The people working in this group feel that they can succeed or fail without suffering undo consequences or repercussions

_____ 27. The people working this project have the respect of their peers, i.e., team members are qualified and respected for their ability to produce quality efforts/products.

APPENDIX D: PHASED RANKINGS OF EFFECTIVENESS INDICATORS

(Figures 4 through 18)

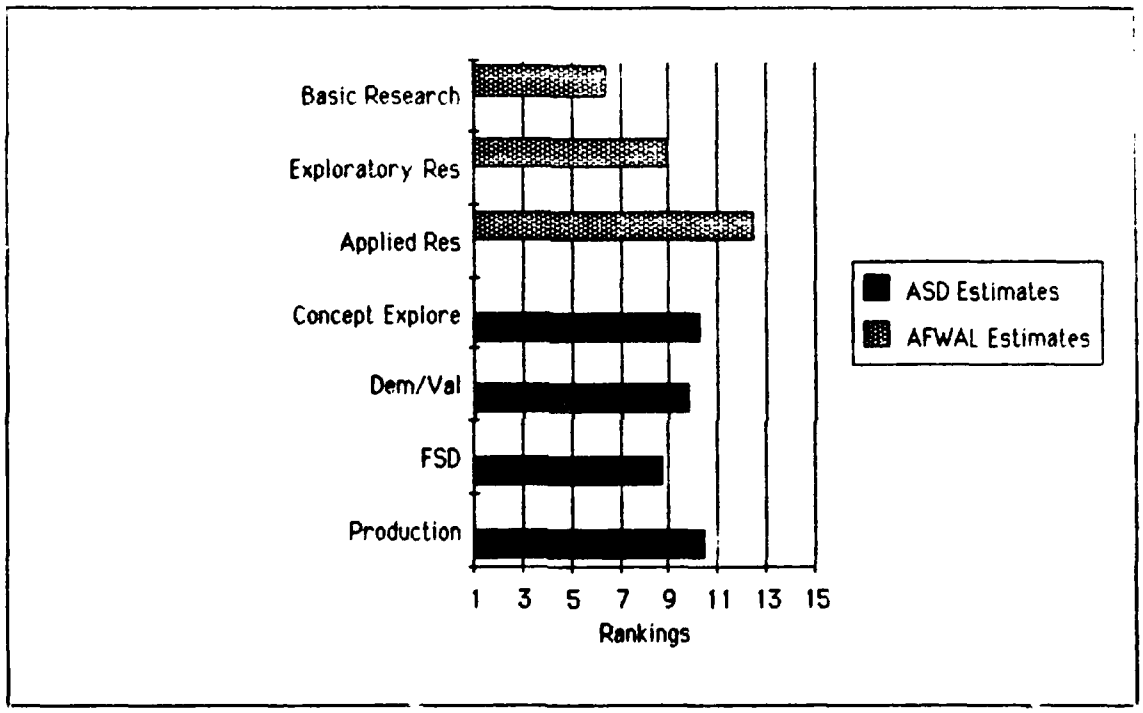

Figure 4. Phased Rankings of Adaptability

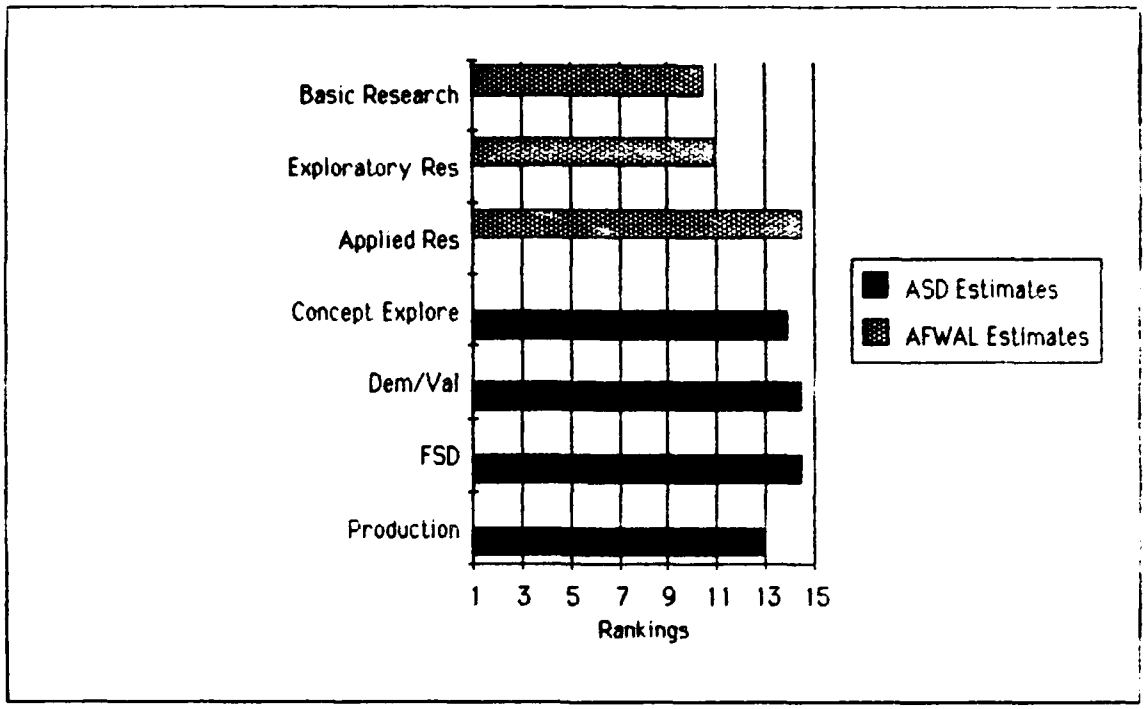

Figure 5. Phased Rankings of Autonomy

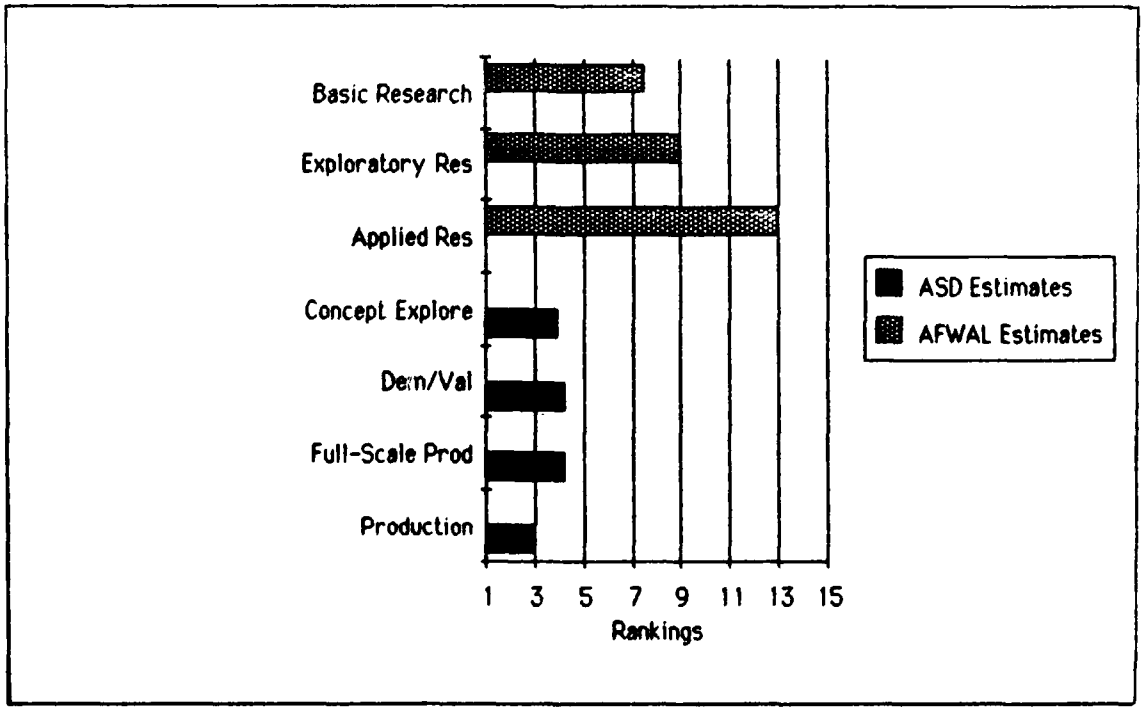

Figure 6. Phased Rankings of Budget Goals

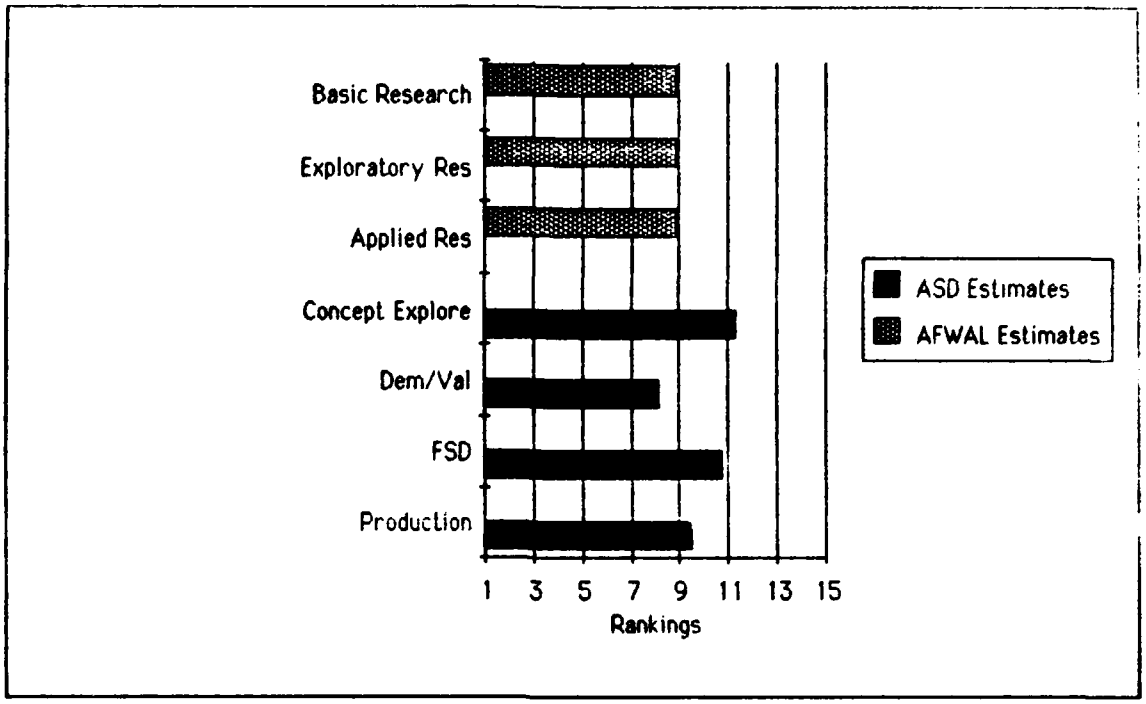

Figure 7. Phased Rankings of Cooperation

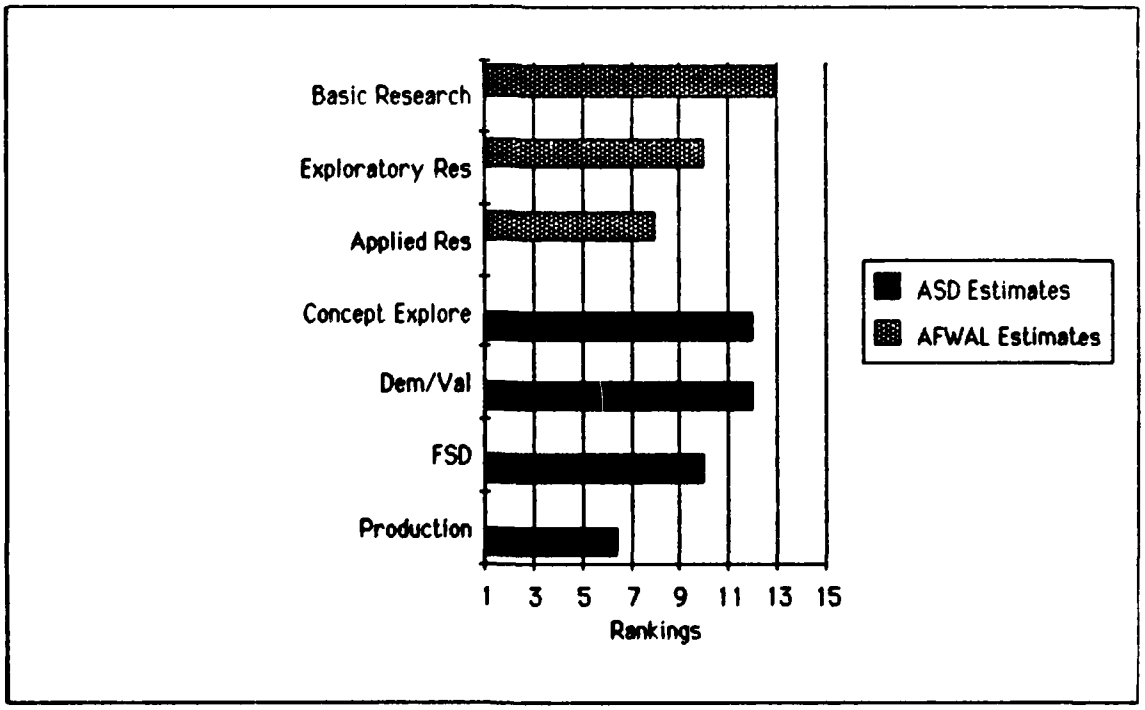

Figure 8. Phased Rankings of Credibility

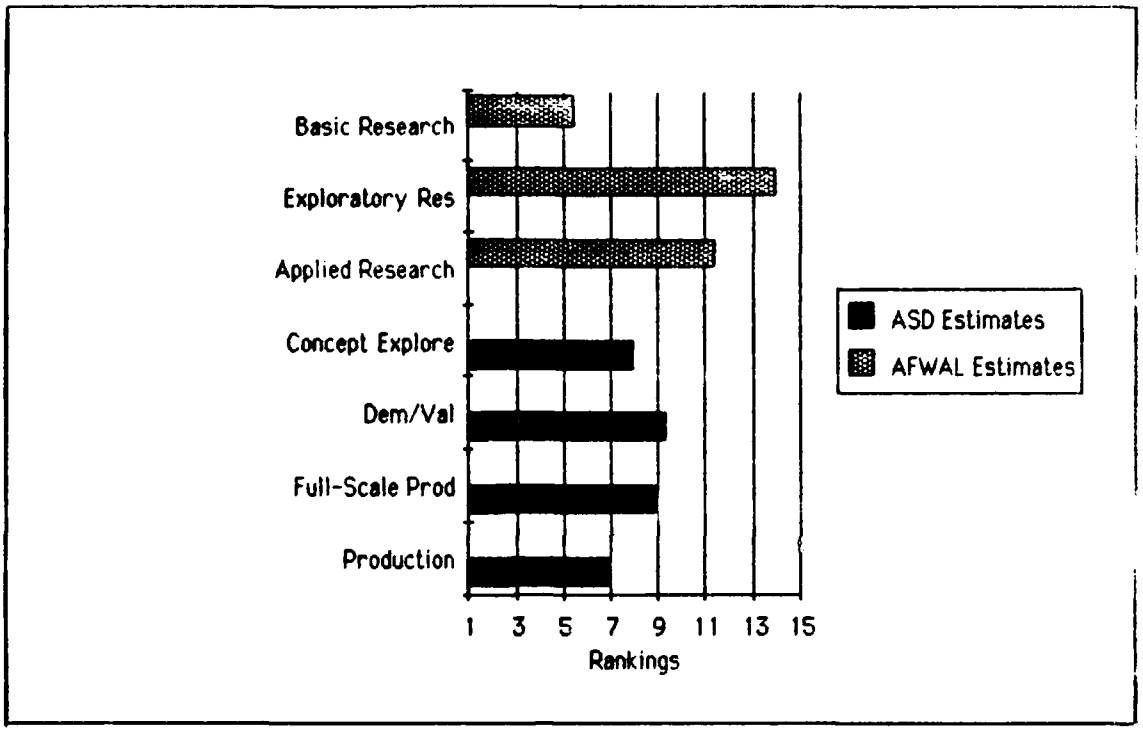

Figure 9. Phased Rankings of Flexibility

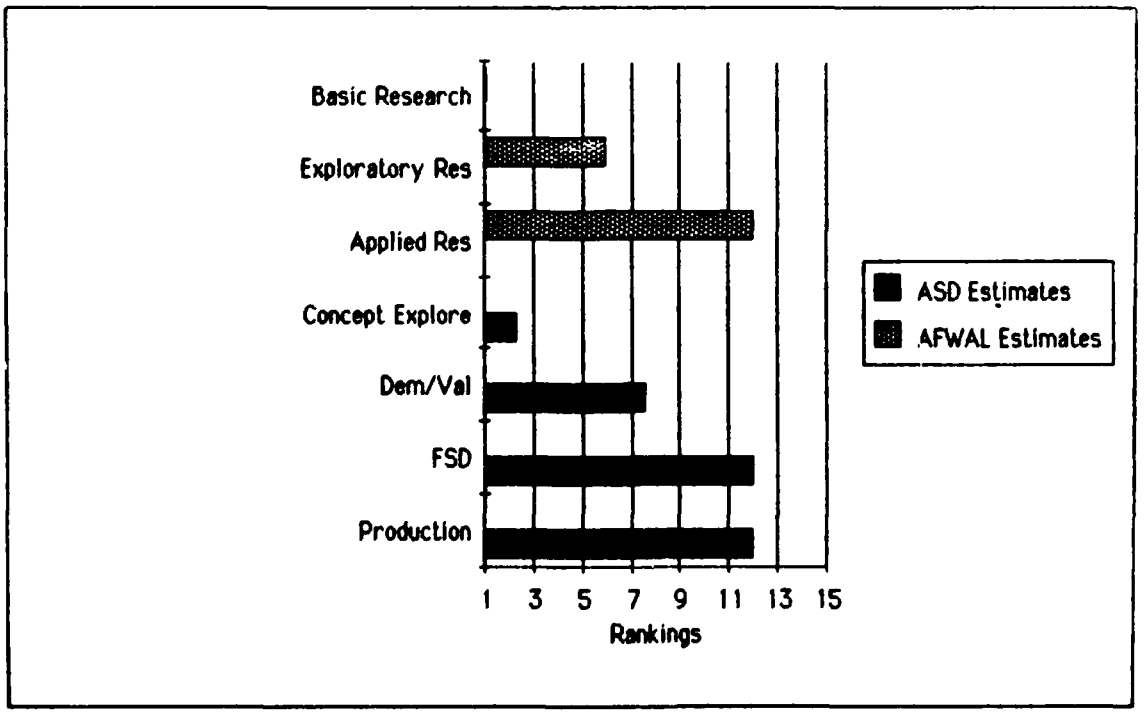

Figure 10. Phased Rankings of Innovation

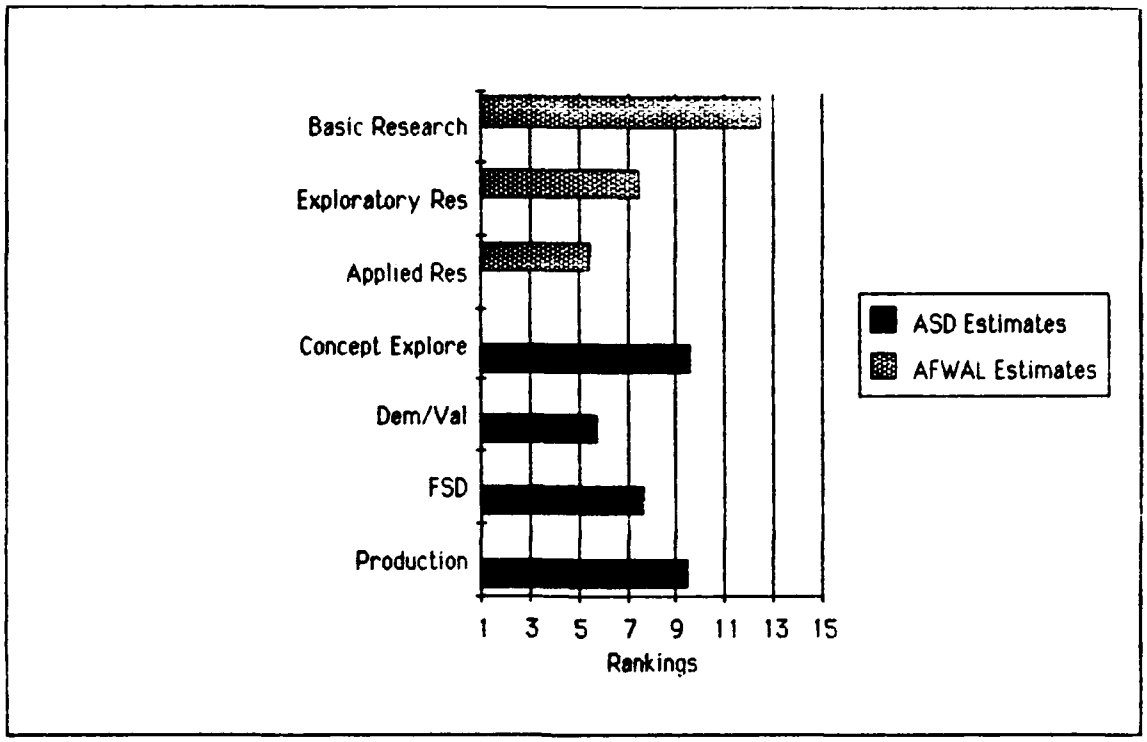

Figure 11. Phased Rankings of Integration

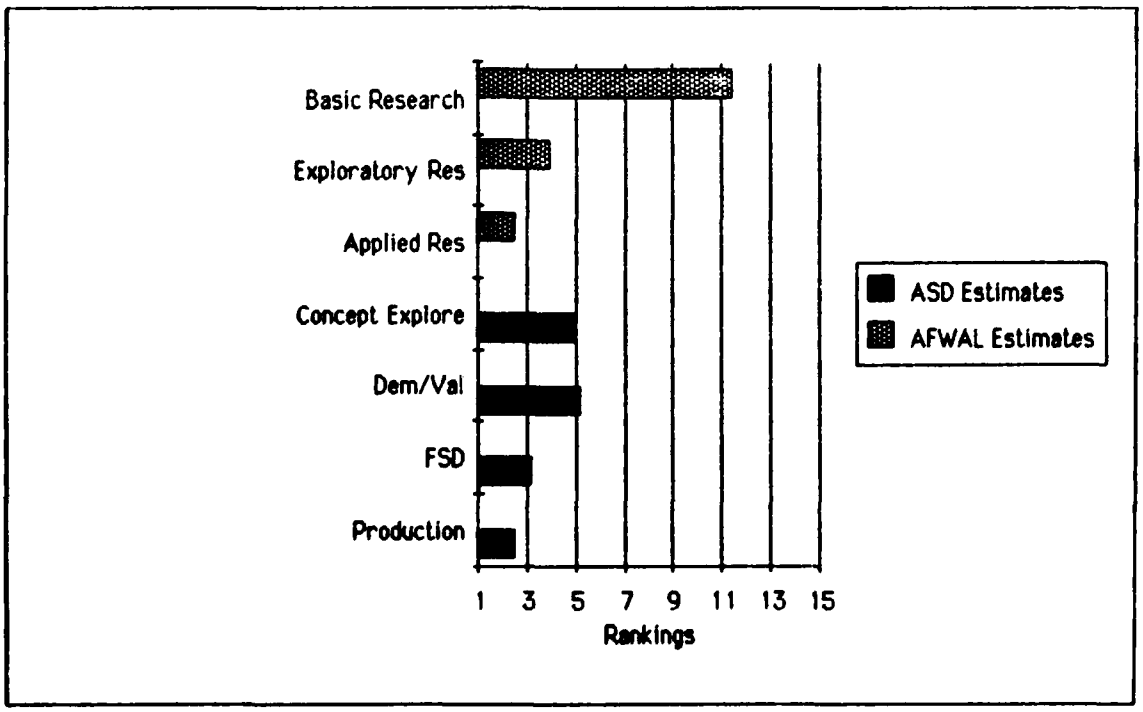

Figure 12. Phased Rankings of Mission

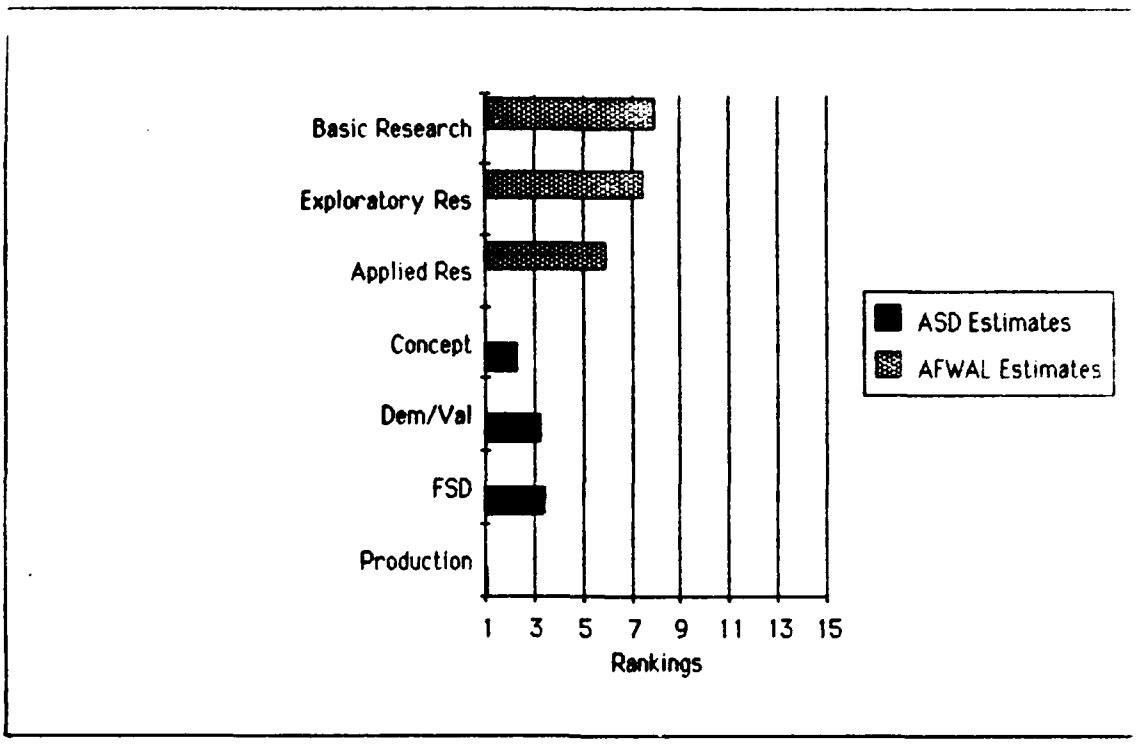

Figure 13. Phased Rankings of Planning

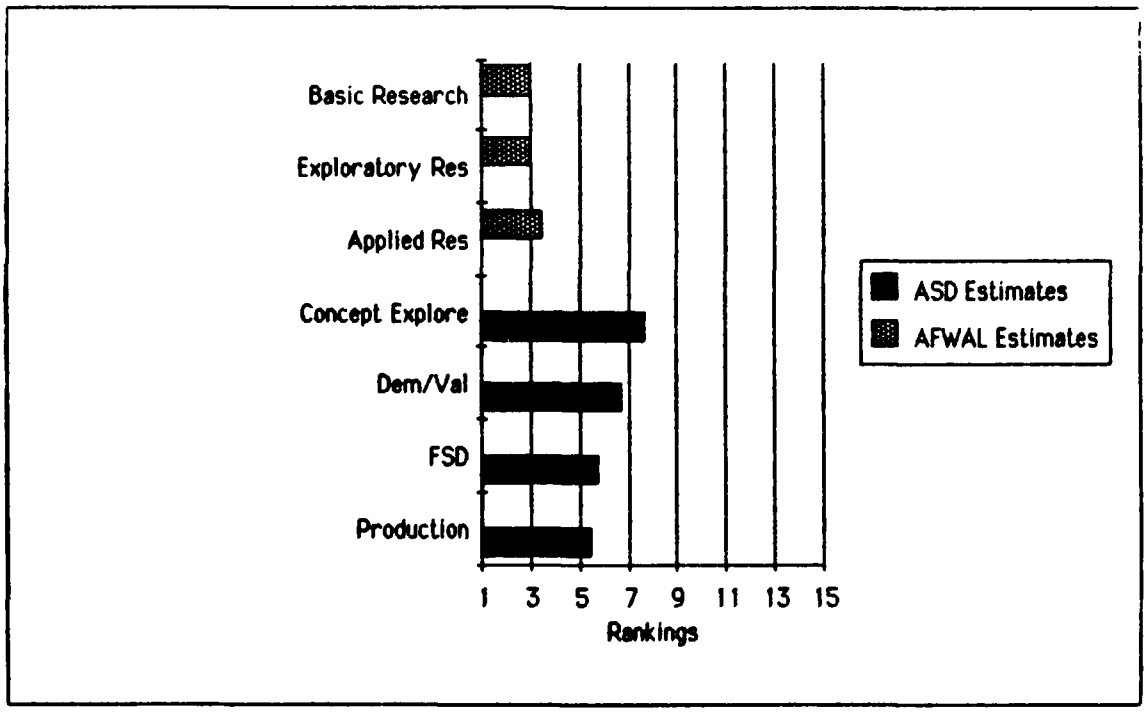

Figure 14. Phased Rankings of Quality

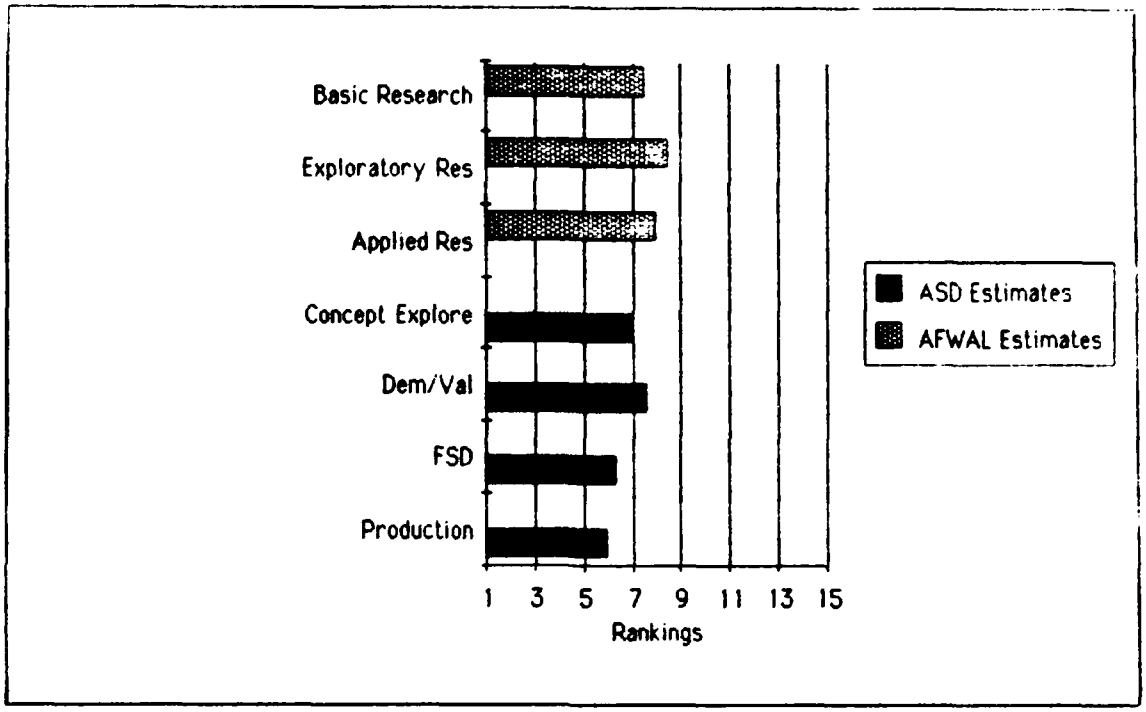

Figure 15. Phased Rankings of Resource Utilization

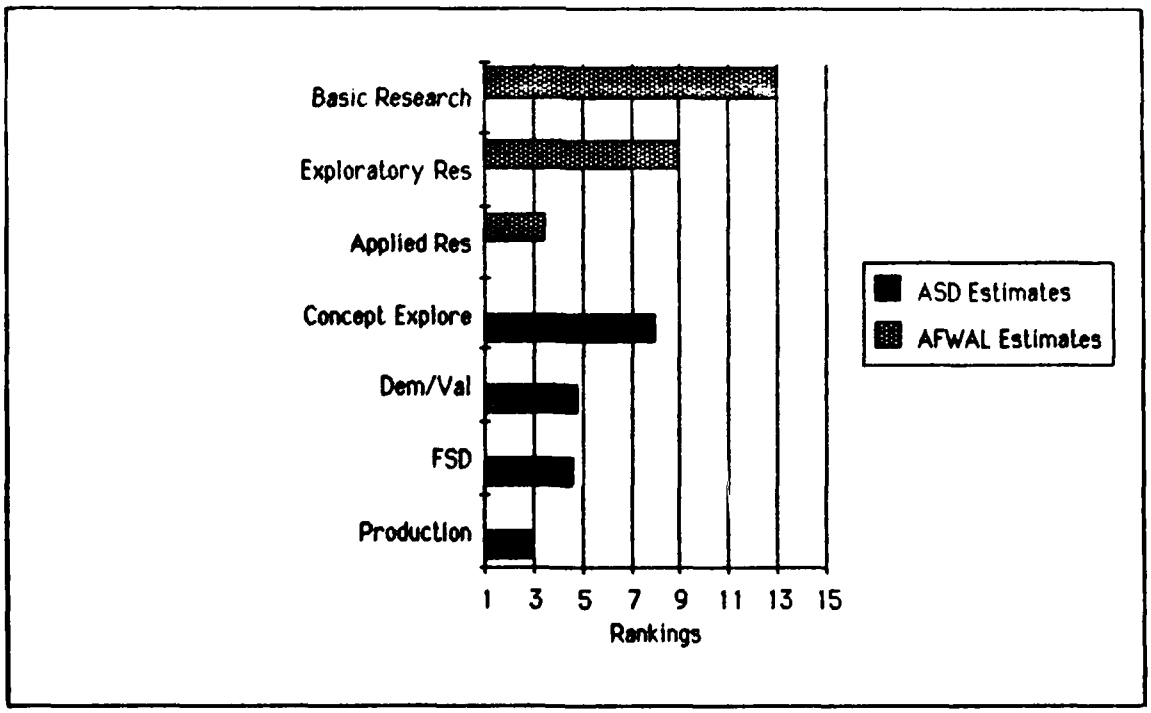

Figure 16. Phased Rankings of Schedule

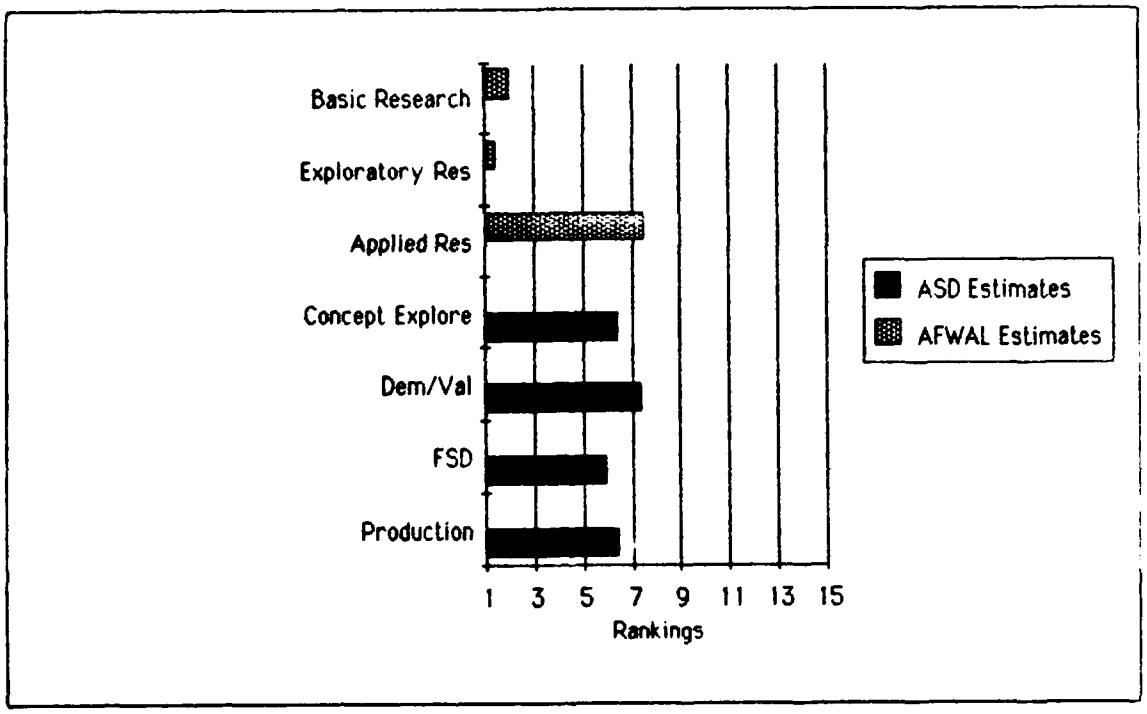

Figure 17. Phased Rankings of Technical Excellence

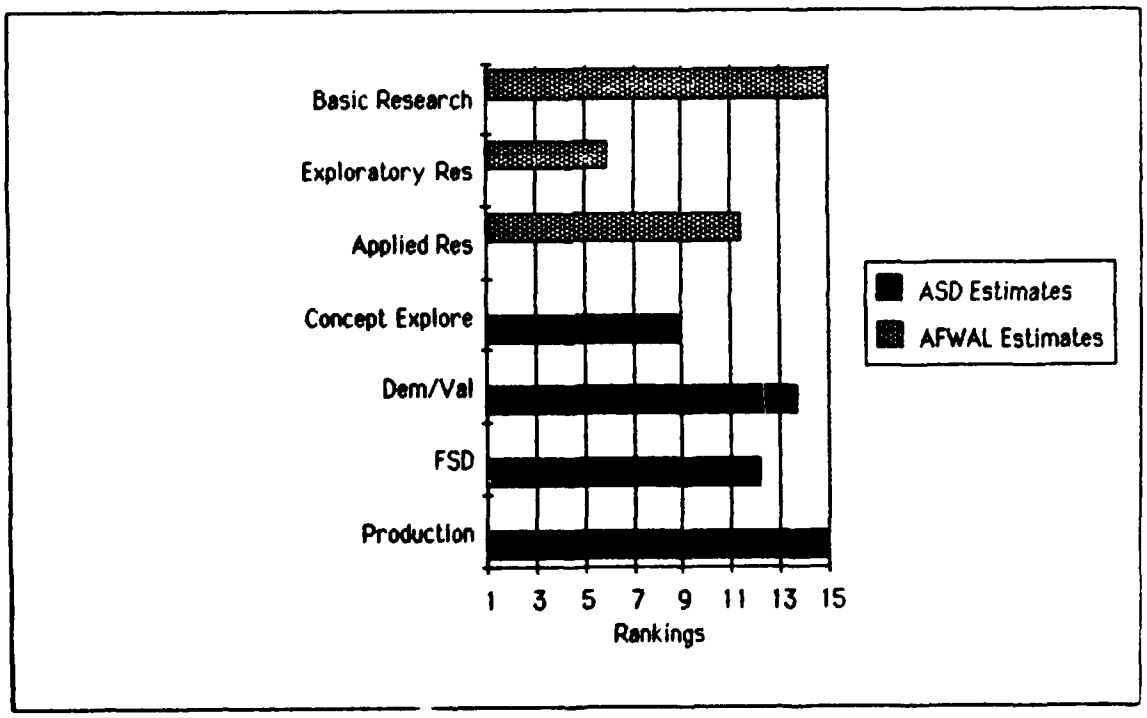

Figure 18. Phased Rankings of Training

Biliography

1. Almy, Colonel D. B., USAF. Deput Director, Materials Laboratory. Personal interview. Air Force Wright Aeronautical Laboratories, Wright- Patterson AFB OH, July 1986.

2. Badawy, M. K. "Organizational Designs for Scientists and Engineers: Some Research Findings and Their Implications for Managers," IEEE Transactions on Engineering Management, EM-22: 134-138 (November 1975).

3. Brabson, D. B., Col, USAF. "Evaluation of Laboratories," Concepts, 5. 68-81 (Spring 82).

4. Carr, Merle G. Assistant Deput for Programs. Deputy for Strategic Systems. Personal Interview. Aeronautical Systems Division, Wright-Patterson AFB OH, July 1986.

5. Caspe, M. S. "A Breakthrough in Matrix Communication," Project Management Quarterly. 29-34 (Sep 1980).

6. Delbecq, Andre and others. "Matrix Organizations: A conceptual Guide to Organizational Variation," Wisconsin Business Papers. 200-219 (September 1969).

7. Department of the Air Force. Air Force Research and Development. AFR 80-1. Washington: Hq USAF, 15 June 1979.

8. Emory, C. William. Business Research Methods. Homewood IL: Richard D. Irwin, Inc., 1985.

9. Ford, James A. "The suitability of Matrix Management for Development Projects - A Review," Project Management Quarterly. 41-45 (Mar 82).

10. Frame, J. D. "Quantitative Indicators for Evaluation of Basic Research Programs/Projects, " IEEE Transactions on Engineering Management, EM-30. 106-111 (August 1983).

11. Galbraith, Jay R. "Matrix and Organization Designs," Business Horizons, 14: 29-40 (February 1971).

12. Gemmill, G., and D. L. Wilemon. "The Power Spectrum in Project Management," Sloan Management Review. 17-22 (Winter 1981).

13. Gunz, H.P. and A. W. Pearson. "Introduction of a Matrix Structure into a R&D Establishment," R&D Management, Vol 7, No 3: 173-181 (1977).

14. Intrilligator, Michael D. Economic Models, Techniques and Applications. Englewood Cliffs NJ: Prentice Hall, Inc., 1978.

15. Katz, Ralph, and Thomas J. Allen. "Project Performance and the Locus of Influence in the R&D Matrix," Acadamy of Management Journal, 28: 67-87 (March 1985).

16. Keller, Robert T. and Winford E. Holland. "The Measurement of Performance Among Research and Development Professional Employees: A Longitudinal Analysis," IEEE Transactions on Engineering Management, EM-29: 54-57 (May 1982).

17. Krueger, Dr. Charles H., Jr., Acting Deputy Director, Avionics Laboratory. Personal interview. Aeronautical Systems Division, Wright-Patterson AFB OH, 9 July 1986.

18. Kuehner, Colonel Gregory A., USAF. Assistant Deputy for Special Operation Forces/Cargo Trainers. Deputate for Airlift/Trainer Systems. Personal interview. Aeronautical Systems Division, Wright-Patterson AFB OH, July 1986.

19. Kur, C. E. "Making Matrix Management Work," Supervisory Management, 27: 37-43 (March 1982).

20. Laubendorfer, William J. Assistant Deputy. Deputate for Reconnaissance/Strike and Electronic Warfare Systems. Personal interview. Aeronautical Systems Division, Wright-Patterson AFB OH, 8 July 1986.

21. Lawrence, P. R., and J. W. Lorsch. "New Management Job: The Integrator'," Harvard Business Review. 142-151 (November-December 1967).

22. Mahoney, Thomas and William Weitzel. "Managerial Models of Organizational Effectiveness," Administrative Science Quarterly, 14: 357-365 (1969).

23. Matres, Solomon R. Acting Deputy Director, Flight Dynamics Laboratory. Personnel Interview. Air Force Wright Aeronautical Laboratories, Wright-Patterson AFB OH, July 1986.

24. McClave, James T. and P. George Benson. Statistics for Business and Economics. Santa Clara CA: Dellen Publishing Company, 1982.

25. Might, Robert J. and William A. Fischer. "The Role of Structural Factors in Determining Project Management Success," IEEE Transactions on Engineering Management, EM-32: 71-77 (May 1985).

26. Montgomery, Douglas C. Design and Analysis of Experiments. New York: John Wiley and Sons, Inc., 1976.

27. Moser, Martin R. "Measuring Perfc. mance in R&D Settings," Research Management, 28: 31-33 (September-October 1985).

28. Nie, Norman H. and others. SPSS: Statistical Package for the Social Sciences. New York: McGraw-Hill, Inc., 1975.

29. Pappas, Richard A. and Donald S. Remer. "Measuring R&D Productivity," Research Management, 28: 15-22 (May-June 1985).

30. Peschke, Lt Col Richard E., Ph.D. Lecture Materials distributed for CMGT 523 entitled: "Readings for Contracting and Acquisition Management (CMGT 523), Vol I." School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, Spring 1986.

31. Quinn, Robert E. and Kim Cameron. "Organizational Life Cycles and Shifting Criteria of Effectiveness: Some Preliminary Evidence," Management Science, 29: 33-51 (January 1983).

32. Rowen, T. D. and others. "The Pro's and Con's of Matrix Management," Administrative Management. 22-24 (December 1980).

33. Russo, Dr. Vincent J. Special Assistant to the Director, Aero Propulsion Laboratory. Personnel Interview. Air Force Wright Aeronautical Laboratories, Wright-Patterson AFB OH, 9 July 1986.

34. Schainblatt, A. H. "How Companies Measure the Productivity of Engineers and Scientists," Research Management, XXV: 10-18 (May 1982).

35. Shulti, Harry E. Assistant Deputy for Tactical Systems. Personal interview. Aeronautical Systems Division, Wright-Patterson AFB OH, July 1986.

36. Stahl, Michael J. and Joseph A. Steger. "Measuring Innovation and Productivity--A Peer Rating Approach," Research Management, 19: 35-38 (January 1977).

37. Stickney, F. A. and W. R. Johnston. "One More Time: Why Project Management?" Proceedings of the Project Management Institute Seminar Symposium, AF Flight Dynamics Lab, Wright Patterson AFB OH. 305-319 (1979).

38. Struckenbruck, L. C. "The Matrix Organization," Project Management Quarterly, 11: 23-33 (September 1979).

39. Thamhain, H. J. and G. R. Gemmill. "Influence Styles of Project Managers: Some Project Performance Correlates," Acadamy of Management Review, 17: 216-224 (January 1974).

40. Triscari, Thomas, Jr. Organizations and Information Processing: A Field Study of Research and Development Units Within the United States Air Force Systems Command. PhD Dissertation. Rensselaer Polytechnic Institute, Troy NY, August 1984.

41. Tushman, Michael and William L. Moore. Readings in the Management of Innovation. Marshfield Massachusetts: Pitman Publishing, inc. 1982.

42. Vasconcellos, Eduardo. "A Model for a Better Understanding of the Matrix Structure." IEEE Transactions on Engineering Management, EM-26: 56-65 (August 1979).

43. Wall, W. C. "The General Manager of Matrix Organization," Defense Systems Management Review. 7-15 (1979).

VITA

Connie Fairchild Peterson was born 4 June 1950 in Ogden, Utah. She graduated from Ben Lomand High School, Ogden, Utah. She received her Bachelor of Science Degree from Weber State College, also in Ogden, Utah, where she graduated Cum Laude.

In her first logistics position (1978 to 1979), Ms Peterson functioned as an EOQ Inventory Manager in ground photographic equipment at Ogden ALC, Hill AFB, Utah. She later became the production manager responsible for management of the RF-4C aircraft program also at Hill AFB (1979 to1981). Later (1981 to 1984) she assumed responsibility for the F-4 world-wide depot repair program. At this point in her career, Ms Peterson competed for the executive cadre of the Logistics Civilian Career Enhancement Program (LCCEP). She was accepted into the cadre in 1984 and soon thereafter accepted a position at Hanscom AFB, Massachucetts, as a Logistics Management Specialist. At Hanscom AFB, Ms Peterson served as staff focal for spares provisioning policy on new acquisitions.

Ms Peterson received a Sustained Superior Performance Award in August 1983. That same year, she also received a "Top of the Hill Award" from Hill AFB for outstanding support to the USAFE forces. She is a member of the Society of Logistics Engineers (SOLE), the Phi Kappa Phi Honor Society, and the Sigma Iota Epsilon (SIE) Management Honor Society.

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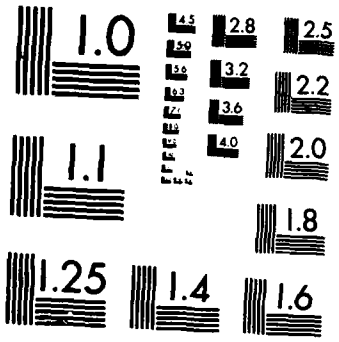

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Thesis Advisor: Thomas Triscari, Captain, USAF
Assistant Professor of Systems Management

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The purpose of this study was to develop a research design for measuring the relationship between project effectiveness and the balance of power between the functional and project managers in matrixed organizations during different project phases. Specifically, it was proposed that dominant functional manager influence relates positively to organizational effectiveness in early research phases of project or technology development. Conversely, it was proposed that dominant project manager influence relates positively to organizational effectiveness in later phases of project development. A survey instrument was developed to test these possible relationships. Actual testing of these hypotheses, however, is a subject for follow-on research effort.

Interviews with Air Force Wright Aeronautical Laboratory (AFWAL) and Aeronautical System Division (ASD) deputate level managers at Wright-Patterson Air Force Base, Ohio, provided information on the weighting of organizational indicators across the various phases of a project's life cycle. This was accomplished to verify assertions advanced in the literature review that the importance of different effectiveness indicators may vary with the phase of the project. Interview findings tended to support the literature; i.e., certain effectiveness indicators do vary in importance based on the phase of the project.

The interviews also revealed that such a study would generally be well received by the ASD managers. Conversely the AFWAL managers were cooperative but relatively uninterested in possible findings of such a study. This lack of interest may be attributable to the fact that the laboratories are already operating within a structure which supports project effectiveness in early project phases (i.e., one in which the functional manager is dominant).

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