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Leadership characteristics, management controls and project characteristics: Their contribution to successful project management

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Claremont Graduate School, 1989

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LEADERSHIP CHARACTERISTICS, MANAGEMENT CONTROLS, AND PROJECT CHARACTERISTICS: THEIR CONTRIBUTION TO SUCCESSFUL PROJECT MANAGEMENT

by

E. C. Williams

A Dissertation submitted to the Faculty of Claremont Graduate School in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Graduate Faculty of Management.

Claremont, California

1989

Approved by:

Jean Lipman-Blumen

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We, the undersigned, certify that we have read this dissertation and approve it as adequate in scope and quality for the degree of Doctor of Philosophy.

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ABSTRACT OF THE DISSERTATION

LEADERSHIP CHARACTERISTICS, MANAGEMENT CONTROLS, AND PROJECT CHARACTERISTICS: THEIR CONTRIBUTION TO SUCCESSFUL PROJECT MANAGEMENT

by
E.C. Williams

The Claremont Graduate School: 1989

This research examined the effect leadership characteristics, management controls, and project characteristics have on project management success. Three measures of success were used: a weighted objective rating of project success, the project managers' subjective rating of project success, and the project managers' subjective rating of their own performance. Two groups were evaluated: the first consisted of 55 project managers and 124 projects, and the second consisted of 16 project managers and 44 projects.

The research findings indicate the project managers' achieving styles, professional background, and use of legitimate power are positively related to project success. More specifically, the results suggest successful project managers are charismatic leaders who make effective use of their instrumental and direct achieving styles.

The principal achieving styles employed by the project managers are: 1) the personal and reliant instrumental and 2) the intrinsic and competitive direct. The project managers use aspects of the self (i.e., personal instrumental) to enlist support from others upon whom they are reliant (i.e., reliant instrumental) to achieve their objectives. Their internal standards of excellence (i.e., intrinsic direct) and their competition with others (i.e., competitive direct) are factors which are used to achieve project success. Conversely, the findings suggest that either project managers are over-specialized for their assignments or their assignments are not commensurate with their educational background.

The research results suggest that management control functions are not necessarily conducive to project success. The findings indicate the effectiveness of the management control system is related to the project size and the position power of the project manager. Further, the results indicate that standardization of the control system throughout the firm

is important to project success. Finally, the effectiveness of management controls is related to the management level evaluating the management control system.

The findings related to project characteristics suggest that as project hardware complexity increases software complexity also increases. The combined effect significantly reduces the likelihood of project success. The results indicate that the project managers' prior software experience is a necessary condition for project success when software constitutes a large percent of the project's budget.

DEDICATION

This work is dedicated to the memory of my father Elmore F. Maehl. Perhaps it is only a memory of the footsteps he left behind, but his accomplishments in engineering, art, poetry, and music remain as standards by which my own milestones are measured.

ACKNOWLEDGEMENTS

There are many people without whose help this work could not have been accomplished. I appreciate the support provided by my management. Their patience throughout this effort is gratefully acknowledged.

To my colleagues and co–workers I wish to extend my thanks for your constant inquiries and encouragement. Your support was of inestimable value. Several deserve special attention for the assistance they provided in making the dissertation come together. Richard and Brenda Galliardt's time and effort are acknowledged as being instrumental for the final presentation of the dissertation. They contributed many hours to making everything just so. They exhibited extreme patience with the many revisions with which they had to contend. David Smith and Ken Phipps demonstrated wizardry at the CAD equipment in transforming sketches into legible figures.

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Finally, a special acknowledgement is extended to my children. Their forbearance throughout this exercise made it possible. Perhaps now we can catch up on the excitement of being alive and together.

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CHAPTER 1

INTRODUCTION

Background

Project management plays an important role in an aerospace company's success in today's highly competitive defense industry. The selection and assignment of a project manager is often key to a project's ultimate success. Successful projects should be a reflection of the assigned project manager. The inverse is not necessarily true. Project managers' demonstrated success on prior projects is not sufficient reason to believe success will be achieved on subsequent projects to which they are assigned. Frequently, a project managers' qualifications are not commensurate with the difficulty of the project to which the project manager has been assigned. The result is that neither the project manager nor the project is judged to be successful.

To overcome this problem, a strategy is often employed to engineer the task for the manager or change the manager to fit the task. The former might be accomplished by breaking the task into smaller parts to be assigned to different managers. The latter solution is more difficult. To effect change in an individual may require more time than is available to complete the project. A simpler strategy is available: match the leadership characteristics of the manager to the characteristics of the project.

A project's characteristics can be defined by dimensions which measure size, technical composition, and technological complexity. To enable us to match the manager to the project, it is necessary that we define a set of dimensions which describe the leadership characteristics of the project manager. Project management involves more than just the classical management principles of planning, organizing, staffing, controlling, and directing. Certain leadership characteristics are required which the project manager employs in melding all elements of human and capital resources together in a successful project.

A project manager should not be appointed simply on his/her availability. Nor is success as a functional manager or technical leader a sufficient condition for appointment as a project manager. Project size may dictate specific management skills for exercising management controls on the project. These may relate to budget, schedule, and technical criteria. The manager is expected to be knowledgeable about and use these controls. The project's technical composition, as it relates to the percent of software and hardware used on the project, may place constraints on the project manager selection. Past experience and familiarity with specific design elements may be important requisites. The technological complexity encountered also imposes specific requirements on the project manger selection.

Thus, the managers' leadership characteristics, defined by their achieving styles, leadership styles, work standards, and ethics are all relevant dimensions for matching the manager to the project. This research is intended to examine the leadership characteristics of project managers and the importance of these characteristics in determining project success.

Relevance of Research

In a summary of why project management fails, Avots (1969) presented ten lessons for management. The second lesson noted:

> Do not skimp on the project manager qualifications. Managing a project is a difficult job requiring not only technical knowledge as noted, but also an orientation toward planning and the ability to work together with people at different organizational levels and representing various disciplines. [1]

Leadership effectiveness in the context of organizational climate, task complexity, and position power of the project manager has been addressed by Thamhain and Wilemon (1977). The influence of project managers on project success has been researched by

Thamhain and Gemmill (1974). Kemp (1984) studied the effect of management level on project success. The effect of organizational structure on project success has been thoroughly researched by Gailbraith (1970), Lawrence and Lorsch (1967), Posner (1986), Thamhain and Wilemon (1975a,1975b), and Wall (1984).

The studies cited have addressed particular aspects of project management. They have generally fallen into categories related to leadership styles, leader influence, project planning, project control, and organizational structure. The literature has also focused on definitions of project success as they relate to budget, schedule, and technical control.

Certain characteristics that might measure the project manager's success have not been directly addressed in the literature. For example, very little has been written regarding the project manager's success when related to promotion or advancement to larger project responsibility. The achieving styles and management skills of the managers have not been addressed. The project manager's training, either formal or company designed, tenure with the firm, and positions held within the company hierarchy have not been examined in relation to project success. Nor for that matter has the size or composition of the project been related to project manager's success. Avot's maxim regarding the project manager's qualifications seems to have been overlooked in the academic research relevant to project manager's success.

Presumably, if the characteristics surrounding project manager's success can be defined, then the selection and training of personnel to fill the ever increasing complex task of project management can be improved. Further, if the dimensions defining project management success can be related to the dimensions defining project success, the assignment of project managers can be improved with an attendant improvement in project success.

Framework of Research

The research examines the project managers' leadership characteristics and their contribution to successful project management. Two principle areas are investigated. The first area includes those variables defining leadership characteristics and their relation to successful project managers. The second area focuses on the variables defining project characteristics and their relation to successful projects.

Leadership Characteristics

Leadership characteristics are important factors which should be considered in the appointment of project managers. The characteristics examined in this research included leadership styles, achieving styles, needs for power and achievement, education, management skills, experience, and education. These characteristics were explored at different project management levels. The purpose was to examine how these characteristics vary at different management levels and the impact this variation has on project success.

To lead a project, the project manager must establish and maintain many interfaces over the project life–cycle. The project manager is not an island unto himself/herself and is dependent on others to achieve the project's objectives. These require certain relational skills with people and an ability to accomplish objectives through others.

A manager of a specific discipline, accustomed to few interfaces, may be disastrous on a project requiring multiple interfaces and having multiple disciplines. A manager with poor communication skills may encounter extreme difficulty conveying the project's objectives to the project team with equally disastrous results.

The assignment of a task–oriented project manager, immune to a subordinate's feelings, can create high turnover on the project. The result is a loss of continuity and subsequent project delays. Similarly, a relational–oriented project manager can become so embroiled in personal relations that the project objectives may be forgotten through the inability of the manager to relate to the task.

The managers' education and experience are the basic skills they bring as qualifications for project management assignments. Past experience and tenure with their firm provide them insight on how best to manage their job. Their prior experience is useful in defining skills and resources required. Their tenure provides them access to the information networks to exercise necessary political influence. Tenure, coupled with experience, also provides the necessary knowledge about work process and work flow through the firm during the project life-cycle.

Project Characteristics

The project characteristics examined included the project's size, composition, and technological complexity. Project size was defined by the budget allocated to complete the project. Two variations were considered in evaluating project size. The first considered size as related to the engineering budget. The second considered size as related to the total budget. The distinction between the two was that the second included the production effort associated with the delivery of a development system or prototype. The project composition was defined by the amount of software and hardware used on the project. The technological complexity was defined as the technical sophistication of the hardware and software used on the project. These three factors were selected on the assumption they were the most critical characteristics affecting project success. Problems encountered with these factors are usually manifested as cost overruns, schedule delays, and technical deviations or waivers.

Project size determines the resources required, the interfaces established and maintained, and the controls exercised. Projects on which there is a large percentage of software do not seem to be amenable to the same management controls as those exercised on hardware projects. Software, as an engineering discipline, is still emerging. The controls exercised on hardware have evolved over many decades. The controls are just beginning to be imposed on software. The technology chosen for a project is frequently not available in the time frame originally planned. Research may discover flaws in the original proposed technology. Vendors may not be able to produce the technology required in sufficient quantities or may have problems in their yield rates. Substitute parts are frequently used or scheduled deliveries are delayed waiting on critical parts. These factors contribute to technical deviations and waivers. The correction of the deviations and waivers is an additional, unplanned expense that must be borne by the firm.

Problem Statement

Frequently, little consideration is given to the qualification of the individual selected as a project manager. Lack of adequate training or exposure to other technical disciplines can result in unnecessary crises that management controls exerted on budgets and schedules cannot overcome. The project may eventually be delivered, but the cost in human and capital resources may be irrecoverable. Thus, leader qualifications are critical to project management success.

This research addresses several questions related to project and project management success. How effective is management control alone on project success? How effective are leadership characteristics alone on project success? Do management controls, in combination with leadership characteristics, improve the likelihood of project success? What effect do project size, composition, and technological complexity have on project and project management success? Can high motivational needs for power and achievement be related to project management success? To what extent are leadership styles and achieving styles important to project success? How important are training, education, company tenure, and past experience to project and project management success?

The answers to these questions are expected to be useful in establishing the criteria for the selection and assignment of future project managers.

Dissertation Overview

Chapter 2 provides a review of the related literature Chapter 3 presents the methodology employed in the conduct of this research and a formal statement of the hypotheses. Chapter 4 summarizes the initial data analysis, the construction of several dependent variables, the project manager's demographics, and the project characteristics. Two distinct data sets were identified in the initial data analysis. The results obtained from analysis of the principal data set are presented in subsequent chapters. Chapter 5 presents the results of the analyses performed on hypotheses one through three. Chapter 6 summarizes the results of the analyses performed on hypotheses four through six.

Chapter 7 reviews the results of the path analyses performed in this research. Chapter 8 provides an analysis of the results, suggestions for further research, and the conclusions. Appendices contain the actual questionnaires, supporting exhibits, the analyses performed on the secondary data set, and a bibliography.

FOOTNCTE

[1] Ivars Avots, "Why Does Project Management Fail?," California Management Review XII (Fall 1969): 81.

CHAPTER 2

REVIEW OF RELATED LITERATURE

Project Management

Project management is often viewed as an organization that is formed to address unique, complex, multidisciplinary tasks having a defined duration. For example, Kerzner (1982) defined project management as follows:

> Project management is the planning, organizing, directing, and controlling of company resources for a relatively short–term objective that has been established to complete specific goals and objectives. Furthermore project management utilizes the systems approach to management by having functional personnel (the vertical hierarchy) assigned to a specific project (the horizontal hierarchy). [1]

He avoided the classical management function of staffing as he felt staffing was a line management responsibility within the matrix organization of project management. He also avoided any reference to the personal characteristics or qualifications required of the individual who heads the project management organization.

Ruskin and Estes (1982), in their definition of project management, introduce the idea that the personal characteristics and qualifications of the project manager are important.

> Project management is an integrating activity and is best done when the manager has a holistic outlook. A typical project involves numerous conflicting pressures and requires artful compromises. These compromises can be made successful only when the project manager understands how all the elements of the project interact and work together to accomplish the projects objectives. [2]

There is no direct reference, however, to the project manager's leadership characteristics or qualifications. It is only implied that project leaders should possess certain skills. We are told the project managers must be able to negotiate compromise and be able to work under conflicting pressures.

Conflict in project management has long been recognized. Over seventy years ago, Henri Fayol predicted the consequence of project management.

> Should it (the principle of unity of command) be violated, authority is undermined, discipline is in jeopardy, order disturbed and stability threatened. This rule seems fundamental to me so I have given it the rank of principle.[3]

Project conflict has been thoroughly reported in the literature by Argyris (1967), Butler (1973), Cleland (1968), Evan (1965), Goodman (1967), Posner (1985), Reesor (1969), Thamhain and Wilemon (1975a, 1975b), and Wilemon and Cicero (1970). The conflict addressed in these studies is caused by the use of a matrix organization in project management. Personnel assigned to a project owe allegiance to two managers: their functional manager and the project manager.

French and Raven (1959) defined five bases of power which could be considered as an influence on person (P) produced by another person, group, or part of a group (O). These five bases of power were (1) reward power, (2) coercive power, (3) legitimate power, (4) referent power, and (5) expert power. More than one study has been performed examining a project manager's authority in the context of French and Raven's work. These studies by Cicero and Wilemon (1970), Gemmill and Thamhain (1973), Katz and Allen (1985), and Thamhain and Wilemon (1977) have generally concluded that referent and expert power are the two chief authoritative strategies that can be assumed by the project manager. The studies also conclude that reward and coercive power belong in the realm of the functional manager. Further, the studies suggest that legitimate power can be exercised only in relationship to the rank of the project manager in the management hierarchy.

Two studies on project conflict and the techniques used in conflict resolution are of interest: Thamhain and Wilemon (1975a) and Posner (1986). Both defined four project phases, seven areas of project conflict, and five techniques used by the project managers for conflict resolution. The project phases and relative rankings of the conflict areas from the two studies are shown in Table 2.1. The principal difference in the conflict areas over the 11

TABLE 2.1

CONFLICT ISSUES ACROSS PROJECT PHASES

Issue	Formation	Build-Up	Main Program	Phase-Out
Schedules	3(1)	2(3)	1(1)	1(1)
Cost	5(2)	7(5)	6(3)	5(2)
Priorities	1(3)	1(2)	4(2)	4(4)
Manpower	4(4)	5(1)	3(6)	3(5)
Tech. Issues	6(5)	4(4)	2(4)	6(7)
Procedures	2(6)	3(6)	5(7)	7(6)
Personalities	7(7)	6(7)	7(4)	2(3)

Thamhain and Wilemon (1975a) ranking of conflict issues are shown first in each column as reported in their study.

Posner (1986) rankings of conflict issues are shown in parentheses and are based on the means of the importance of each issue in their study.

year elapsed time between the two studies is related to cost. This is attributed to the different contracting policies in the Defense Department. The emphasis has shifted from cost plus contracts awarded in the 1970s to fixed price contracts in the 1980s.

The terminology of the techniques used in conflict resolution is similar in the two studies, and the ranking of the techniques is the same. Thamhain and Wilemon referred to confrontation, compromise, smoothing, forcing, and withdrawal, whereas Posner referred to collaboration, compromising, accommodating, dominating, and avoidance. The preferred method used in any conflict situation was not identified in either study. The studies do show, however, that different techniques are used by project managers to resolve conflict. These, in turn, may be employed in relation to the leadership style adopted by the project manager in a given situation.

Leadership

Leadership is difficult to define. Burns (1978) cites one study with 130 definitions of the term. Zaleznik (1977) distinguished between managers and leaders, noting they had different attitudes toward their goals, careers, relations with others, and themselves. His paper defined how, through a one-to-one relationship with a managerial mentor, leaders could be developed into managers. He noted that:

> One often hears leaders referred to in adjectives rich in emotional content. Leaders attract strong feelings of identity and indifference or of love and hate. Human relations in leader dominated structures often appear turbulent, tense, and at times disorganized.[4]

If we view project management in terms of short-term objectives, then the leader characterized by Zaleznik may be the image of the successful project manager. He notes that managers "tend to adopt impersonal, if not passive attitudes toward goals. Leaders adopt a personal and active attitude toward goals." He states "Managerial goals rise out of the necessity rather than desires, and therefore are deeply embedded in the history and culture of the organization." The attitude of a leader toward goals "is to change the way people think about what is desirable, possible, and necessary." Zaleznik noted that "where managers act to limit choices, leaders work in the opposite direction, to develop fresh approaches to long standing problems and to open issues for new options. Leaders create excitement in work."[5]

Perhaps these feelings of intensity or indifference, love/hate, and the ability to create excitement in work is the charisma that may be associated with successful project managers. They instill in others the desire for achievement and recognition through their own ambition and desire. Their own traits may be so strong as to create an image that others try to emulate. Certainly, the project manager quite frequently works in a dynamic environment and is often called on to overcome problems entrenched in bureaucratic discipline. Those who are successful are those selected for their ability to "get things done." Zaleznik states:

> It takes neither genius nor heroism to be a manager, but rather persistence, tough mindedness, hard work, intelligence, analytical ability, and perhaps most important, tolerance and good will.[6]

These traits are similar to those felt to be consistent with a successful project manager.

Thamhain and Wilemon (1977) came to several conclusions relative to the effectiveness of project managers. Two tentative conclusions were formulated.

> 1. The effectiveness of the project manager depends on his leadership style and his work environment, and
>
> 2. Task complexity and the position power of the project manager does not appear to be an important determinant of the leadership style.

They found organization climate was a factor contributing to project manager effectiveness. They defined organization climate to be the quality of communications within the project, continuity of work for project personnel at the project's conclusion, and the project's personnel prospects for future career growth in the firm.

They determined that if the organization climate was good and the project was highly complex or the project manager had low position power, then a team–centered leadership style was most effective. On the other hand, if organization climate was poor and the project manager had high position power, then the project manager should be task–oriented or authoritative. In the sense of creating excitement in work, they found:

> The project manager can influence the work environment by his own actions. His concern for the project team members, his ability to integrate personal goals and need of project personnel with project goals, and his ability to create personal enthusiasm in the work itself can foster a climate which is high in motivation, work involvement, open communication, and subsequent project performance.[7]

Katz and Allen (1985) found that project performance was linked to the perceived organizational influence exerted by the project manager. They contended that the project manager should be externally oriented and

> should be concerned with gaining resources and recognition for the projects and with linking it to other parts of the business to ensure that the project's direction fits the overall business plan of the organization. . . the greater the project manager's organizational influence, the easier it will be for them to integrate and negotiate with functional managers whose technological goals are often in conflict.[8]

Hodgetts (1968) examined the techniques used by project managers to overcome what he defined as the "authority–gap". He defined "authority–gap" to be a condition in which project managers find their responsibility outweighs their authority. His research consisted of interviews with managers in four different industries after which questionnaires were mailed to a number of firms using project management. The initial interviews were conducted in aerospace, construction, a chemical firm, and an agency of the Nebraska state government. Within the aerospace and construction firms, the principal techniques used to overcome the "authority–gap" were negotiation, personality and/or persuasive ability, competence, and reciprocal favors. Project managers in the chemical firm used persuasive personality and technical competence. The state government agency project manager relied on personality and powers of persuasion. The questionnaires were then sent to additional aerospace, construction, and other firms known to be using project management to obtain their assessment of the importance placed on these methods of overcoming the "authority–gap". Project managers in the aerospace firms rated the techniques as shown in Table 2.2.

TABLE 2.2

RANKING OF TECHNIQUES TO OVERCOME AUTHORITY GAP[9]

Method	Very Important	Not Important	Important
Negotiation	26%	65%	9%
Personality/Persuasion	39%	57%	4%
Competence	52%	48%	—
Reciprocal Favors	10%	37%	53%

In general, Hodgetts found that the larger the projects in dollar value the more the project manager relied on formal structure and on the authoritative role. The reasons given were that the number of personnel assigned to the large projects precluded sufficient time on the project manager's part to assume a personal relations approach. Further, the larger projects had more crises which took a great deal of the project manager's time. The converse was true for the smaller projects, where the project managers were able to work more closely with the assigned project personnel.

Leadership Styles

Is there one leadership style that fits the project manager? The answer is probably no. The dynamics within a project change too rapidly and call for multiple skills. What works in one situation on a given day may not be apropos in the same situation on another day. The leader must be capable of adapting to a given circumstance.

Is there a leadership theory that might best describe the characteristics of a project manager? Perhaps there is within the situational models of leadership.

> The situational models are concerned with the changing interaction between the group being led and the leader.The group may be affected initially by the externals of technology, information systems, and/or environmental change. The primary concern, however, is always with the results of those changes on the basic group leader interaction in whatever form it takes. [10]

One advantage of the situational model is that it brings into perspective the multiple theories proposed by numerous writers in behavioral science.

> Leaders differ in their concern for the group's goals and the means to achieve them. Those with strong concern are seen as task oriented (Fiedler, 1967), concerned with production (Blake & Mouton, 1964), in need of achievement (McClelland, 1961) and production oriented (Katz et. al., 1950) . . . . Such leaders are likely to keep their distance psychologically from their followers and to be more cold and aloof. . . . When coupled with an inability to trust subordinates, such concerns for production is likely to manifest itself in close controlling supervision (McGregor, 1960). . . . Leaders also differ in their concern about the group members in the extent to which they pursue a human relations approach and try to maintain friendly, supportive relations with followers (Katz

> et. al., 1950), concern for people (Blake & Mouton, 1964), and in the need of affiliation McClelland, (1961). Usually associated with a relations orientation is a sense of trust in subordinates, less felt need to control them, and more general than close supervision (McGregor, 1960). [11]

There are three possible situational models of leadership effectiveness that could apply to project managers. These are the life-cycle theory proposed by Hersey and Blanchard (1969), the path-goal theory proposed by House (1971), and the contingency leadership theory proposed by Fiedler (1967).

The life-cycle model suggested by Hersey and Blanchard (1969) suggests the leader group interaction should be responsive to the maturity of the organization. The maturity of the organization is defined to include the group's level of education and amount of experience. Maturity, as they define it, does not pertain to the people's age. This theory suggests the leader's behavior should change as the organization matures.

> According to life cycle theory, as the level of maturity of one's followers continues to increase, appropriate leader behavior not only requires less and less structure (task) but also less and less socio-emotional support (relationships)... Maturity is defined... by the relative independence, ability to take responsibility, and achievement motivation of an individual or a group. [12]

The theory alleges that the leader's initial behavior is high task – low relationship and moves to high task – high relationship behavior, through high relationship – low task, and finally to low relationship – low task behavior as the followers move from immaturity to maturity. This is somewhat analogous to the four stages in a project lifecycle. These four stages are defined as the concept or initiation stage, the growth stage, the production stage, and the shut-down stage. The time span of the project, however, may not provide the time necessary for the followers to move from immaturity to maturity.

The path-goal theory championed by House (1971) suggests that the interaction between the group leader and the group led is based on the behavior exhibited by the leader. House suggests that the leader arouses subordinates to perform and achieve satisfaction from the job to be done. An important aspect of this theory is that the leader controls the rewards the subordinates value and clears a path for them to achieve these rewards.

> The leader, at least in part, determines what extrinsic rewards should be associated with work–goal accomplishment... the leader, through his interactions with the subordinate, can increase the subordinate's path instrumentality concerning the rewards forthcoming as a result of work–goal accomplishment. . . through his own behavior he can provide support for the subordinate's efforts and thereby influence the probability that this effort will result in work–goal achievement... the leader influences the intrinsic valences associated with goal accomplishment... by the way he delegates and assigns tasks to subordinates... the leader can increase the net intrinsic valence associated with goal–directed behavior. . . by reducing frustrating barriers, being supportive in times of stress, permitting involvement in a wide variety of tasks, and being considerate of subordinate's needs. [13]

The contingency leadership model portrayed by Fiedler is a derivation of his work with the leader's personality attributes and leadership effectiveness traits.

> Whether or not a man becomes an occupant of a leadership position is frequently a matter of chance, but a man's ability to motivate other men may well be related to one or more personality attributes. It seems, therefore, more fruitful to deal with leadership effectiveness traits. These can be defined as personality attributes of the leader which promote a high level of group productivity. A leader is then effective to the extent to which his group is productive, or achieves its assigned goals. [14]

From his original work, Fiedler operationalized the measurement of a leader through the use of an instrument called the Least Preferred Co–Worker Scale (LPC). It is a self–report questionnaire designed to measure an individual's perception of his/her least favored colleague. A high LPC score denotes a person who is relationship oriented and a low LPC score, one who is task oriented. The research shows a correlation between the LPC score of the group leader and the group performance on the y axis and the three determinants of the situation, defined as leader–member relations, task structure, and leader position power on the x axis. Fiedler found that low–LPC leaders performed better and managed more effective groups when the quality of the leader–member relations, the task structure, and the position power were either very favorable or unfavorable to the leader. The high–LPC leaders were more effective when neither of these extremes occurred.

Fiedler's contingency theory has been criticized in the literature by Ashour (1973), Rice (1978), and Schriesheim and Kerr (1977), to name a few. Nevertheless, despite the criticism, there are others who feel the theory has made significant contributions to work in the study of leadership. Szilagyi and Wallace (1980) suggest the following reasons for the importance of Fiedler's work:

> First, the contingency model was one of the first approaches to leadership that included situational factors within its theoretical framework. . . Second, it provides the subtle but important implication that one should not speak of leadership as being either good or poor. Rather a more realistic viewpoint would be that the manager's style of leading may be effective in one situation, but not in another. Finally, leadership effectiveness is a function of the leader's motivational base and the interaction of situational factors. [15]

Bass commented on the contingency model in the following manner:

> The contingency model offers a remedial plan for increasing leadership effectiveness different from all leadership theories. Blake and Mouton (1964), Vroom and Yetton (1974), or Likert (1977) would see the need to educate leaders to improve their styles. In the case of Blake and Mouton, it would be toward "9–9", the one best way. For Likert it would be toward a democratic style. For Vroom and Yetton, it would depend on the problem situation. But Fiedler (1978) sees an entirely different course of action. Because a leader's LPC is relatively unchanging, then either one must identify and select leaders of high or low LPC to fit given situations or leaders need to know their LPC scores and in what situations they are most effective in order to change the situation rather than themselves. [16]

To select a leader in a given situation, Fiedler does acknowledge it may be easier to change the organization than to change the leadership style of the manager. He suggested that we can engineer the organization to fit the leader by changing the individual's task assignment, the leader's position power, or the leader–member relations of the group. This he feels is much easier than changing the individual.

> A person's leadership style . . . reflects the individuals basic motivational and need structure. At best it takes one, two, or three years of intensive psychotherapy to affect lasting changes in personality structure. It is difficult to see how we can change in more than a few cases an equally important set of core values in a few hours of lectures and role playing or

> even in the course of a more intensive training program of one or two weeks.[17]

Kennedy (1982) suggests that it is the middle LPC leader who may be more effective than either the high–LPC or low–LPC leader. According to his research, the best all around managers are those who are middle LPC managers.

> . . .the results . . . provide strong support for the hypotheses that middle LPC managers perform well in all situations . . . these results suggest that the middle LPC manager who . . . is least concerned with the task and with the opinion of others, appears to be most capable of performing leadership tasks in an effective manner, regardless of the situation. A person who is able to stand by his decisions, regardless of the opinions and feelings of other, and who can function with relatively little social support, should be effective in more types of situations. Because leadership involves essentially interpersonal situations, the middle LPC leaders should be able to perform the appropriate leadership behaviors without becoming overly concerned with the manner in which they perceive him.[18]

In support of Kennedy's remark, this author believes the concept of situational leadership, as it applies to the project manager, is best described by the contingency theory of leadership defined by Fiedler. The organizational structure in which project managers must perform will frequently preclude them from directly rewarding members of the project. Thus, the path–goal theory of leadership which emphasizes the leader's ability to reward members of the group does not appear to be appropriate in a project management organizational structure.

The life–cycle theory of leadership suggested by Hersey and Blanchard may have some application to project management. This presumes, however, the project is sufficiently long to achieve the organizational maturity to which the theory applies. Certainly, the four stages of a project may lend themselves to the four quadrants of task and relationship orientation that this theory suggests. The theory describes a continuum of leadership style changing from the high task orientation and low relationship orientation to low task and low relationship orientation. Yet, a project may require that project managers vary their style of leadership for a given situation. There does not appear to be a continuum over the project, but rather a need for adaptation to handle all contingencies.

Herein is where the Fiedler contingency model seems best suited to a project management leadership style. It provides for eight octants of leadership style dependent on the three determinants of leader–member relations, task structure, and leader position power. The model also accounts for whether these determinants are strong or weak. Certainly within the constraints of project size and complexity, the project manager's leadership style will vary according to need and the stress impinging upon the project from external sources. If the project can be defined beforehand, it may, as Fiedler suggests, be easier to engineer the task for the leader than to change the leader for the task.

To summarize leadership necessary for project managers, the words of Stogdill seem appropriate.

> The leader is characterized by a strong drive for responsibility and task completion, vigor and persistence in pursuit of goals, adventuresomeness and originality in problem solving, drive to exercise initiative in social situations, self confidence and sense of personal identity, willingness to accept consequences of decision and action, readiness to absorb interpersonal stress, willingness to tolerate frustration and delay, ability to influence other person's behavior and capacity to structure social interaction systems to the purpose at hand. [19]

Need for Power and Achievement

The field of achievement research has been amply addressed by the work of McClelland, Atkinson, and their colleagues (1953, 1955). The participants in these early studies were older men, typically veterans who had returned to college after the Second World War. McClelland (1961) published his findings of a cross–cultural and cross–national study that linked early child rearing experiences to later economic growth in the country.

McClelland's work may have been tailored after the original hypothesis of Max Weber (1930) who suggested the "Protestant ethic" promoted self reliance, denial of personal pleasure, and the evaluation of work as good in itself. The instrument used by McClelland was the Thematic Apperception Test (TAT) adapted from an instrument developed by Murray (1938). This procedure involved presenting a series of pictures to the subjects and asking them to write a short story that described what was taking place.

From this early work, McClelland concentrated his subsequent research on the need for achievement (n Ach), need for power (n Pow), and the need for affiliation (n Aff). His later work (1975, 1976, 1985a) has been directed toward n Pow and n Ach. An interesting study of AT&T managers (McClelland and Boyatzis, 1982) found that the careers of managers having both high n Ach and n Pow peaked at a lower level than the managers who had high n Pow and low n Ach. This was explained by McClelland (1985b) who suggested that individually top management did not require high n Ach as they preferred to achieve through the exertion of power over others. On the supposition they have low n Ach, but exercise their high n Pow in accord with organizational constraints and in meeting organizational objectives, they are not constrained by their feelings in their hard decisions involving others.

There may also be some fulfillment of their n Ach through a vicarious relational achieving style of accomplishment as suggested by Lipman–Blumen (1987). She defined the vicarious relational achieving style to be:

> The vicarious relational style entails achieving indirectly, even passively, through identifying with another achieving individual, group, organization, institution, or nation. Individuals who prefer this style take pride in and satisfaction from the achievements of others, including organizations, as if those accomplishments were their very own. [20]

This definition suggests that the project managers will also have a sense of vicarious achievement through the accomplishments of the project team at the project completion.

A summary of the characterizations of the individual having strong n Ach, n Pow, and n Aff was made by Letwin and Stringer (1968).

> People with high need for achievement prefer a situation where there is a challenge, where there is some risk of not succeeding, but where that risk is not so great that they may not overcome it by their own efforts. The man who has a strong concern for achievement also wants concrete feedback on how well he is doing. Men with a strong need for power will usually attempt to influence others directly by making suggestions, by giving their opinions and valuations, and by trying to talk others into doing things. . . . They are usually verbally fluent, often talkative, sometimes argumentative. Men with a strong need for power are seen by others as forceful and outspoken, but also as hard–headed

> and demanding. Men with a strong need for affiliation are likely to pay attention to the feelings of others. In group meetings they make efforts to establish friendly relationships or in giving emotional support.[21]

Additional research has been conducted by Stahl and Harrell (1981, 1982, 1983) on n Ach, n Pow, and n Aff. Their work has led to the development of the Job Choice Exercise (JCE) that is intended to eliminate the psychometric problems reported with the TAT.[22] Stahl (1983) reports that in a nationwide survey of 1,417 managers, the JCE could reliably distinguish individuals having high managerial motivation by the presence of both high n Pow and n Ach scores and conversely, could identify individuals having low managerial motivation by the absence of both. His findings tended to support those of Varga (1975), Cummin (1967) and Wainer and Rubin (1969). They had found high n Ach and high n Pow to be adequate measures enabling them to distinguish between the successful and unsuccessful subjects they studied.

These findings contradict the work done by McClelland and Boyatzis (1982), but may be related to the level of management to which the tests were administered. This would be supported by the studies performed by Maehr and Braskamp (1986). They found in a study of 1,095 adults, whom they categorized in four career stages, a young career group (age 20 – 35), a middle career group (age 36 – 44), a later career group (age 45 – 54), and a group over 55 years of age, that the individuals in the 45 – 54 age group "have the most intriguing and challenging jobs . . . . it is not surprising that at this stage of their life work they would express enhanced opportunities to pursue whatever power incentives they have."[23] Moreover, "With increasing age, the high achieving group tended to become less extrinsically oriented – that is, less concerned with recognition for work and financial rewards but more concerned with helping others."[24]

Thus, in assessing the n Ach and n Pow drives in the program management hierarchy, there may be a relation between age and the manager's needs for achievement and power. In the entry stages of program management, it is expected there will be high n Ach and low to medium n Pow, with high n Ach and n Pow in the middle level project managers, and high n Pow and low n Ach in the senior program management.

Although we have addressed the leadership styles and the needs for power and achievement of the project manager, there is still another dimension that affects how the project managers' accomplish their tasks. This is their achieving styles. This particular characteristic of the project managers provides insight as to the methods they employ to achieve their objectives.

Achieving Styles

Although much has been reported in the literature on achievement motivation and the need for achievement, power, and affiliation, little has been written regarding the strategy employed in goal achievement. One set of researchers (Lipman-Blumen, Handley-Isaksen, Leavitt, 1983) has focused on the achieving styles employed by managers as the means to achieve their objectives. They have identified three major sets or domains: direct, instrumental, and relational, each having three substyles.

The direct domain consists of the intrinsic, competitive, and power styles and are the task-oriented means to goal achievement. The instrumental domain is comprised of the personal, social, and reliant styles and represents how the individual uses the system and group process, including aspects of self and relations with others to achieve goals. The relational domain consists of the collaborative, contributing, and vicarious styles. These styles are characterized by the degree to which an individual will contribute to the achievement of others to achieve individual goals.

An individual's achieving styles will change in concert with age, position held, and relationships with others. The instrument derived from their studies is the L-LB Achieving Styles Inventory. It is expected that the achieving styles of the project managers will change in relationship to both their age and position held within the project management hierarchy.

Project Management Control

Several researchers, Gerloff (1973), and Peck (1962), have attempted to establish the value of project control systems. Their work was directed to an examination of the direct relationship between individual control methods and project success. They were unable to identify any statistically significant pattern between the type or level of control system used and project success.

Might (1984) studied this phenomenon to ascertain what, if any, relation existed between project control systems and project success. The study was based on an empirical investigation of 103 development projects. Approximately 75 percent of these projects were sponsored by DoD and NASA.

Might defined two dimensions which affected project success: situational conditions and control system implementation. The situational conditions were the general management functions related to planning, monitoring, frequency and type of project reviews, and the resources used in the control process. The control system implementation examined aspects of the project manager's leadership, administrative capability, and responsibility change. Also included were variables defining the project team's enthusiasm, perceived work challenge, and communications within the project and other groups.

Project success was defined by budget, schedule, and three measures of technical performance. Each of the technical performance measurements was a subjective evaluation made by the project teams. The project teams were asked how they rated their performance relative to original objectives, similar projects, and overcoming technical problems encountered on their project.

Might's findings are shown in Table 2.3 as general guidelines for project control systems. The results indicated "why a single set of decision criteria for selecting project control systems has not been discovered. The success of the project depends very heavily on the project manager, the project team, and the environment in which they work."[25]

Project Technical Composition and Technological Complexity

The qualifications of the project manager have become even more important in today's highly complex aerospace industry. The technical composition and technological complexity of many aerospace projects has changed dramatically in the past twenty years. Many of the studies previously cited were conducted in an era when the major portion of

TABLE 2.3

GUIDELINES FOR PROJECT MANAGEMENT CONTROL [26]

1. If the project has a high priority, emphasize periodic cost and schedule reports.
2. As the responsibility of the project manager increases:
   a. reduce detailed schedule, cost, and technical planning.
   b. reduce periodic cost and schedule reports, and
   c. reduce the emphasis (i.e., expenditure ofmanpower and funds) on cost and technical monitoring.
3. If the project manager is considered a technical expert:
   a. consider using detailed task planning techniques such as PERT, CPM, Gantt Charts, and WBS, and
   b. emphasize technical monitoring.
4. If the project manager is considered a capable administrator:
   a. emphasize detailed cost planning,
   b. use PERT or CPM
   c. avoid Gantt charts and WBS, and
   d. be very careful of the overall monitoring efforts.
5. If the project team is enthusiastic and provides a high level of support to the project:
   a. avoid detailed cost planning, and
   b. avoid a high level of technical monitoring.
6. If communication within the division is high:
   a. avoid detailed cost planning, and
   b. reduce emphasis on technical monitoring.
7. If the communication pattern within other parts of the firm is good:
   a. reduce the level of detailed interface planning within the firm,
   b. avoid detailed cost planning,
   c. reduce the number of periodic management reviews, and
   d. avoid a high level of expenditures on cost planning.

TABLE 2.3 (Cont'd)

8.	If the project manager is a flexible leader: a. increase detailed interface planning, b. make extensive use of design reviews and periodic management reviews, and c. increase the emphasis on cost monitoring.
9.	If the manager has a high level of interest in technical problem identification, reduce the level of technical planning.
10.	If the initial uncertainty is high: a. emphasize detailed interface planning, b. use scheduled design reviews, and c. be careful not to overemphasize schedule and technical monitoring.
11.	If there is a history of underestimating the level of uncertainty (i.e., the final uncertainty is often higher than the team usually estimates at the beginning): a. reduce the cost planning, and b. do not use informal scheduling techniques (if a technique is needed select a formal system).

the Department of Defense research and development (R&D) budget was spent on "hardware". Computer programming was in its infancy, albeit growing, and its product "software" was just evolving. Software has evolved from a state of machine language, requiring programmers to write software in binary arithmetic, to complex higher order languages (HOL) requiring extreme sophistication to use. Then, as now, software could not be physically seen or touched, and the magnitude of its complexity was, and still is, underestimated. Two Defense Department managers, De Roze and Nyman (1977), place the problem in perspective.

> Software is big business within the DoD. As noted earlier, the current annual expenditure in software for embedded systems (weapons, platforms, command and control, and intelligence) is now estimated in excess of $3 billion; yet even this substantial sum is only the tip of the iceberg. It includes direct costs only and represents a conservative number based on incomplete and nonuniform data.

> The distribution of software costs for all military systems for a given fiscal year shows that 68 percent of known costs are consumed in development of new systems (R&D) while the remaining 32 percent of the known cost is categorized as operation and maintenance (O&M) of systems already in the field. [27]

They acknowledged that the DoD had become "somewhat expert", knowing how to divide the responsibilities or the "requirement", "development", and "procurement" people in the hardware acquisition process. No doubt this is related to an ability to be able to measure and weigh tanks, cruisers, and airplanes. These are physical entities that can be accounted for visually and physically.

Yet software remained an enigma. It could not be physically touched nor visually seen, and it was difficult to equate its cost to the product delivered. They went on to say:

> Software, however, creates something of a problem, for up until recently most managers and contracting personnel were content to treat it simply as data. As cost began to soar, it became obvious that some management changes were in order.
>
> More to the point, however, DoD personnel must recognize that from a functional standpoint, computer software is equivalent to hardware, and must be delivered as an active system component. This means that technical and management control is required to insure a quality engineered product. Management instruments and disciplines influencing computer software engineering, prototyping, configuration control, reliability, maintainability, standardization, modular partitioning, design reviews, and life cycle costing must be applied. [28]

The magnitude of the problem has increased. The figures presented in Table 2.4 summarize, on a five year basis since 1962, the DoD budget and that proportion allocated to research, development, test and evaluation (RDT&E). This is compared to the total research and development (R&D) budget. The importance of the figures is that most of the weapons development funded by the DoD comes from the RDT&E budget.

We might assume that the proportion of software in development systems, based on De Roze and Nyman's remarks, has increased even further since 1977. Table 2.5 lends credence to that assumption. In 1976, computer science accounted for about 33 percent of the DoD's obligated funds for basic research. By 1984, the percentage had nearly reached 50 percent. The importance of software in delivered aerospace projects is increasing, and its use is becoming more widespread as the Department of Defense procures more sophisticated weapons.

Project Manager Qualifications

Industry's management appears inadequately prepared to manage increasingly complex aerospace projects that include a large portion of software. Further, academia doesn't prepare the new graduates for the realities of the practical world. This was noted by Cooper (1977) and Thayer, Pyster, and Wood (1981). Cooper's analysis strikes to the heart of the problem:

> Probably the greatest single obstacle to corporate managers is a lack of computer related experience on the part of corporate decision makers. When these executives received their education and served their apprenticeships, computers had not yet emerged as a significant system development factor. As a consequence, they often lack an appreciation for the unique complexities of software development.
>
> Another obstacle to software management from a corporate viewpoint is the hardware orientation of the industry. Hardware came first and this is deeply entrenched. Software is relatively new, intangible, and has evolved with an aura of the mystic. It is human nature to concentrate on the things

TABLE 2.4

DEPARTMENT OF DEFENSE BUDGET[29]

(BILLIONS OF DOLLARS)

Year	Total Budget	RDT&E	Total R&D
1962	52.2	6.3	6.7
1967	71.4	7.2	7.6
1972	79.2	7.9	8.2
1977	97.2	9.8	10.2
1982	185.3	17.7	18.4
Est. 1987	282.2	34.2	5.3
Est. 1992	370.9	40.6	N/A

TABLE 2.5

FEDERAL OBLIGATIONS FOR BASIC RESEARCH IN INFORMATION TECHNOLOGY RELATED FIELDS[30]

(MILLIONS OF DOLLARS)

Year	Computer Science	Electrical Engineering
1974	N/A	38.45
1975	N/A	47.75
1976	26.59	53.08
1977	31.02	55.14
1978	40.28	57.41
1979	42.96	62.03
1980	46.22	70.59
1981	52.21	78.51
1982	67.45	93.63
1983	80.25	91.89
1984	103.66	115.38

> that are familiar and shy away from the unknown or foreign. As a result projects are usually staffed with a dominance of hardware engineers, project managers try to treat software just like hardware.[31]

Although he criticized industry for lack of foresight and training and their inability to staff project management functions with multidisciplined personnel, he addressed two other problems that are frequently encountered.

> There is also a strong desire by the project manager, his staff and his contractor to use the latest, greatest, so–called "state of the art" to produce an elegant system.
>
> Project managers (industry) also are too often reluctant to say no to a user request for a change or a new feature. Instead they accept the task of attempting too many new developments simultaneously.[32]

He continued:

> In order to optimize their probability of success projects should be kept as simple as possible and still be able to satisfy their fundamental requirements.[33]

Thayer, et. al, (1981) attempted to identify what industry, government, and university leaders felt to be the problems in software engineering project management (SEPM). The participants in their study were recognized industry technical leaders in computer science, practicing project managers, educators, and other personnel interested in project management.

The twenty questions asked of the respondents were all related to the classical management problems of planning, organizing, staffing, directing, and controlling. The problems are shown in Table 2.6 and the results of the study shown for the composite and SEPMs only in Table 2.7. There was a widely held belief that the solutions to the problems rested with management. A large number of the respondents were managers. Thus, the study seems to have revealed an abrogation of responsibility on the part of management.

Another interesting aspect of the study was a followup to the original study with university professors in computer science. They were queried about the disparity that existed between what they felt were important software issues and the attention these issues received in their classrooms. The principal reasons given for the disparities were (l) the professor's lack of expertise, (2) lack of texts, and (3) inappropriateness for computer science departments.

> The reason they felt there were no textbooks which adequately handled the material was because the area is so new and these issues are indeed problems so there are no solutions to write about! Perhaps the most interesting reason cited for not teaching more SEPM material is that some professors felt the material was not appropriate for a computer science department. Because the material is managerial these professors believed it should be taught in business schools within the university. When asked whether, in fact, this material was currently being taught in the business school on their campus, the answer was invariably no.[34]

TABLE 2.6

TWENTY HYPOTHESIZED PROBLEMS IN SOFTWARE ENGINEERING MANAGEMENT[35]

Planning Problems

Problem 1 (Plan Requirement): Requirement specifications are frequently incomplete, ambiguous, inconsistent, and or immeasurable.

Problem 2 (Plan Success): Success criteria for a software development are frequently inappropriate which results in poor "quality" delivered software, i.e., not maintainable, unreliable, difficult to use, relatively undocumented, etc.

Problem 3 (Plan Project): Planning for software engineering projects is generally poor.

Problem 4 (Plan Cost): The ability to estimate accurately the resources required to accomplish a software development is poor.

Problem 5 (Plan Schedule): The ability to estimate accurately the delivery time on a software development is poor.

Problem 6 (Plan Design): Decision rules for use in selecting the correct software design techniques, equipment, and aids to be used in designing software in a software engineering project are not available.

Problem 7 (Plan Test): Decision rules for use in selecting the correct procedures, strategies, and tools to be used in testing software developed in a software engineering project.

Problem 8 (Plan Maintainability): Procedures techniques, and strategies, for designing maintainable software are not available.

Problem 9 (Plan Warranty): Methods to guarantee or warrant that the delivered software will "work" for the use are not available.

Problem 10 (Plan Control): Procedures, methods, and techniques for designing a project control system that will enable project managers to successfully control their projects are not readily available.

Organizing Problems

Problem 11 (Organization Type): Decision rules for selecting the proper organizational structure, e.g., project, matrix, function are not available.

Problem 12 (Organizational accountability): The accountability structure in many software engineering projects is poor, leaving some question as to who is responsible for various project functions.

TABLE 2.6 (Cont'd)

Staffing Problems

Problem 13 (Staff Project Manager): Procedures and techniques for the selection of project managers is poor.

Directing Problems

Problem 14 (Directing Techniques): Decision rules for use in selecting the correct management techniques for software engineering project management are not available.

Controlling Problems

Problem 15 (Control Visibility): Procedure, technique, strategies, and aids that will provide visibility of progress (not just resources used) to the project manager are not available.

Problem 16 (Control Reliability): Measurements or indexes of reliability that can be used as an element of software design are not available, i.e., there is no practical way to show that a given program is more maintainable than another.

Problem 17 (control Maintainability): Measurement or indexes of maintainability that can be used as an element of software design are not available, i.e., there is no practical way to show that a given program is more maintainable than another.

Problem 18 (Control Goodness): Measurements or indexes of "goodness" of code that can be used as an element of software design are not available, i.e., there is no practical way to show that one program is better than another.

Problem 19 (Control Programmers): Standards and techniques for measuring the quality of performance and the quantity of production expected from programmers and data processing analysts are not available.

Problem 20 (Control Tracing): Techniques and aids that will provide an acceptable means of tracing a software development from requirements to completed code are not generally available.

TABLE 2.7

SUMMARY OF RESULTS [36]

(Expressed as a Percentage of Respondents)

Index	Major Issue	Importance of Problem		Nature of Problem		Nature of Solution	
	NR (Short Title)	Composite	Proj Mgrs	Composite	Proj Mgrs	Composite	Proj Mgrs
	Number Reported	294	72	29	72	294	72
1	Plan require.	97	100	64	69	61	64
2	Plan success	82	75	70*	74*	66	70
3	Plan project	90	92	87*	89*	84*	86*
4	Plan cost	88	92	71*	76*	66	67
5	Plan schedule	94	97	68	71*	64	70*
6	Plan design	72	71	45	50	45	50
7	Plan test	79	85	41	49	40	48
8	Plan maint.	67**	68**	44	47	45	48
9	Plan warrenty	74	72	52	47	50	53
10	Plan control	61**	54**	79*	86*	76*	81*
11	Organize type	46**	51**	92*	94*	91*	93*
12	Organ. account.	81	75	94*	97*	92*	95*
13	Staff proj mgr	77	73	95*	98*	96*	97*
14	Direct technique	59**	58**	89*	86*	83*	80*
15	Control visibility	58**	65**	74*	78*	72*	78*
16	Control reliab.	85	90	23***	22***	24***	22***
17	Control maint.	76	76	36	42	36	42
18	Control good	62**	60**	27***	30	22***	26***
19	Control prog.	78	77	65	62	61	61
20	Control tracing	67**	67**	62	67	59	65

Legend

* = Inconclusive   ** = Management solution   *** = Technical solution

Absence of either ** or *** indicates a joint management/technical solution

This in fact was a problem even cited by Cooper who stated:

> Academia could be of greater help to corporate level software management problems than it currently is. Computer science students are not prepared to face the real world of nonacademic problems.[37]

Project Manager Experience

There is very little in the literature related to the importance of the project managers' experience to project success. Cooper (1978) decried the lack of computer related experience on the part of corporate management. He felt they lacked the appreciation of the complexities associated with software development.

This lack of expertise in corporate management, as well as project management, has become crucial. This is particularly true as increasing shares of the Defense Department's RDT&E budget become allocated to systems containing software, The experience and qualifications of the project managers are even more important when attempting to maintain costs and schedules and still meet technical objectives.

Only one study was found in the literature that related project manager general experience to project success. This study (Rubin and Seelig, 1967) evaluated 48 projects awarded by 12 government agencies, ranging in size from $l million to $60 million, with project lives from 1 to 6 years. A path analysis was performed in which only two items were found to have a positive correlation to final technical performance. These two variables were the priority given the project by the firm and a responsibility index of the project manager that was comprised of the project manager's experience and his/her performance on past projects.

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[29] Extracted from Executive Office of the President, Office of Management and Budget, Historical Tables, Budget of the United States (Washington: U. S. Government Printing Office, 1986).

[30] Information Technology and R&D: Critical Trends and Issues (Washington, D.C.: U. S. Congress, Office of Technology Assessment, OTA–CIT–208, February 1985): Table 2.

[31] John D. Cooper, "Corporate Level Software Mangement," IEEE Transactions on Software Engineering SE–4 (July 1978): 321.

[32] Ibid.: 322.

[33] Ibid.: 322.

[34] Ibid.: 341.

[35] Ibid.: 338.

[36] Ibid.: Extracted from Tables III through V, pp. 338–340.

[37] Ibid.: 320.

CHAPTER 3

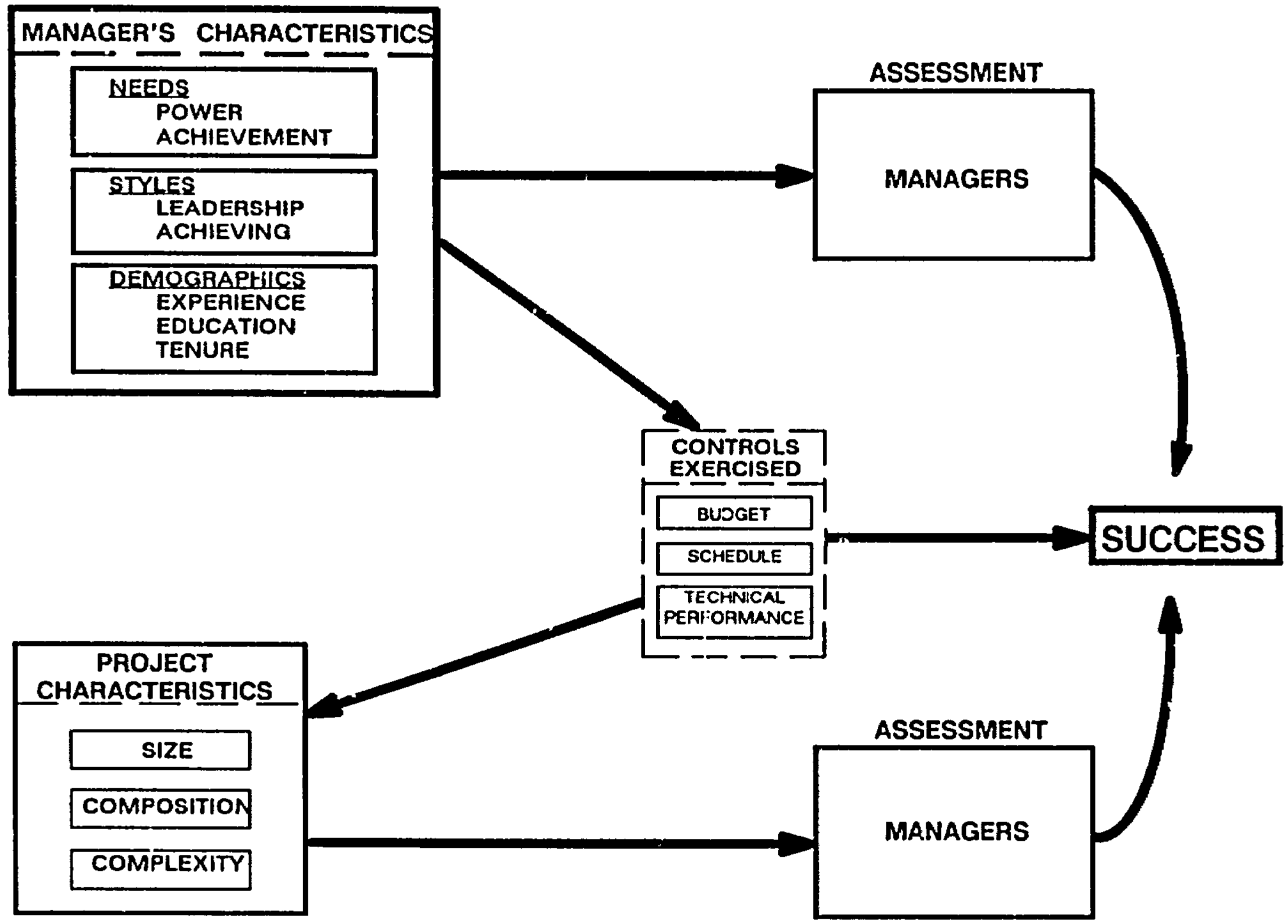
RESEARCH DESIGN

This chapter discusses the elements of design which comprise the dissertation research. The first section presents the project management model used as the basis of this research. The next section identifies the population from which the data are obtained, and the methods employed to obtain the data. The following section restates the research questions presented in Chapter 1 as formal hypotheses. The questionnaires used in the research are presented in the next section. Finally, the data analysis methods for each hypothesis are summarized to enable the reader to relate each research question to analysis methods.

Project Management Model

The project management model used in this research is shown in Figure 3.1. The model depicts three measures of success that are applied to the project and its manager. Two of these measures are qualitative and the third is quantitative. The first qualitative measurement is the managers' assessment of their performance on the projects for which they are responsible. The second qualitative measurement is the managers' assessment of the projects' success for which they are responsible. The quantitative measurement is mathematically derived from data provided by the project managers on project performance relative to budget, schedule, and technical requirements.

The model proposes that the three separate measures of success applied to the project mangers and to the projects are related. Projects are considered as successful if, upon completion, they meet preestablished goals related to budget, schedule, and technical performance. If the projects are successful, then this aura of success encompasses the project



Project Management Model
Figure 3.1

manager. The model proposes that the project managers' are the keystone to project success.

The project managers' characteristics are related to all elements that define either a successful project or a successful project manager. There are specific characteristics about the managers which enable them to motivate and direct their people to successful project completion. These personal characteristics of the managers are evaluated in relation to the managers' self-assessment of their success.

Projects will typically have a management control system imposed on them by the contract, the corporation, or the department in which the work is performed. The control system is usually applied to some combination of budget, schedule, and technical performance and, in most instances, to all measures of performance. The project managers are expected to have knowledge about and use the control systems to measure project performance. The model proposes that the use of control systems is a contributor to project success.

The model also proposes that the project characteristics are a factor in determining project success. The project size, its technical composition, and the technological complexity of the elements comprising the project are determinants in evaluating project success. Each of these elements is a factor when considering an individual for assignment as a project manager. The individual's past experience, performance on similar projects, education, training, and tenure with the organization are key factors in the selection and assignment of the individual to subsequent projects. The project characteristics are evaluated in relation to the managers' assessment of project success.

Above all, the project managers must represent the project to all who interface with the project. This boundary spanning role places a unique responsibility on the project managers. The project managers must not only fulfill their management and technical role, but must also act as the figurehead, leader, and spokesman for the project. It is they, then, upon whom the ultimate success of the project rests.

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respondents, apprised them the data were being gathered for a doctoral dissertation, and then administered the questionnaires.

The intermediaries in the other firms were professional acquaintances who volunteered to solicit members of their project management groups to participate in the survey. The completed questionnaires were returned to the author by the intermediaries. The response rate to the survey was 72 percent. Two of the responses from the mailing could not be used. Thus, the data base consists of 71 respondents.

Hypotheses

Chapter 1 stated the research problem and a series of related questions. The literature review in Chapter 2 identified areas in which additional research in leadership characteristics, project characteristics, and project management, as they relate to project and project management success, is warranted. A formal statement of the hypotheses, which this research addresses, is as follows:

Hypothesis 1

> The effectiveness of management controls to ensure project success is dependent on the project size. The larger the project, the less effective management controls are in ensuring project success.

Hypothesis 2

> The effectiveness of leadership characteristics on project success is dependent on the management level of the project manager. The higher the management level, the less effective leadership characteristics alone are on project success.

Hypothesis 3

> Leadership characteristics, coupled with management controls, will lead to project success greater than that achieved by leadership characteristics or management controls alone.

Hypothesis 4

Project size, composition, and technological complexity are determinants of project success. As project size, proportion of software in project composition, and technological complexity increase, singly or in combination, project success will decline.

Hypothesis 5

Projects will be more successful when led by managers having the most experience, tenure, and cross–disciplinary training in the disciplines comprising the project. This will be more pronounced on those projects on which software comprises a significant portion of the engineering budget.

Hypothesis 6

Project management success is dependent on project managers with high motivational needs for both power and achievement, multiple dominant achieving styles, and with middle LPC leadership styles.

Hypothesis 7

There is a causal relationship between management controls, project characteristics, and project success. A causal relationship also exists between leadership characteristics and project management success. The leadership characteristics so defined will have more effect on project success than the management controls have on project management success.

Instruments

The instruments used in this research measure leadership styles, achieving styles, the needs for power and achievement, managerial skills, demographics of the respondents, and characteristics of the projects on which the subjects are employed. An ancillary instrument was also used to capture the organizational climate of the firms in which the respondents were employed.

Personality Instruments

The Least Preferred Co-Worker Scale
F. E. Fiedler (1967)

This instrument is a self-report questionnaire designed to measure an individual's perception of his least favored colleague. The respondent is asked to "think of the person with whom you can work least well.... He does not have to be the person you like least well, but should be the person with whom you had the most difficulty getting a job done." [1] This least preferred co-worker is evaluated by a series of 16 eight-point bi-polar semantic differential scales. The favorable pole is rated as an 8 and the unfavorable pole as a 1. The sum of the scores constitutes a person's LPC. A high LPC score denotes a person who is relationship-oriented and a low score, one who is task-oriented. High scores are 94 and above, low scores are considered to be 54 and below. The range between, fifty-five to ninety-three, is assigned to those people said to be both relationship and task-oriented.

This instrument has been demonstrated to have a reliability coefficient between .80 and .90.

Achieving Styles Inventory
Lipman-Blumen and Leavitt (1983)

This instrument measures the achieving styles used by an individual to accomplish his/her objective. It consists of forty-five questions answered on a seven-point Likert type scale. Three major sets or domains are identified: direct, instrumental, and relational, each having three substyles. The direct domain consists of the intrinsic, competitive, and power styles. These represent doing the job oneself, competing with others to accomplish the task, taking charge and delegating the task respectively. The instrumental domain is comprised of the personal, social, and reliant styles. These reflect how the individual uses the self, the system, and group processes to achieve goals. The relational domain consists of the collaborative, contributing, and vicarious styles. These styles are characterized by the degree to which an individual will contribute actively or passively to the achievement of others to accomplish individual goals.

The instrument has been demonstrated to have a reliability of .70 or better.

Job Choice Exercise
Stahl and Harrell (1982)

This instrument consists of thirty job descriptions which the respondents evaluate with respect to job attractiveness and the intensity with which they will actively seek to obtain the job.

Each job is described by three cues that are rated as either very high or very low. A decision is then required as to how attractive the job appears to the respondent. The scale ranges from –5 to +5 with the anchor points defined as very unattractive and very attractive respectively. Furth er information is provided about the job. The respondents must then make another decision about how much effort they would exert to obtain the job. The anchor points on this scale range from 0 to 10 and represent zero effort or a great effort respectively.

The first six job descriptions in the test are a warm–up exercise to acquaint the respondent with the methodology. They are not used in the analysis of the respondent's n Ach, n Pow, and n Aff. Thus, the complete JCE has 30 jobs, 24 of which are scored.

The instrument has been demonstrated to have an average test–retest reliability of .82 and an average internal reliability of .77.

Managerial Skill Instrument

Managerial Dimension Survey
William Buchanan (1984)

This instrument provides a measure of thirty skills and abilities of the individuals being evaluated. The instrument is a self assessment made by the managers of their managerial skills. Each skill is scored from one to five, one being weak and five being exceptional. The thirty skills can then be factor analyzed into four groups of variables representing leadership skills, professionalism, communication skills, and success motivation.

Organizational Climate

Profile of Organizational Characteristics
Rensis Likert (1978)

This instrument consists of thirty-two items which help an organization evaluate its management system by providing a means for employees to describe the system in use in their organization. Based on the work of Rensis Likert, the instrument measures the following: leadership, motivation, communications, decision making, and control.

The instrument measures the management system as it is now and where the members would like it to be. This feature highlights the areas of greatest concern to members of the organization. The instrument has been demonstrated to have split-half reliability coefficients in the .90 to .96 range.

Project Data and Demographics

A two-section, pretested Program/Project Management questionnaire was used to obtain data regarding the project characteristics and the project managers' demographics. The first section of the questionnaire requested information about the projects for which the respondents were responsible. The respondents were asked to provide information for up to three projects. This section included questions related to project size, technical composition, and technological complexity. The respondents were also asked to provide information relative to the projects' status and management controls in force. The second section of the questionnaire requested information about the respondents' background related to education, experience, tenure with the firm, and advancement within the firm.

Methods of Analysis

The hypotheses are reiterated in Table 3.2 together with the variables used in their analysis and the instruments used to collect the data. An analysis of variance was performed on the data sets to determine the homogeneity of the data prior to any other statistical analyses being performed. The statistical methods used in the analyses include multivariate correlation analysis, multiple linear regression, and discriminant analysis. All variables were analyzed by calculating their means and standard deviations. The specific statistical methods employed were dependent on the hypotheses being tested.

TABLE 3.2

HYPOTHESES, VARIABLES USED IN THEIR ANALYSIS, AND INSTRUMENTS USED FOR DATA CAPTURE

Hypothesis 1

The effectiveness of management controls to ensure project success is dependent on the project size. The larger the project, the less effective management controls are in ensuring project success.

The data source is the Program/Project Management questionnaire.

The dependent variables used in testing this hypothesis are two composite variables composed from information obtained in questions Q1–25 through Q1–27 in section 1 of the questionnaire. The two variables are the weighted score of project success (AATOTAL) and the managers' rating of project success (JOBR).

The independent variables used in testing this hypothesis are:

1. Type of contract	Q1–07
2. Project dimensions subject to control	Q1–18
3. Who imposed the control	Q1–19
4. Type of control used	Q1–20
5. Effectiveness of control	Q1–21
6. Management control required	Q1–22
7. Visibility of project	Q1–23
8. Information about project	Q1–23
9. Authority on project	Q1–23

The analysis used was a stepwise multiple linear regression, controlling for project size, of the independent variables against the dependent variable AATOTAL, project success. This regression in turn was compared to a similar regression performed against the manager's rating of project success, JOBR.

TABLE 3.2 (Cont'd)

Hypothesis 2

The effectiveness of leadership characteristics on project success is dependent on the management level of the project manager. The higher the management level the less effective leadership characteristics alone are on project success.

The data sources are the Achieving Styles Inventory (ASI), the Least Preferred Co-Worker Scale (LPC), the Managerial Dimension Survey (MDS), and the Program/Project Management questionnaire.

The dependent variables are the weighted score of project success (GAATOTAL) and the project managers' rating of project success (GJOBR).

The independent variables used in testing this hypothesis are:

1.	The nine achieving styles	ASI
2.	The leadership styles	LPC
3.	The variables defining professional competence and leadership characteristics.	MDS

The analysis used was a step-wise multiple linear regression, controlling for management level, of the independent variables against the dependent variable AATOTAL, project success. This regression in turn was compared to a similar regression performed against the manager's rating of project success, GJOBR.

Hypothesis 3

Leadership characteristics, coupled with management controls, will lead to project success greater than that achieved by leadership characteristics or management controls alone.

The data sources used were the LPC, ASI, MDS, and the Program/Project Management questionnaire.

The dependent variables used in testing this hypotheses are the weighted score of project success (GAATOTAL) and the managers' rating of project success (GJOBR).

TABLE 3.2 (Cont'd)

The independent variables used in testing this hypothesis are:

1.	Leadership styles	LPC
2.	Achieving styles	ASI
3.	Professional competence and leadership characteristics	MDS
4.	Management control variables defined in Hypothesis 1.	Questionnaire

A step–wise multiple linear regression of the independent variables was performed against the dependent variable GAATOTAL, project success. This regression in turn was compared to a similar regression performed against the managers' rating of project success, GJOBR.

Hypothesis 4

Project size, composition, and technological complexity are determinants of project success. As project size, proportion of software in project composition, and technological complexity increase, singly or in combination, project success will decline.

The data source is the Program/Project Management questionnaire.

The dependent variables used in testing this hypothesis are the weighted score of project success (AATOTAL) and the managers' rating of project success (JOBR).

The independent variables used in testing this hypothesis are:

1.	Project size	Q1–12
2.	Hardware content of project	Q1–13
3.	Software content of project	Q1–13
4.	Software complexity of project	Q1–14
5.	Hardware complexity of project	Q1–15
6.	Software language used	Q1–16
7.	Software environment	Q1–17

The analysis used a step–wise linear regression of the independent variable against the variable AATOTAL, project success. This regression in turn was compared to a similar regression performed against the manager's rating of project success, JOBR.

TABLE 3.2 (Cont'd)

Hypothesis 5

Projects will be more successful when led by managers having the most experience, tenure, and cross–disciplinary training in the disciplines comprising the project. This will be more pronounced on those projects on which software comprises a significant portion of the engineering budget.

The data source is the Program/Project Management questionnaire.

The dependent variables used in the analysis of this hypothesis are the weighted score of project success (AATOTAL) and the managers' rating of project success (JOBR).

The independent variables to be used in testing this hypothesis are:

1. Education	Q2–1
2. Years of professional experience	Q2–5
3. Years of software experience	Q2–6
4. Years of hardware experience	Q2–7
5. Years with present employer	Q2–8
6. Years in present position	Q2–12
7. Years of project experience	Q2–13
8. Change in responsibility	Q2–17

The analysis of this hypothesis used a stepwise multiple linear regression of the independent variables against AATOTAL, project success. This regression in turn was compared to a similar regression performed against the manager's rating of project success, JOBR. A discriminant analysis is also performed against the rankings of project success, SUCCESS.

Hypothesis 6

Project management success is dependent on project managers with high motivational needs for both power and achievement, multiple dominant achieving styles, and with middle LPC leadership styles.

TABLE 3.2 (Cont'd)

The data sources will be the ASI, LPC, Job Choice Exercise (JCE), and the Program/Prcject Management questionnaire.

The dependent variable is the weighted score of project managers' success (ATOTAL).

The independent variables to be used in testing this hypothesis are:

1.	Leadership styles	LPC
2.	Achieving styles	ASI
3.	Needs for power and achievement	JCE
4.	Needs for control	Questionnaire

A stepwise multiple linear regression of the independent variables is performed against the dependent variable project manager's success, ATOTAL. A discriminant analysis is also performed against the rankings of project manager's success, MGRSUC.

Hypothesis 7

There is a causal relationship between management controls, project characteristics, and project success. A causal relationship also exists between leadership characteristics and project management success. The leadership characteristics so defined will have more effect on project success than the management controls have on project management success.

The data sources are the LPC, ASI, JCE, MDS, and the Program/Project Management questionnaire.

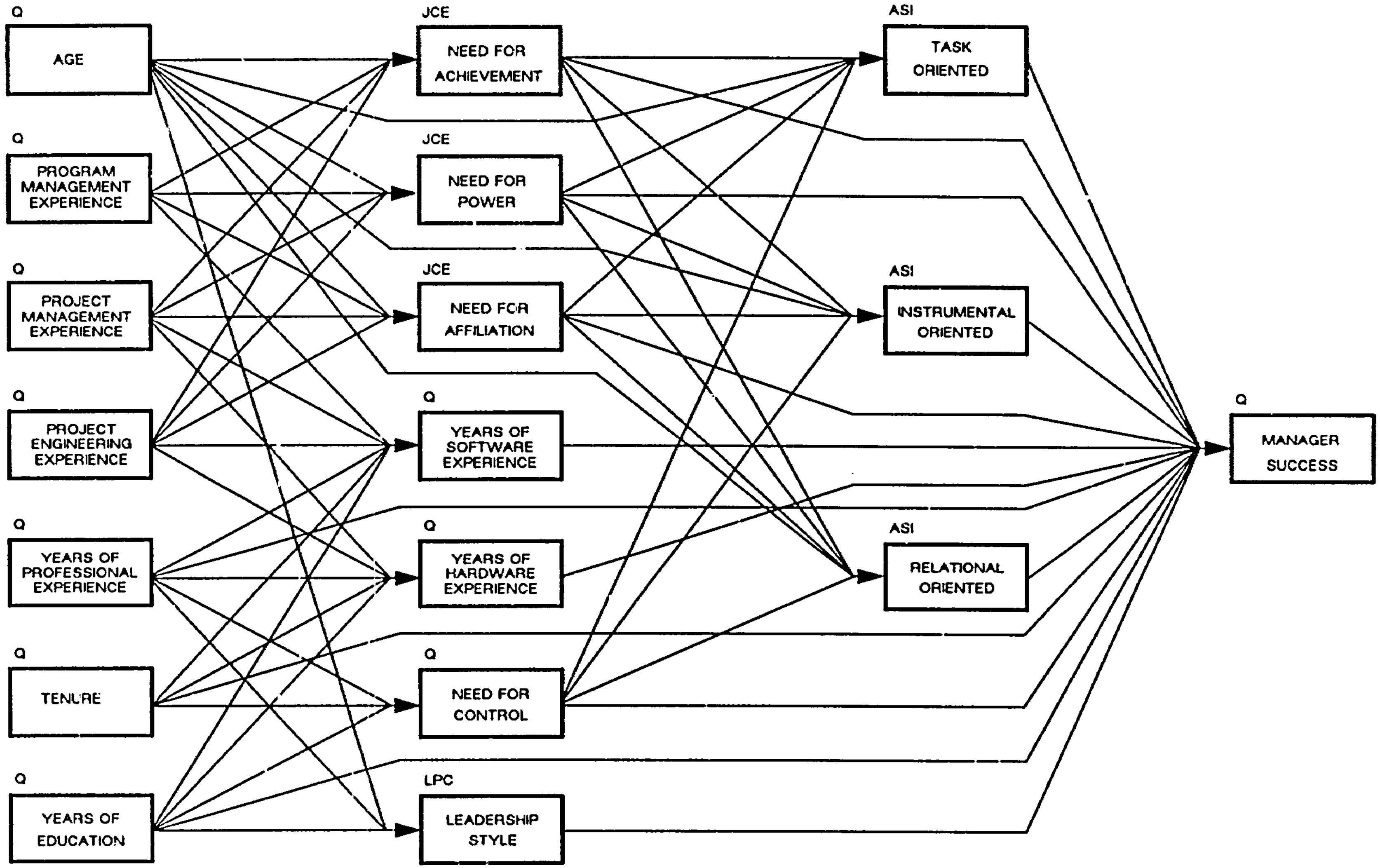
The dependent variables in this analysis are the weighted score of project success (GAATOTAL), the managers' rating of project success (GJOBR), and the weighted score of project managers' success (GATOTAL).

The independent variables to be used in testing this hypothesis are:

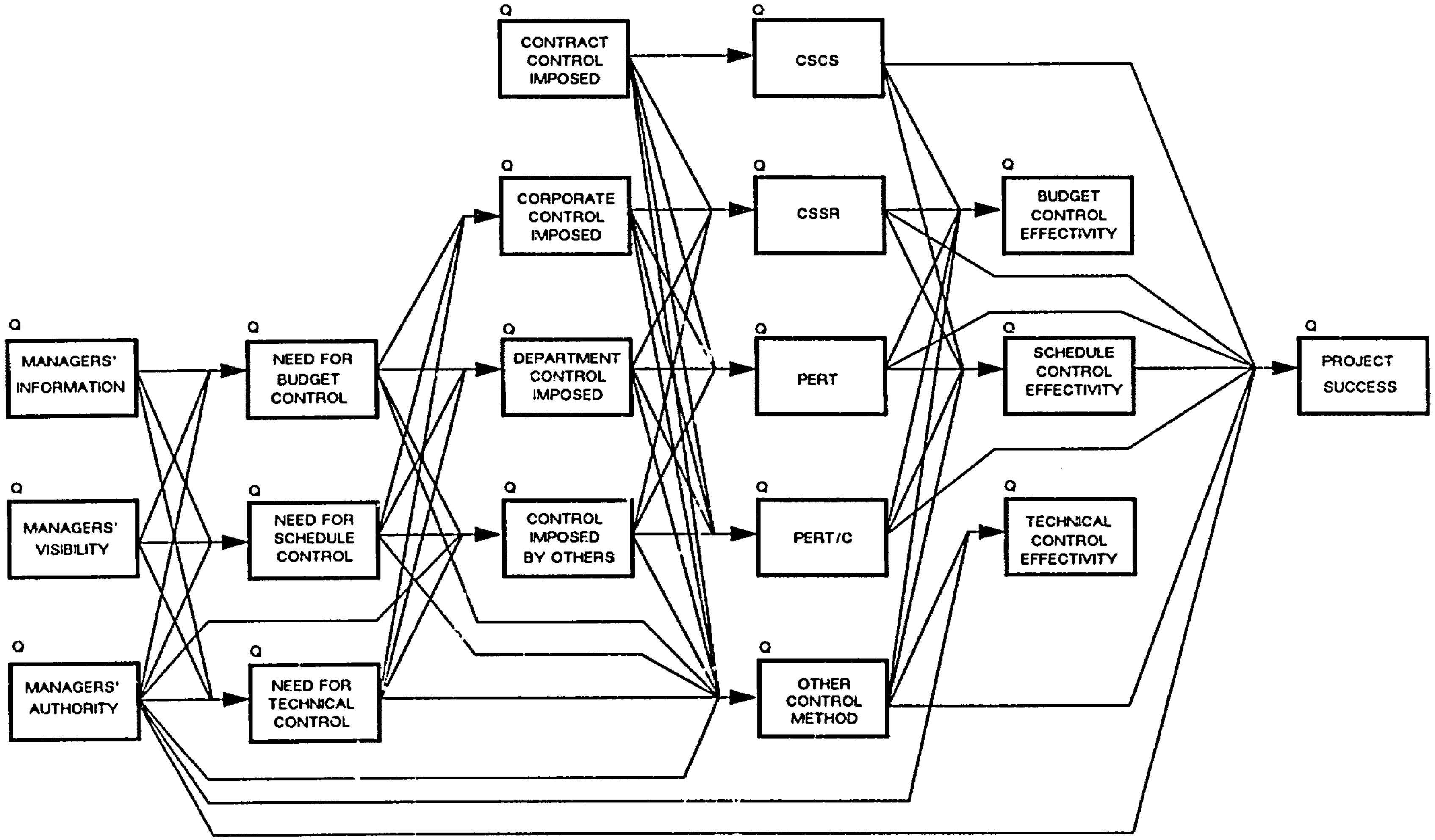
1.	Leadership styles	LPC
2.	Achieving styles	ASI
3.	Needs for power and achievement	JCE
4.	Professional competence and leadership	MDS
5.	Project characteristics	Questionnaire
6.	Manager characteristics	Questionnaire

TABLE 3.2 (Cont'd)

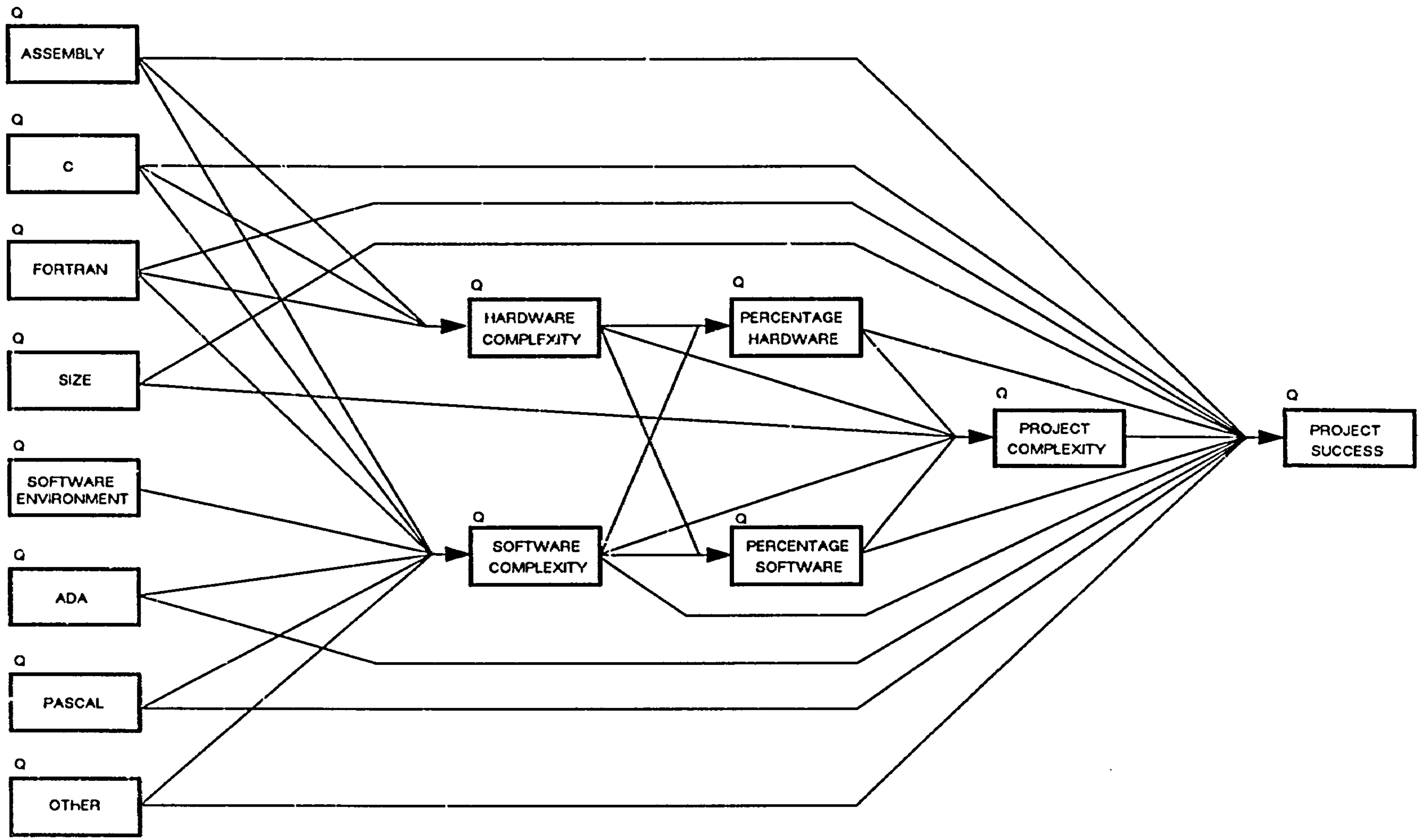
The analysis consists of four path analyses. Three of the path analyses will relate leader characteristics, management control functions, and project characteristics individually to project manager success and to project success. These are depicted in Figures 3.2 through 3.4 respectively. The fourth path analysis will combine the leadership characteristics, management control functons, and project characteristics into a combined path model to evaluate the dimensions of project and project manager success. A separate figure is not shown for the fourth path analysis as it is simply a combination of the path analyses shown in Figures 3.2 through 3.4.



Leadership Characteristics Path Analysis – Manager Success
Figure 3.2



The Control Function Path Analysis —Project Success
Figure 3.3



Project Characteristics Path Analysis — Project Success
Figure 3.4

FOOTNOTE

[1]F.E. Fiedler, A Theory of Leadership Effectiveness (New York: McGraw-Hill, 1967), pp. 268-269.

CHAPTER 4

PRELIMINARY DATA ANALYSIS

This chapter presents the preliminary analyses of the data files and the resultant combination of data sets. The chapter also presents how several key dependent variables were constructed, the demographics of the project managers, and key project characteristics. Finally, a summary is given of the differences noted in the two data sets between the project managers and projects.

Data File Structure

The respondents were requested to provide information on up to three projects for which they were responsible or to which they were assigned. Two data files were required to analyze the data with regard the project characteristics and leadership characteristics. The first was structured to analyze project characteristics. This required that the personal data be repeated for each of the projects on which the managers reported. There are 168 projects in the data base.

The second data file was structured to analyze the respondent's leadership characteristics. Each file contains data about the projects on which the respondents reported. To achieve a direct one–to–one relationship of managers to projects, means were taken for the projects associated with each respondent in the data file. If a manager only reported on one project, that became the mean project score in his/her data file. If two projects were reported, the mean was the average of the two, etc.

Pictorially the data files appear as follows:

DATA FILE 1 Project Data		DATA FILE 2 Personal Data	
Respondent 1	Project 1	Respondent 1	Project Mean
Respondent 1	Project 2		
Respondent 1	Project 3		
Respondent 2	Project 1	Respondent 2	Project Mean
Respondent 2	Project 2		
....	....		
....	....		
Respondent n	Project 1	Respondent n	Project Mean
Respondent n	Project 2		
Respondent n	Project 3		

Preliminary Analysis

The data were initially partitioned into three groups consisting of Firm A, Firm B, and other firms and identified as groups 1,2, and 3. An analysis of variance was performed using the SPSS/X ONE-WAY procedure with the RANGES subcommand SCHEFFE test set at 0.05.[1] There were 63 variables tested. These were the 12 test scores from the Achieving Styles Inventory (ASI), 32 test scores from the Managerial Dimension Survey (MDS), six test scores from the Job Choice Exercise (JCE), 12 demographic variables from the Program/Project Management Questionnaire, and the test score from the Least Preferred Co-Worker Scale (LPC).

The one-way analysis of the variables in data file 1 revealed 35 significant differences between the means of groups 1 and 3 with group 2. A one-way analysis of data file 2 revealed 15 significant differences between the means of groups 1 and 3 with group 2. This suggested there was sufficient homogeneity between groups 1 and 3 to combine them into one set of data for further analysis. Thus, two data bases resulted. The two data bases are identified as Group 1 and Group 2 hereafter.

The first, and principal, data base consists of 55 respondents and 124 projects. The second data base consists of 16 respondents and 44 projects. The results of the analysis performed on the second data base are presented in appendix G.

As a point of interest, further testing was performed to identify the major cause of distinction among the three groups. This testing used a series of one-way analyses of variance on different combinations of management levels in the data base. The management levels investigated were senior, upper, middle, supervisory, and professional nonsupervisory.

There were no significant differences in the 63 variables tested among the three lower management levels. The upper management level was then included with the three lower management levels. A one-way analysis of these four management levels resulted in 12 significant differences. The senior management level was then evaluated with the three lower management levels. The one-way analysis of these four management levels revealed only four significant differences. These three analyses suggested that the upper-level managers were the principal cause of the distinction among the three groups. Eliminating the upper-level managers from the data base would have increased the principal data base to 57, but would have eliminated a management level for subsequent analyses. Thus, no further combination of respondents was considered.

Construction of Dependent Variables

Two dependent variables were mathematically constructed from the responses to the Program/Project Management Questionnaire. One was related to project success and the other to project manager success. The dependent variable related to project manager success was identified as ATOTAL in data file 1 and GATOTAL in data file 2. These variables were then categorized into four classifications of project manager success (MGRSUC and GMGRSUC) dependent on whether data file 1 or data file 2 was being used. The classifications ranged from a 1 for those project managers rated as good to outstanding to a 4 for those rated as unsatisfactory.

Similarly, the dependent variable related to project success was identified as AATOTAL in data file 1 and as GAATOTAL in data file 2. The projects were also grouped into four classifications of project success (SUCCESS). Those projects rated as good to outstanding were classified as a 1 and those which were unsatisfactory were classified as a 4. The construction of these variables is described in the subsequent paragraphs.

Manager Success

The managers were asked to rate their performance on each project with respect to how they performed on budget (URPERB), schedule (URPERS), and technical criteria (URPERT). Their responses were scaled from 1 = Unsatisfactory to 5 = Outstanding. They were also asked to rate on a five-point scale the importance they attributed to budget (RBUD), schedule (RSCHED), and technical performance (RTECH) on each project. The ratings were scaled 1 = Least important to 5 = Most important.

As a cross check to the ranking given these criteria, the managers were also asked which single criterion they would be willing to sacrifice in order to protect the other two. In all instances, the one criterion they selected corresponded to the one identified as being least important on the project.

The mathematical formula used to compute managers' success (ATOTAL) was:

$$ATOTAL = ((URPERB*RBUD) + (URPERS*RSCHED) + (URPERT*RTECH)) / (RBUD + RSCHED + RTECH)$$

The managers' success was then classified as follows:

MGRSUC = 1; if ATOTAL was GE 4.0
MGRSUC = 2; if ATOTAL was GE 3.0 and LT 4.0
MGRSUC = 3; if ATOTAL was GE 2.0 and LT 3.0
MGRSUC = 4; if ATOTAL was LT 2.0

where:

MGRSUC = 1 is rated good to outstanding
MGRSUC = 2 is rated as average to good
MGRSUC = 3 is rated marginal to average, and
MGRSUC = 4 is rated less than satisfactory.

On this basis, the ranking of managers' success in the two data sets is as follows:

Ranking	DATA SET 1 Number		DATA SET 2 Number
Good to Outstanding	19		11
Average to Good	20		2
Marginal	14		0
Unsatisfactory	2		3
TOTAL	55	TOTAL	16

Project Success

A similar method was used to construct the project success variable. The construction began with a rating given to the state of the budget (BUDGET), schedule (SCHED), and technical performance (TEK) reported by the managers. These initial ratings assumed that budget, schedule, and technical performance were all equally weighted.

These ratings were then modified dependent on whether the project was conducted on either a fixed price (FP) or cost plus (CP) contract. A further modification was made based on the weight given by the respondents to the importance of budget, schedule, and technical performance.

The initial ratings given to budget, schedule, and technical status are shown in Table 4.1. The numeric code assigned to each category of 1, 3, and 5 was arbitrarily selected. These ratings were assigned for several reasons. If the contract is a CP contract, then the contractor must share in the cost overrun, and if underrun, share the underrun with the

TABLE 4.1

PROJECT CRITERIA RATINGS

Budget	Schedule	Technical
1 = Overrun	1 = Late	1 = Deviation required
3 = Underrun	3 = On-time	3 = Exceeded specifications
5 = On budget	5 = Early	5 = Met all specifications

contracting agency. This was not considered as successful as meeting the targeted budget. A similar reasoning was applied to rating schedule. The lowest rating was given if the project was late. If a project was ahead of schedule or had delivered early it received the highest rating.

The ratings given to the technical state of the projects were derived in a similar vein. Technical deviations were considered to be the least desirable. A project which met all specifications was initially given the highest rating. The reasoning was that an unfavorable budget or schedule position may have been incurred in the process of exceeding specifications.

The modifications made to these initial ratings then proceeded. If the project was performed on a FP contract, and the budget was either underrun or on target, the budget variable (BUDGET) was recoded to a 5. If the project was on-time or early, the schedule variable (SCHED) was recoded to a 5. Finally, if the technical performance either met specification or exceeded specification, and BUDGET and SCHED were 5, the technical variable (TEK) was recoded to a 5. No modification to the original ratings was made if the project was performed on a CP contract.

The manager's weight given to the importance of budget, schedule, and technical criteria was then used to create the variable defining project success (AATOTAL). The computation was as follows:

AATOTAL = ((BUDGET*RBUD) + (SCHED*RSCHED) + (TEK*RTECH))
/(RBUD + RSCHED + RTECH)

The success of each project was then classified as follows:

SUCCESS = 1; if AATOTAL was GE 4.0

SUCCESS = 2; if AATOTAL was GE 3.0 and LT 4.0

SUCCESS = 3; if AATOTAL was GE 2.0 and LT 3.0 S

SUCCESS = 4; if AATOTAL was LT 2.0

where:

SUCCESS = 1 is rated good to outstanding

SUCCESS = 2 is rated as average to good

SUCCESS = 3 is rated as marginal to average, and

SUCCESS = 4 is rated as less than satisfactory.

On this basis, the ranking of the projects' success in the two data sets is as follows:

Ranking	DATA SET 1 Number		DATA SET 2 Number
Good to Outstanding	46		19
Average to Good	22		10
Marginal	25		6
Unsatisfactory	31		9
TOTAL	124	TOTAL	44

Correlations

Correlations of the constructed variables defining manager's success (ATOTAL) and project's success (AATOTAL) were then performed with the ranking of project success made by the managers (JOBR), their perception of how their customers rated the projects (CJOBR), and how the managers rated one another (INDRAT). The latter variable is used as a measure of how objective the managers were in their own self ratings. These correlations are shown in Table 4.2. The results do indicate that the constructed variables agree favorably with the managers' responses.

Demographics and Project Characteristics

The respondent demographics and the project characteristics are shown in Tables 4.3 and 4.4 respectively. The ranges of the project sizes are shown in Figures 4.1 and 4.2. Figure 4.1 depicts the range of project values expressed in terms of the engineering budget. Figure 4.2 depicts the range of project values expressed in terms of the total contract value.

Summary

There were several distinctions between the two groups relative to the managers' demographics and the projects' characteristics. The principal differences in the managers' demographics related to management level and experience. The management levels covered in Group 1 and Group 2 are quite different, whether viewed from a corporate or project management level. Group 2, for example, did not include any corporate manager below middle management. Further, the Group 2 respondents did not include any project engineers.

Group 1 respondents had more hardware experience and less software experience than the Group 2 respondents. The respondents in Group 1 have less program and project management experience, but more project engineering experience than the Group 2 respondents. Note also that the Group 1 respondents have been in their positions longer than the Group 2 respondents.

The distinctions between the groups relative to the project characteristics include the contract types, how the contracts were obtained, and specific project differences. Proportionately, Group 2 had more cost plus fixed fee (CPFF) and less cost plus incentive fee (CPIF) contracts than Group 1. Group 2 also had proportionately more follow–on business than Group 1. The projects reported by Group 2 were smaller, with a shorter time to first article delivery, and contained significantly more software than Group 1.

There was another distinction between the two groups not readily seen from the raw data. Although Group 2 is classified as being in the aerospace industry, the respondents referred to themselves as an "engineering services" firm as opposed to an "aerospace" firm. Conversations with the firm's group vice–president also revealed the respondents came from the highest growth division in his group. Further, there had been a recent reorganization which might account for the relative short time the managers in Group 2 have been in their present positions.

TABLE 4.2

CORRELATIONS OF RATING VARIABLES

	ATOTAL[a]	AATOTAL[b]	JOBR[c]	CJOBR[d]	INDRAT[e]
AATOTAL	0.41 n(138) $p<.001$	1.00 n(144) .	0.44 n(147) $p<.001$	0.44 n(147) $p<.001$	0.13 n(83) $p=.129$
JOBR	0.44 n(147) $p<.001$	0.47 n(143) $p<.001$	1.00 n(159) .	0.58 n(159) $p<.001$	0.31 n(95) $p=.001$
CJOBR	0.44 n(151) $p<.001$	0.43 n(143) $p<.001$	0.58 n(159) $p<.001$	1.00 n(159) .	0.24 n(95) $p=.008$
INDRAT	0.25 n(89) $p=.010$	0.13 n(83) $p=.129$	0.31 n(95) $p=.001$	0.24 n(95) $p=.008$	1.00 n(95) .

[a] Weighted score of managers' success
[b] Weighted score of projects' success
[c] Managers' rating of project success
[d] Managers' estimate of customer's rating of project success
[e] Respondents' rating of their peers' performance

TABLE 4.3

MANAGERS' DEMOGRAPHICS

Number of Managers by Management Level	Group 1	Group 2
Senior Managers	5	5
Upper Managers	7	7
Middle Managers	16	4
Supervisors	14	–
Professional Non–supervisory	11	–
Number of Managers by Project Management Level		
Program Management	21	12
Project Management	11	3
Project Engineers	21	–
Number of Managers by Gender		
Male	53	16
Female	2	–

	Group 1		Group 2	
	M	SD	M	SD
Age	48.1	7.1	50.7	7.2
Education (yrs)	17.2	1.9	17.8	1.6
Professional experience (yrs)	22.6	8.5	25.6	7.4
Hardware experience (yrs)	15.6	11.3	11.4	10.6
Software experience (yrs)	5.4	6.4	8.9	5.6
Years with present employer	13.8	8.6	6.8	2.3
Program Management experience (yrs)	3.8	5.7	8.8	7.7
Project Management experience (yrs)	3.9	4.4	5.1	4.5
Project Engineering experience (yrs)	7.1	5.7	2.2	3.4
Years in present position	4.0	3.2	1.1	0.5
Projects responsible for	2.5	2.2	4.6	3.3

TABLE 4.4

PROJECT CHARACTERISTICS

Contract Type		Group 1		Group 2
Fixed price		45		16
Fixed price incentive fee		5		1
Cost plus fixed fee		14		15
Cost plus incentive fee		48		7
Other		10		3
How Contract was Obtained				
Competitive		40		15
Sole Sourced		62		17
Follow-On		10		8
Other		5		3

	M	SD	M	SD
Size:Valued by engineering budget (000) thousands	$27,659	$117,029	$9,094	$32,743
Size:Valued by total budget (000) thousands	$43,483	$142,125	$11,849	$41,717
Time to first article delivery (months)	22.5	15.1	3.6	4.6
Percent complete	.60	.34	.58	.32
Time required by manager Expressed as a percent	.40	.40	.29	.24
Percent of engineering budget allocated to hardware	.65	.25	.31	.36
Percent of engineering budget allocated to software	.35	.25	.69	.36

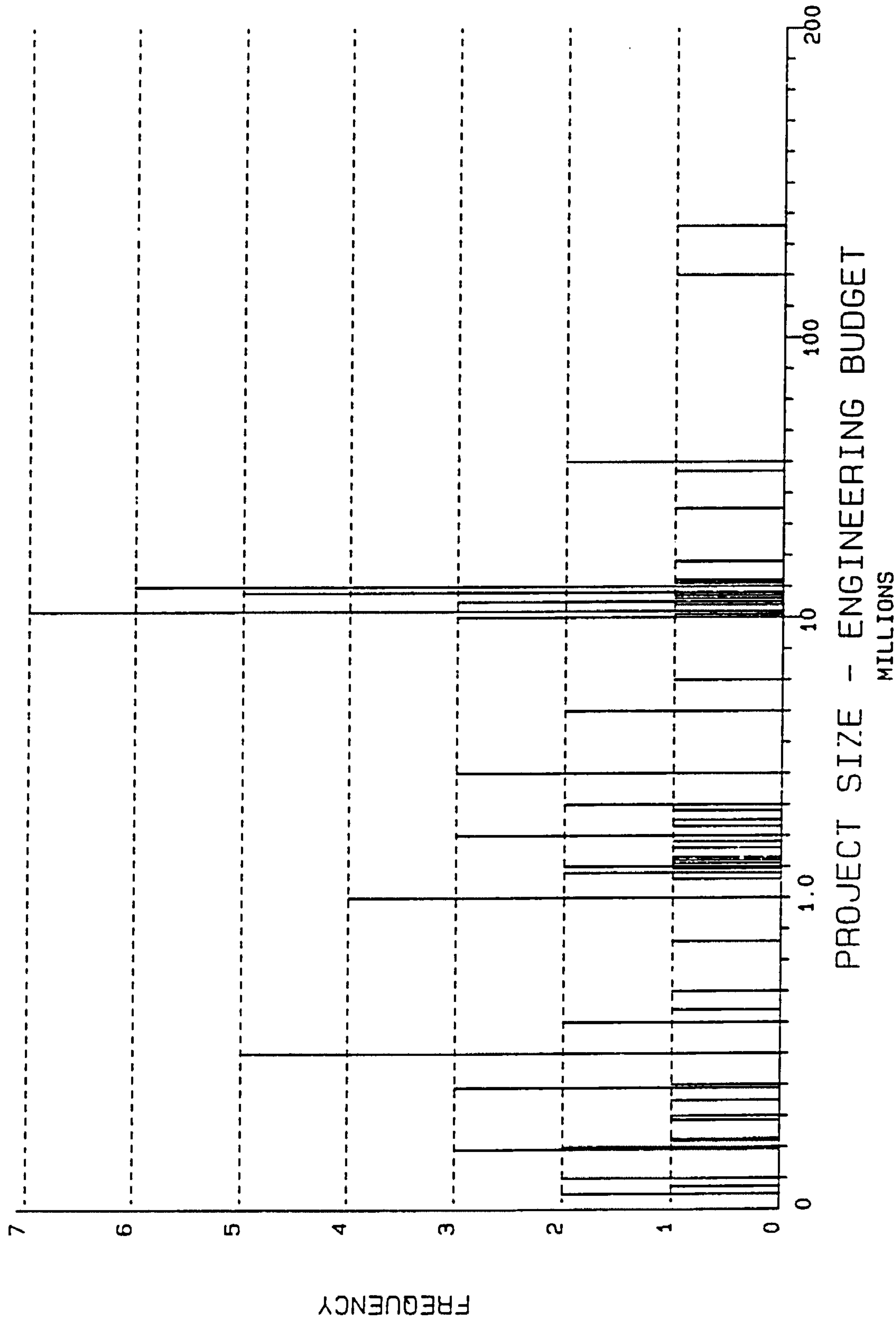

FREQUENCY
0
1
2
3
4
5
6
7
0
1.0
10
100
200
PROJECT SIZE - ENGINEERING BUDGET
MILLIONS

Figure 4.1

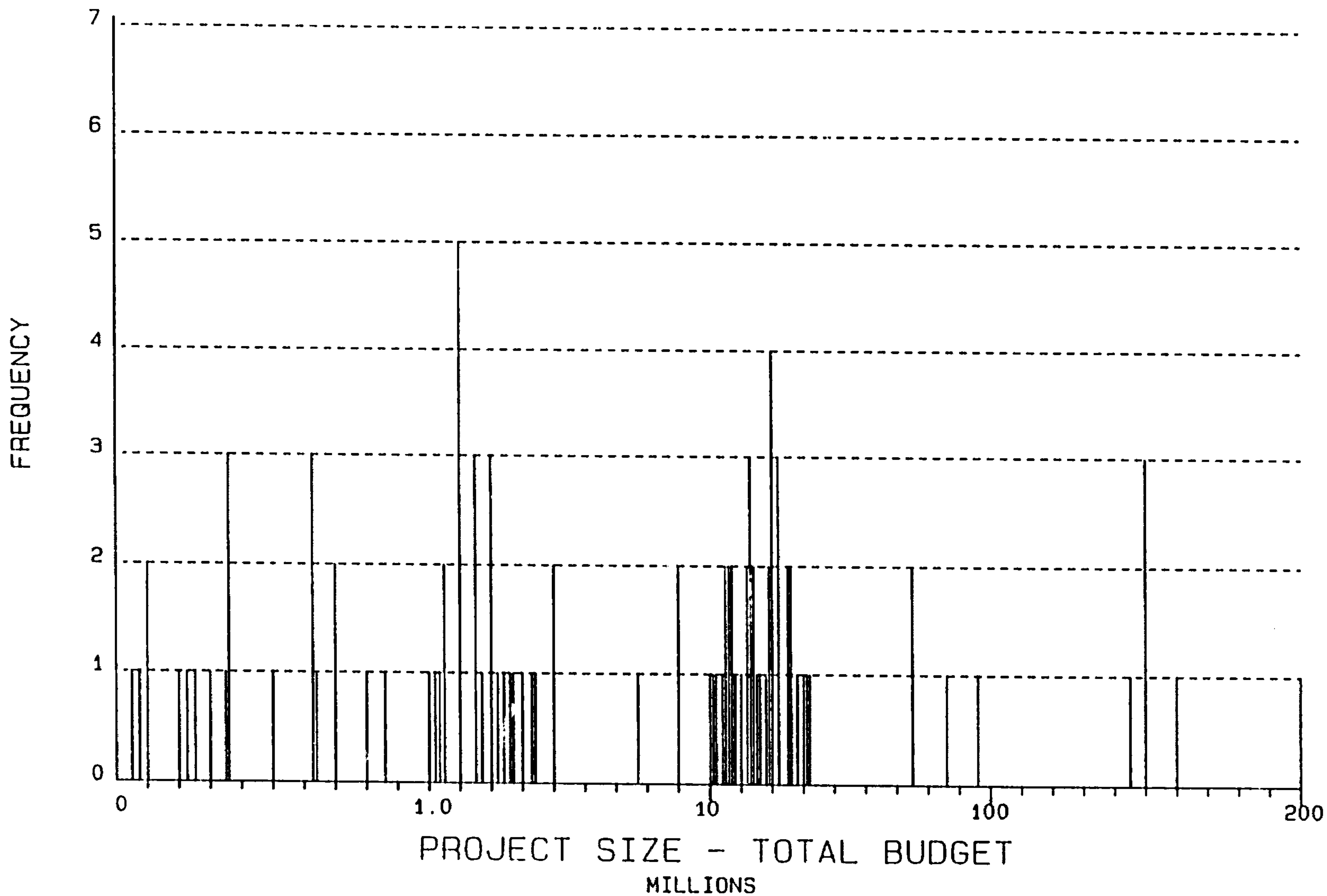

FREQUENCY
0
1
2
3
4
5
6
7
0
1.0
10
100
200
PROJECT SIZE - TOTAL BUDGET
MILLIONS

Figure 4.2

FOOTNOTE

[1] Range is the difference between the largest and smallest observation of a sampled variable. The RANGES test is a procedure used to test the null hypothesis there is no significant difference between means of a given sampled variable in multiple data sets. In small sample distributions, the range is frequently used as a substitute for standard deviations as a measure of variability. The SCHEFFE' RANGES test is a variation of the student's range test using the F test in which an adjustment is made to the required degrees of freedom necessary to determine the F statistic.

CHAPTER 5

ANALYTICAL RESULTS

Hypotheses 1 – 3

The analytical results of hypotheses 1 – 3 are presented in this chapter. These hypotheses are presented as a group because they examine the effect management controls and leadership characteristics have on project success, singly and in combination. The first section examines the effect management controls have on project success. The second section examines the effect leadership characteristics have on project success. The final section evaluates the effect that the combination of management controls and leadership characteristics have on project success.

Hypothesis 1

This hypothesis evaluates the effectiveness of management controls on project success when controlling for project size. Projects were grouped according to size as either small, medium, or large. These distinctions were made based on the projects' value when considering either the projects' engineering value or the projects' total contract value. This grouping is shown in Table 5.1.

The dependent variables used to evaluate this hypothesis were the weighted score of project success (AATOTAL) and the managers' rating of project success (JOBR). Multiple regressions were run against these variables using the SPSS/X REGRESSION procedure with stepwise entry. The variables used in the regressions are those outlined in Table 3.2. To guard against multicollinearity, TOLERANCE is set at 0.25[1]. To ensure significance of

TABLE 5.1

HYPOTHESIS 1

GROUPING OF PROJECTS BY SIZE

Project Size Based on Engineering Value		
SIZE	Project Value (000) Thousands	n
Small	$ 1 through $ 1,000	34
Medium	$ 1,001 through $ 10,000	28
Large	$ 10,001 through $ 140,000	34
Project Size Based on Contract Value		
JSIZE	Project Value (000) Thousands	n
Small	$ 2 through $ 2,000	31
Medium	$ 2,001 through $ 20,000	31
Large	$ 20,001 through $ 200,000	37

results, PIN is set at 0.05 and POUT is set at 0.10[2]. The mean of the variables was used for missing data. This choice was made for the following reason:

There were 25 variables used in the regressions. A visual inspection of the frequencies of their occurrence indicated that all variables only had one or two missing data points, with the exception of two variables, which had four missing data points. Using pairwise or listwise deletion significantly reduced the data set for analysis. The results of the regressions are shown in Tables 5.2 through 5.5.

Weighted Score of Project Success: AATOTAL

The results obtained from the regressions performed on the weighted score of project success (AATOTAL) are mixed. When size is defined by the projects' engineering value, Table 5.2, R increases as project size increases from 0.35 to 0.51. The amount of variance thus explained by the independent variables increases from 13% (R^2) to 26% (R^2). The significance of the independent variables which explain the variance is also weak as is the significance of the regression equation.

When project size is determined by the projects' total contract value, Table 5.3, a regression equation did not result for small projects. Medium sized projects, however, had an R value of 0.68 as opposed to 0.55 for large projects. The variance explained in the dependent variable (AATOTAL) declined from 46% (R^2) to 31% (R^2) as project size increased. The significance of the regression equations improved as did the significance of the independent variables which explain the variance in the dependent variable.

Regardless of how project size is defined, the independent variables which explain the variance in project success (AATOTAL) for small or medium sized projects are positively related to project success. On small projects, Program Evaluation and Review Techniques (PERT) are used as a management control technique. For medium size projects, project control is imposed on the project by the corporation (CORP). It is not surprising that PERT or some other method of control is used on small and medium size projects. The mean value of the projects in these two categories is below the mandatory threshold for the government's contract requirement to use either Cost Schedule Status Reports (C/SSR) or Cost Schedule Control System Criteria (C/SCSC) control techniques.

Cost Schedule Status Reports (C/SSR) control techniques are required on those contracts on which R&D funding is greater than $5 million, but is less than $25 million. C/SCSC control techniques are imposed on those government contracts on which R&D funding is in excess of $25 million. The implication is that the majority of the projects in this study, in the small to medium size category, didn't require the use of the government control techniques and that the corporation used PERT or some other method of management control.

The independent variables for large projects, however are negatively related to project success. There are two: project control is imposed by contract requirements (CONT), and the authority the managers feel they have on their projects (AUTH). The average value for large projects is well within the contract value which requires the use of C/SCSC control methods. The use of this management tool places additional administrative burdens on the project managers. In many instances, they are given additional responsibility without the authority to administer this management tool.

TABLE 5.2

HYPOTHESIS 1

PROJECT SIZE BASED ON ENGINEERING VALUE

DEPENDENT VARIABLE

AATOTAL Weighted score of project success

PROJECT SIZE (Small): n = 34

$R = .36$ $R^2 = .13$ Adj $R^2 = .10$ $F = 4.7$ SIG $F = .0367$

INDEPENDENT VARIABLE

		BETA	SIG
PERT	PERT is used for project control	0.36	.04

PROJECT SIZE (Medium): n = 28

$R = .41$ $R^2 = .17$ Adj $R^2 = .14$ $F = 5.3$ SIG $F = .0290$

INDEPENDENT VARIABLE

		BETA	SIG
CORP	Project control imposed by the corporation	0.41	.03

PROJECT SIZE (Large): n = 34

$R = .51$ $R^2 = .26$ Adj $R^2 = .22$ $F = 5.7$ SIG $F = .0076$

INDEPENDENT VARIABLES

		BETA	SIG
CONT	Project control imposed by the contract	-0.39	.02
AUTH	Authority felt to be held by the project manager	-0.35	.03

The second independent variable, which indicates how much authority the managers feel they have on their projects (AUTH), provides a clue to the problem of project control. The indication is that the managers feel they haven't sufficient authority on their projects to enable them to use the contract imposed management tools effectively. As senior and upper level managers constitute more than 50% of the project managers in this study, project size could be a determining factor in their ability to exercise control over the projects for which they are responsible.

TABLE 5.3

HYPOTHESIS 1

PROJECT SIZE BASED ON CONTRACT VALUE

DEPENDENT VARIABLE

AATOTAL Weighted score of project success

JOB SIZE (Small): n = 31

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

PROJECT SIZE (Medium): n = 30

$R = .68$ $R^2 = .46$ Adj $R^2 = .42$ $F = 11.8$ SIG $F = .0020$

INDEPENDENT VARIABLES

		BETA	SIG
VALUEJK	Project corporate value	–0.63	.00
CORP	Project control imposed by the corporation	0.50	.00

PROJECT SIZE (Large): n = 37

$R = .55$ $R^2 = .31$ Adj $R^2 = .26$ $F = 7.5$ SIG $F = .0021$

INDEPENDENT VARIABLES

		BETA	SIG
CONT	Project control imposed by the contract	–0.41	.01
AUTH	Authority felt to be held by the project manager	–0.38	.01

Managers' Rating of Project Success: JOBR

The results of the regressions performed on the managers' rating of project success (JOBR) are presented in Tables 5.4 and 5.5. Similar results are obtained regardless of how project size is determined. In both instances, R is about the same for small and large projects and least for the medium sized projects. The significance of the regression equation is greatest for the large projects and least for the medium sized projects.

For project sizes determined by the projects' engineering value, R is nearly constant for all project sizes: 0.60, 0.59, and 0.61 respectively for small, medium, and large projects.

TABLE 5.4

HYPOTHESIS 1

PROJECT SIZE BASED ON ENGINEERING VALUE

Dependent Variable

JOBR Managers' rating of project success

PROJECT SIZE (Small); n = 34

R=.60 R^2=.37 Adj R^2=.33 F=8.9 SIG F=.0009

INDEPENDENT VARIABLES

		BETA	SIG
SCON	Schedule control is exercised on the project	0.48	.00
FPIF	Project performed on FPIF contract	–0.42	.01

PROJECT SIZE (Medium); n = 28

R=.59 R^2=.35 Adj R^2=.32 F=13.7 SIG F=.0010

INDEPENDENT VARIABLE

		BETA	SIG
DEPT	Project control imposed by the department	–0.59	.00

PROJECT SIZE (Large); n = 34

R=.61 R^2=.37 Adj R^2=.35 F=19.1 SIG F=.0001

INDEPENDENT VARIABLE

		BETA	SIG
BUDEFF	Managers' assessment of budget control effectiveness	0.61	.00

The amount of variance explained in the dependent variable defining project success (JOBR) is 37%, 35%, and 37% respectively. When size is determined by the projects' contract value, R is 0.65, 0.50, and 0.62 for small, medium, and large projects respectively. The corresponding amount of variance explained in the dependent variable defining project success (JOBR) is 42%, 25%, and 39%.

When considering how project size is determined, the independent variables which explain the variance are not the same. For small projects, whose size is determined by the projects' engineering value, the independent variables indicating schedule control is used

(SCON) and that the project is performed on a fixed price contract (FPIF) explain the variance in project success (JOBR). SCON is positively related to JOBR and FPIF is negatively related to JOBR. The positive relation of schedule control (SCON) on project success is probably offset by problems encountered on fixed price projects (FPIF) where budget control is an important factor.

The independent variables on small projects, whose size is determined by total contract value, are all positively related to project success (JOBR). The managers feel they have sufficient authority, (AUTH) on small projects to control the projects' outcome. Program Evaluation and Review Techniques (PERT) are viewed as a positive method of job control. The projects are being performed on cost plus contracts (CPIF) on which cost control may not be as restrictive as that encountered on fixed price projects.

The independent variables on medium sized projects are also different. For size determined by the projects' engineering value, the independent variable indicating management control is imposed by the performing department (DEPT) is negatively related to project success (JOBR). This result is thought to represent a lack of consistency in the control method imposed. This is suggested by the positive relation corporate management control (CORP) has on project success (JOBR) when project size is determined by the projects' contract value. This may indicate that the project managers are using department controls that are not consistent with corporate management controls.

The independent variable that indicates technical control is effective (TEKEFF) is positively related to project success (JOBR) when size is determined by the projects' contract value. This is interpreted to mean that the managers do use a method of corporate control to achieve the projects' technical objectives.

There are similarities in the regressions on project success (AATOTAL and JOBR) when large projects are considered, regardless of how the project size is determined. In either case, the effectiveness of budget control (BUDEFF) is positively related to project success. When project size is determined by the projects' contract value, however, the use of budget control (BCON) is negatively related to project success. The implication is that although budget control is effective, either the effort to invoke budget control or the method

TABLE 5.5

HYPOTHESIS 1

PROJECT SIZE BASED ON CONTRACT VALUE

DEPENDENT VARIABLE

JOBR Managers' rating of project success

PROJECT SIZE (Small): n = 31

$R = .65$ $R^2 = .42$ Adj $R^2 = .36$ $F = 6.6$ SIG $F = .0018$

INDEPENDENT VARIABLES

		BETA	SIG
AUTH	Authority felt to be held by the project manager	0.75	.00
PERT	PERT method of job control is used on the project	0.59	.00
CPIF	The project is performed on a CPIF contract	0.37	.02

PROJECT SIZE (Medium): n = 31

$R = .50$ $R^2 = .25$ Adj $R^2 = .20$ $F = 4.7$ SIG $F = .0173$

INDEPENDENT VARIABLES

		BETA	SIG
TEKEFF	Managers' assessment of technical control effectiveness	0.45	.01
CORP	Project control imposed by the corporation	0.35	.05

PROJECT SIZE (Large): n = 37

$R = .62$ $R^2 = .39$ Adj $R^2 = .35$ $F = 10.7$ SIG $F = .0002$

INDEPENDENT VARIABLES

		BETA	SIG
BUDEFF	Managers' assessment of budget control effectiveness	0.64	.00
BCON	Budget control is exercised on the project	–0.34	.02

used for budget control is detrimental to project success. The latter is probably the reason. When asked in the Program/Project Management questionnaire what aspect of the control function they felt should change, many of the managers mentioned improving the timeliness of monthly budget information.

Summary

There are similarities in the regressions run on the two dependent variables that define project success (AATOTAL and JOBR). The interpretation of the independent variables which account for the variance in AATOTAL and JOBR is clarified by using the two measures of project size.

For small projects, control is positively related to project success. The managers feel they have sufficient authority to control their projects. This suggests that the projects are small enough to be performed principally in an organization in which the manager exercises position power. In this instance, the managers are possibly able to control all aspects of the project. For medium sized projects, control imposed by the corporation is positively related to project success. Department control, however, is negatively related to project success. There are several possible explanations. Either corporate control methods are not complied with at the department level, or the department control methods, if imposed, are inadequate.

For large projects, budget control is viewed to be an effective measure contributing to project success. Nevertheless, the contractual imposition of budget control is negatively related to project success. The project managers do not feel they have sufficient authority to control their projects. This suggests that the managers, who are held accountable for all aspects of project performance, view budget control as adversely affecting project success, as they may have insufficient control over budgets outside of their own departments. Either that or the project managers responsible for the budgets are not at the same hierarchal level as the department managers who control the budgets. A conflict may then result due to hierarchical position power. The hypothesis is supported.

Hypothesis 2

This hypothesis evaluates the impact of management level on project success. The limited size of the data base (55 respondents) precluded a direct evaluation of management subsets within the data set. To circumvent this shortcoming, the analysis was performed by grouping several management levels together so that a common management level was contained in each set. Distinctions among the sets could then be evaluated by observing what, if any, variables were common among the sets. These commonalities could then be attributed to the common management level.

The analyses were conducted on both the project management levels and the corporate management levels. The relationship of project management to corporate level management is shown in Table 5.6.

TABLE 5.6

CORPORATE VERSUS PROJECT MANAGEMENT LEVEL

Program Level	Corporate Level				
	Senior	Upper	Middle	Supervisory	Non-Supervisory
Program Manager	5	6	9	1	1
Project Manager	–	1	5	4	1
Project Engineer	–	–	2	9	10

The dependent variables used to evaluate this hypothesis were the weighted mean of project success (GAATOTAL) and the managers' rating of project success (GJOBR). Multiple regressions were run against these variables using the SPSS/X REGRESSION procedure with stepwise entry. The variables used in the regressions are those outlined in the research design in Table 3.2. The means and standard deviations for these variables are contained in the appendices.

To guard against multicollinearity, TOLERANCE is set at 0.25. To ensure significance of results, PIN is set at 0.05 and POUT is set at 0.10. The significance of the parameters TOLERANCE, PIN, and POUT is defined in the notes at the end of this chapter. There were 42 variables used in the regressions. A visual inspection of the frequencies of their occurrence indicated that all variables only had one or two missing data points. Using pairwise or listwise deletion significantly reduced the data set for analysis. For this reason the variables' mean value was used for missing data points. The results of the regressions are shown in Tables 5.7 through 5.10.

Weighted Score of Project Success: GAATOTAL

The regressions against the dependent variable representing the weighted score of project success (GAATOTAL) were performed for both the project management level and the corporate management level. The results of the regressions are shown in Tables 5.7 and 5.8.

Project Management Level

Two management subsets were created with a common management level between them for this evaluation. The management subsets were: 1) the program and project managers and, 2) the project managers and project engineers. The common management level between these two subsets is the project managers.

There was no significant regression against the dependent variable when evaluating the management subset of program and project managers. The regression for the management subset of project managers and project engineers yielded R = 0.42, indicating that 18% (R^2) of the variance in GAATOTAL is explained by the independent variable representing the competitive direct achieving style (COMPDIR2). This achieving style is negatively related to project success.

Managers who exhibit this achieving style tend to define situations as competitive and other individuals as competitors, whether working in a group or alone. Such managers tend to define situations in ways that permit clear comparisons of their accomplishments to relevant others. This achieving style is inappropriate for managers charged with leading a group to project success. The constant competition by the manager with project members and external interfaces to achieve recognition for accomplishment can create many obstacles to achieving project success.

There was no opportunity to compare the regressions of the two management subsets to determine if a common independent variable existed between them that could be attributed to the project managers. The lack of a significant regression against the combined management subset of program and project managers precluded this comparison.

The regression against the dependent variable when considering program managers alone resulted in $R = .47$, indicating 23% (R^2) of the variance is explained by the independent variable. This independent variable represents the manager's leadership style (LPCD1) and is negatively related to project success.

The managers in this group were identified as having a middle LPC leadership style. This leadership style is marked by those individuals who are both relational and task–oriented. The LPC scores for these managers ($M = 70.6$; $SD = 9.9$) place them nearer the task–oriented pole of the Least Preferred Co–Worker Scale than the relational–oriented pole. [3] The indication is that a task–oriented leadership style is negatively related to project success. This is supported by results throughout this research that indicate the direct domain achieving styles, which are primarily task–oriented, are negatively related to project success.

The regression against the dependent variable when considering project engineers alone resulted in $R = .66$, indicating 44% (R^2) of the variance is explained by the dependent variables. The independent variables represent the manager's competitive direct achieving style (COMPDIR2) and the manager's ability and desire to initiate independent solutions (VARM12). Both independent variables are negatively related to project success.

The two variables appear related. We have previously seen that competitive direct achievers (COMPDIR1) tend to define situations in ways that permit clear comparisons of their accomplishments with relevant others. Thus, the project managers' who have the ability and desire to initiate independent action is in keeping with their competitive direct achieving style.

Corporate Management Level

Three management subsets were created with a common management level between pairs of subsets for this evaluation. The management subsets were: 1) senior, upper and middle level managers; 2) middle level managers, supervisors, and non–supervisory professionals; and 3) supervisors and non–supervisory professionals. The middle level managers are the common management level in subsets 1 and 2. The supervisors and non–supervisory professionals are the common management levels in subsets 2 and 3.

The regression for the management subset of senior, upper, and middle level managers yielded R = .70, indicating 49% (R^2) of the variance in GAATOTAL is explained by the independent variables. These independent variables represent the managers' leadership style (LPCD1), their effectiveness in guiding a group to its goal (VARM16), and their vicarious relational achieving style (VICREL9). The first two independent variables are negatively related to project success, whereas the third is positively related to project success.

This management subset also has a middle LPC leadership style that is more task–oriented than relational–oriented (M=71.6; SD=9.4). This may account for its negative relation to project success. The managers may devote more attention to the task at hand and forget the individuals for whom they are responsible. Either that or the projects are so large the managers have little time to devote to their employees. The former explanation is most likely based on the inability of the managers to guide a group to its goal (VARM16). The positive relation of the managers' vicarious relational achieving style to project success may indicate that managers who use the vicarious style serve as good mentors for their subordinates and inspire subordinates to work successfully toward a goal.

The regression for the management subset of middle level managers, supervisors, and non–supervisory professionals yielded R = .38, indicating that 15% (R^2) of the variance in GAATOTAL is explained by the independent variable which represents the manager's ability and desire to initiate independent solutions (VARM12). This variable is negatively related to project success. This variable was previously seen to be related to those managers who also exhibit a competitive direct achieving style. The indication is that independent action on the part of the project managers does not contribute to project success.

There were no common variables between these two subsets that could be attributed to the middle level managers. An attempt to isolate the middle managers by regressing the independent variables for the supervisors and non-supervisory personnel against GAATOTAL did not result in a significant regression against the dependent variable.

Comparison of Management Levels

The regressions against the dependent variable representing the weighted objective score of project success (GAATOTAL) support this hypothesis. The principal independent variables in the regressions, which represent the managers' leadership characteristics, are negatively related to project success. This effect is more pronounced for the corporate management level than the project management level.

Two independent variables appear related to specific management levels when evaluating the contribution which the manager's leadership characteristics make to the weighted score of project success (GAATOTAL). The independent variable representing the managers' leadership style (LPCD1) appears in the regressions for both program managers and the senior, upper, and middle level managers. The independent variable representing the managers' desire and ability to initiate independent solutions (VARM12) appears in the regressions for project engineers and for middle managers, supervisors, and non-supervisory professionals.

These results suggest that the negative relationship which leadership style has to project success is associated with the senior and upper level corporate management which includes the majority of the program managers in this research. Similarly, the results suggest that the negative relationship which the manager's desire to inititate independent action has to project success is related to the supervisors and non–supervisory professional who, in this research, are principally project engineers.

The only independent variable having a positive relation to project success was the manager's vicarious relational achieving style. This positive relation to project success is interpreted to mean that the project managers who derive a sense of achievement from the success of those whom they supervise do indeed encourage and/or inspire their subordinates to successful project completion. The mentoring role of these managers is relevant to their subordinates' success..

Managers' Rating of Project Success: GJOBR

The regressions against the dependent variable representing the managers' rating of project success (GJOBR) were performed by both project management level and corporate management level. The results of the regressions are shown in Tables 5.9 and 5.10.

Project Management Level

The regressions for the management subset of program and project managers resulted in R = .69, indicating that 48% (R^2) of the variance in GJOBR is explained by the independent variables. The independent variables represent the manager's effectiveness in coordination (VARM26), their ability to organize and present information clearly and effectively (VARM13), and their reliant instrumental achieving style (RELINST6). Two of the variables (i.e., VARM26 and RELINST6) are positively related to project success. The third (VARM13) is negatively related to project success.

The managers' effectiveness in coordination and their reliant instrumental achieving style are related. A reliant achieving style is associated with individuals who expect whoever is there, and over whom they have little authority or control, will help complete the task. The program and project managers may not have people who report directly to them and must act as if they are requesting, rather than demanding, assistance. Their effectiveness in coordinating the efforts of others would reflect the use of the reliant instrumental achieving style.

TABLE 5.7

HYPOTHESIS 2

PROJECT SUCCESS ASSESSED BY PROJECT MANAGEMENT LEVEL

DEPENDENT VARIABLE

GAATOTAL Weighted score of project success

PROGRAM AND PROJECT MANAGERS; $n = 32$

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

PROJECT MANAGERS AND PROJECT ENGINEERS; $n = 32$

$R = .42$ $R^2 = .18$ Adj $R^2 = .15$ $F = 6.4$ SIG $F = .0169$

INDEPENDENT VARIABLE

		BETA	SIG
COMPDIR2	Competitive–direct achieving style	–0.42	.02

PROGRAM MANAGERS; $n = 21$

$R = .47$ $R^2 = .23$ Adj $R^2 = .18$ $F = 5.5$ SIG $F = .0298$

INDEPENDENT VARIABLE

		BETA	SIG
LPCD1	Leadership style	–0.47	.03

PROJECT ENGINEERS; $n = 21$

$R = .66$ $R^2 = .44$ Adj $R^2 = .38$ $F = 7.1$ SIG $F = .0053$

INDEPENDENT VARIABLES

		BETA	SIG
COMPDIR2	Competitive–direct achieving style	–0.46	.01
VARM12	Managers' ability and desire to initiate independent and innovative solutions	–0.42	.03

TABLE 5.8

HYPOTHESIS 2

PROJECT SUCCESS ASSESSED BY CORPORATE MANAGEMENT LEVEL

DEPENDENT VARIABLE

GAATOTAL Weighted score of project success

SENIOR, UPPER, AND MIDDLE LEVEL MANAGERS, n = 29

$R = .70$ $R^2 = .50$ Adj $R^2 = .44$ $F = 8.2$ SIG $F = .0006$

INDEPENDENT VARIABLES

		BETA	SIG
LPCD1	Leadership style	–0.55	.00
VARM16	Managers' effectiveness in guiding group to goal	–0.57	.00
VICREL9	Vicarious–relational achieving style	0.36	.03

MIDDLE MANAGERS, SUPERVISORS, AND NON-SUPERVISORY: n = 41

$R = .38$ $R^2 = .15$ Adj $R^2 = .13$ $F = 6.8$ SIG $F = .0128$

INDEPENDENT VARIABLE

		BETA	SIG
VARM12	Managers' ability and desire to initiate independent and innovative solutions	–0.39	.01

SUPERVISORS AND NON-SUPERVISORS: n = 25

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable

The managers inability to organize and present information clearly and effectively, whether up or down, reflects the importance of effective communications. The inability of the managers to convey important factors affecting the project to their superiors may result in incorrect decisions that are detrimental to the project. Similarly, if the managers cannot convey their expectations to those reporting to them, the project may suffer.

The regressions for the management subset of project managers and the project engineers resulted in R = .67, indicating 44% (R^2) of the variance in GJOBR is explained by the independent variables. The independent variables represent the managers' reliant instrumental achieving style (RELINST6), their personal instrumental achieving style (PERINST4), and their competitive direct achieving style (COMPDIR2). The first two of these variables (i.e., RELINST6 and PERINST4) are positively related to project success and the third (COMPDIR2) is negatively related to project success.

The positive relation which the reliant and personal instrumental achieving styles have to project success is a reflection of the project managers' political skill to achieve their objectives. As reliant instrumental achievers they expect others will help them in achieving their goals. They will seek others help through requests for assistance. As personal instrumental achievers they will use aspects of the self (i.e., charm, persuasiveness, intelligence, wit, etc.) to achieve further goals. They are usually excellent negotiators and skilled bargainers. The managers, exhibiting this combination of achieving styles, are sensitive to the importance of establishing networks and relationships to achieve their objectives.

The regressions for the program managers alone resulted in R = .64, indicating 41% (R^2) of the variance in GJOBR is explained by the independent variables. The independent variables are the managers' collaborative relational achieving style (COLLREL7) and their personal instrumental achieving style (PERINST4). The former is positively related to project success and the latter is negatively related to project success.

The collaborative relational achievers are characterized by a desire to accomplish tasks through group efforts. They believe their best accomplishments are achieved through group or team settings. Collaborative achievers accept the group goal, but they may or may not determine the means by which they contribute to the group's goal. We saw earlier that the personal instrumental achievers use aspects of the self to achieve their objective. Also, the personal instrumental achievers usually define their own goals and, at the same time, retain control over the means and ends to achieve their objectives.

The program managers may simply be too far removed from the projects to rely on their personal charm and persuasiveness to achieve project success. Further, the program managers are acting as agents to achieve project goals with which they may not agree. This combination would explain why, at this project management level, the personal instrumental achieving style is negatively related to project success.

The collaborative relational achieving style is more akin to a program management level where program managers must work with different groups to achieve project objectives. The program managers are ill–advised to establish their own goals that may not be consonant with the project's goals. At this management level, the project managers are expected to contribute toward project goals that were previously established as a consequence of a prior contractual commitment.

The regressions for the project engineers alone resulted in R = .69, indicating 48% (R^2) of the variance in GJOBR is explained by the independent variables. The independent variables are the managers' skill in reacting to the needs of others (VARM06) and their personal instrumental achieving style (PERINST4). Both independent variables are positively related to project success.

Project engineers are the lowest level of project management studied in this research. They typically do not wield the same authority as program and project managers. The positive relationship which the personal instrumental achieving style has to project success may reflect the project engineers' use of their personal attributes and past accomplishments to achieve their goals.

This level of project management is closest to the day–to–day operational problems of the project and may have a greater knowledge of the technical aspects of the project. This knowledge is frequently exercised in the form of "expert power" (French and Raven, 1959). The results suggest the project engineers use their personal skills and are sensitive to the reaction of others when applying their expert power to achieve project success. This would explain the positive relation which the managers' skill in reacting to the needs of others (VARM06) has to project success.

Corporate Management Level

Three management subsets were created with a common management level between pairs of subsets for this evaluation. The management subsets were: 1) senior, upper, and middle level managers; 2) middle level managers, supervisors, and non–supervisory professionals; and 3) supervisors and non–supervisory professionals. The middle level managers are the common management level in subsets 1 and 2. The supervisors and non–supervisory professionals are the common management level in subsets 2 and 3.

The regression for the management subset of senior, upper, and middle level managers resulted in $R = .69$, indicating that 47% (R^2) of the variance is explained by the independent variables. The independent variables are the manager's collaborative relational achieving style (COLLREL7) and their competitive direct achieving style (COMPDIR2). The former is positively related to project success and the latter is negatively related to project success.

The positive relation of the collaborative relational achieving style to project success is expected at this management level. Collaborative relational achievers prefer to form or join a work group to achieve objectives. They usually expect to share both the rewards and responsibilities for the group's accomplishments. They accept the group goal and they may or may not determine the means by which they contribute to the group's goal.

Conversely, the competitive direct achieving style at this management level would detract from project success. Competitive direct achievers, even on group tasks, rank their own contribution relative to that made by others and always want to outdo others. They may have very high internal standards of excellence, but are more concerned with external standards of excellence by which they may be compared to other competitors. Direct achievers generally determine their own goals and usually the means for pursuing them.

The competitive direct achievers do not lend themselves to situations where group cohesiveness is essential to project success.

The regression for the management subset of middle managers, supervisors, and non-supervisory personnel resulted in R = .71, indicating that 50% (R^2) of the variance is explained by the independent variables. The independent variables are: 1) the manager's reliant instrumental achieving style (RELINST6); 2) their competitive direct achieving style (COMPDIR2); 3) their personal instrumental achieving style (PERINST4); and 4) their ability to engage in politics and power (VARM30). Three of these variables (i.e., RELINST6, PERINST4, and VARM30) are positively related to project success. The fourth variable (COMPDIR2) is negatively related to project success.

The positive relation of the two achieving styles to project success is neatly summarized in the positive relation which the variable (VARM30), defining the managers' ability to engage in power and politics, has to project success. The reliant instrumental achievers routinely look to others to advise, encourage, or otherwise help them accomplish their goals. They simply expect whoever is there will help carry out their task.

A manager using this style, rather than power direct, conveys a nonauthoritarian attitude. Subordinates may respond better to the behavior of a manager who acts as if s/he is depending upon a valued and trusted associate (i.e., reliant instrumental), rather than ordering or delegating tasks in an authoritarian manner (i.e., power direct) to a subordinate.

Personal instrumental achievers use aspects of the self to achieve their goals. Personal instrumental achievers may use their charm, wit, or intelligence to persuade others to engage their commitments to the personal instrumental achiever's task. This management level subset is the one generally charged with project task completion. These two achieving styles reflect the political strategies which these managers may employ in achieving their objectives. Certainly, the managers' effectiveness in the use of power and politics (VARM30) is consistent with such tactics.

Even at this management level the negative relationship to project success of a competitive direct achieving style is emphasized. Those managers who use this achieving style are quite likely to discourage "team-work" and encourage hostility with an associated decline in group morale.

The regressions for these two management subsets resulted in a single independent variable appearing in both regressions. This suggests that this independent variable (COMPDIR2) is associated with the middle level managers that are in both management subsets.

The regression for the management subset of supervisors and non-supervisory professionals resulted in R = .75, indicating 56% (R^2) of the variance is explained by the independent variables. The independent variables are the manager's effectiveness in coordination (VARM26), their contributory relational achieving style (CONTREL8), and their ability to organize and present information clearly and convincingly (VARM13). The first variable (VARM26) is positively related to project success and the other two (i.e., CONTREL8 and VARM13) are negatively related to project success.

This corporate management subset, consisting of supervisors and non-supervisory professionals, includes the 21 project engineers in this research. As a management subset, these managers effectiveness in coordinating personal and group work structures, processes, and tasks (VARM26) is positively related to project success.

Their contributory relational achieving style (CONTREL8) is negatively related to project success. Contributory relational achievers contribute actively and directly to another's achievement. They experience a sense of achievement by facilitating or contributing to someone else's successful performance. Further, they accept as their own the goals defined by other achievers. They frequently play a "behind-the-scenes" role.

The negative relationship this achieving style has to project success may be explained by looking at the achieving styles of the project engineers. They have a high intrinsic direct achieving style score ($\underline{M}$ = 5.65; $\underline{SD}$ = 0.64) compared to their contributory relational achieving style score ($\underline{M}$ = 4.87; $\underline{SD}$ = 0.81). Intrinsic direct achievers rely primarily on themselves and generally maintain control over the means and ends to their objectives. The contributory relational achieving style does not appear amenable to project success at the project engineer level. A more directive or task oriented role may be necessary at the day-to-day operational level.

The final independent variable in this regression (VARM13) reflects the managers' ability to effectively organize and present information. This variable's negative relationship to project success may reflect the inability of the managers at this level to "sell" their management on the need for specific technology, capital, or human resources that would contribute to project success.

There were no independent variables that appeared in the regressions against both management subsets 2 and 3 which could be directly attributed to the supervisors and non-supervisory professionals.

Comparison of Management Levels

The result of the regressions against the managers' subjective rating of project success (GJOBR) are mixed. The variance explained in project success, when controlling for project management level, was nearly the same for the two project management subsets examined. The principal independent variables which explained the variance are, for the most part, positively related to project success. The results were about the same when evaluating specific project management levels.

The variance explained in project success, when controlling for corporate management level, exhibited similar results to those obtained when controlling for project management level. The variance explained in project success was about the same for the three corporate management subsets. The principal independent variables resulting from the regressions were positively related to project success.

There were three independent variables that appear related to a specific management level when evaluating the manager's contribution to the manager's rating of project success (GJOBR). These variables (i.e, RELINST6, COMPDIR2, and PERINST4) appeared in the regressions against GJOBR for the management subsets consisting of: 1) project managers and project engineers; and 2) middle managers, supervisors, and non-supervisory professionals. This result is expected as the project managers and project engineers consist principally of middle managers, supervisors, and non-supervisory professionals.

TABLE 5.9

HYPOTHESIS 2

PROJECT SUCCESS ASSESSED BY
PROJECT MANAGEMENT LEVEL

DEPENDENT VARIABLE

GJOBR Managers' rating of project success

PROGRAM AND PROJECT MANAGERS: n = 32

$R = .69$ $R^2 = .48$ Adj $R^2 = .43$ $F = 8.6$ SIG $F = .0003$

INDEPENDENT VARIABLES

		BETA	SIG
VARM26	Managers' effectiveness in coordination	0.63	.00
VARM13	Managers' ability to organize and present information clearly	–0.52	.00
RELINST6	Reliant–instrumental achieving style	0.34	.02

PROJECT MANAGERS AND PROJECT ENGINEERS: n = 32

$R = .67$ $R^2 = .44$ Adj $R^2 = .38$ $F = 7.5$ SIG $F = .0008$

INDEPENDENT VARIABLES

		BETA	SIG
RELINST6	Reliant–instrumental achieving style	0.42	.01
PERINST4	Personal–instrumental achieving style	0.36	.02
COMPDIR2	Competitive–direct achieving style	–0.30	.04

PROGRAM MANAGERS: n = 21

$R = .64$ $R^2 = .41$ Adj $R^2 = .34$ $F = 6.2$ SIG $F = .0087$

INDEPENDENT VARIABLES

		BETA	SIG
COLLREL7	Collaborative–relational achieving style	0.57	.01
PERINST4	Personal–instrumental achieving style	–0.41	.04

PROJECT ENGINEERS: n = 21

$R = .69$ $R^2 = .48$ Adj $R^2 = .42$ $F = 8.3$ SIG $F = .0028$

INDEPENDENT VARIABLES

		BETA	SIG
VARM06	Managers' skill in reacting to needs of others	0.54	.01
PERINST4	Personal–instrumental achieving style	0.51	.01

TABLE 5.10

HYPOTHESIS 2

PROJECT SUCCESS ASSESSED BY
CORPORATE MANAGEMENT LEVEL

DEPENDENT VARIABLE

GJOBR Managers' rating of project success

SENIOR, UPPER, AND MIDDLE LEVEL MANAGERS: $n = 29$

$R = .69$ $R^2 = .47$ Adj $R^2 = .43$ $F = 11.6$ SIG $F = .0002$

INDEPENDENT VARIABLES		BETA	SIG
COLLREL7	Collaborative–relational achieving style	0.68	.00
COMPDIR2	Competitive–direct achieving style	–0.40	.01

MIDDLE MANAGERS, SUPERVISORS, AND NON-SUPERVISORY: $n = 41$

$R = .71$ $R^2 = .50$ Adj $R^2 = .45$ $F = 9.2$ SIG $F < .0001$

INDEPENDENT VARIABLES		BETA	SIG
RELINST6	Reliant–instrumental achieving style	0.51	.00
COMPDIR2	Competitive–direct achieving style	–0.50	.00
PERINST4	Personal–instrumental achieving style	0.34	.01
VARM30	Managers' ability to engage in power and politics	0.33	.02

SUPERVISORS AND NON-SUPERVISORS: $n = 25$

$R = .75$ $R^2 = .56$ Adj $R^2 = .49$ $F = 8.8$ SIG $F = .0006$

INDEPENDENT VARIABLES		BETA	SIG
VARM21	Managers' effectiveness in coordination	0.81	.00
CONTREL8	Contributory–relational achieving style	–0.60	.00
VARM13	Managers' ability to organize and present information clearly and convincingly	–0.42	.01

Summary

The results obtained from the four sets of regressions support this hypothesis which claims the higher the management level, the less effective leadership characteristics alone have on project success.

The managers' leadership characteristics contribution to project success were evaluated by controlling for both the managers' corporate and project management level. Two measures of project success were used: the weighted objective score of project success (GAATOTAL), and the managers' objective rating of project success (GJOBR).

The regressions of the project managers' leadership characteristics, against the weighted objective score of project success (GAATOTAL), indicate a greater percent of the variance in project success is accounted for by the lower tier project engineers. The project engineers' leadership characteristics account for 44% (R^2) of the variance in GAATOTAL as opposed to only 23% (R^2) for the program managers. The difference isn't as pronounced in the regressions against GJOBR. Here, the project engineers' leadership characteristics account for 48% (R^2) of the variance in project success as opposed to 41% (R^2) for the program managers.

The regressions of the corporate managers' leadership characteristics revealed similar, although not as marked, results. This is seen principally in the regression of leadership characteristics against the managers' rating of project success (GJOBR). The regressions for the lower tier corporate managers (i.e., supervisors and nonsupervisory professionals) explain 56% (R^2) of the variance in GJOBR compared to 47% (R^2) for the upper tier corporate managers (i.e., senior, upper, and middle level managers).

The leadership characteristics which explain the variance in project success are different depending on whether they are regressed against GAATOTAL or GJOBR. The relationship of the independent variables to the weighted objective score of project success (GAATOTAL) is principally negative. The leadership characteristics represented by these independent variables are task oriented.

The independent variables resulting from the regressions against the managers subjective rating of project success (GJOBR) have, for the most part, a positive relationship to project success. The leadership characteristics represented by these independent variables are politically-oriented. Principal among the leadership characteristics are the reliant instrumental and personal instrumental achieving styles. The combination of these two achieving styles suggests the project managers are adept at using politics to achieve their objectives. The relationships and networks they establish and use are instrumental factors in their achieving project success.

Hypothesis 3

This hypothesis examines the effect leadership characteristics and management controls have on project success. Leadership characteristics and management controls were evaluated separately and then evaluated in combination. Two sets of regressions were performed. The first was performed on the weighted score of project success (GAATOTAL). The second was performed on the managers' rating of project success (GJOBR).

Multiple regressions were performed using the SPSS/X REGRESSION procedure with stepwise entry. The variables used in the regressions are those outlined in Table 3.2. To guard against multicollinearity, TOLERANCE is set at 0.25. To ensure significance of results, PIN is set at 0.05 and POUT is set at 0.10. The significance of the parameters TOLERANCE, PIN, and POUT is defined in the notes at the end of this chapter.

More than 50 variables were used in these regressions. A visual inspection of the frequencies of occurrence indicated there were only two variables which had missing data points in this analysis. Thus, the variables' mean was substituted for the missing data. The results of the regressions are shown in Tables 5.11 and 5.12.

Weighted Scores of Project Success: GAATOTAL

Leadership Characteristics

The R for this regression, Table 5.11, is 0.42 indicating the independent variables account for 18% (R^2) of the variance in the weighted score of project success (GAATOTAL). The principal independent variable is the managers' competitive direct achieving style (COMPDIR2), which is negatively related to project success. This variable reflects the managers' concern with their individual performance. They thrive in competitive situations, and their satisfaction comes from outperforming others. The negative relation here to project success indicates they place their individual accomplishments ahead of the project's. It may also reflect that they compete with, rather than help, support, or collaborate with, the people they manage.

The other independent variable, which reflects the managers' vicarious relation achieving style (VICREL9), is positively related to project success. This indicates a willingness of the managers to accept and identify with the goals selected by others. They may even offer encouragement and praise, but do not actively or directly participate in the actual task accomplishment to which the others strive.

These results are interpreted to mean that encouragement and praise by the project manager is more apt to contribute to project success than direct participation in the project by the project manager. This is particularly true if the project manager and the project team members concur on the projects' objectives and do not feel a need to compete with team members to show they are more able.

Management Controls

The R for this regression is 0.48, indicating the independent variables account for 23% (R^2) of the variance in the weighted score of project success (GAATOTAL). Two independent variables (GSEFF and GFP) resulted from this regression and both were positively related to project success. The first variable reflects the managers' assessment of schedule control effectiveness on the project (GSEFF). The second indicates that project success is related to performing on a fixed price contract (GFP).

The two variables complement one another. A prime concern of managers on a fixed price contract is to control costs. If they can control the schedule and deliver the projects on time they are very likely to also control costs. In this context, the project managers would view schedule control as a very effective measure in ensuring project success.

Leadership Characteristics
and Management Controls

Combining these two dimensions increased R to 0.66 indicating that 44% (R^2) of the variance in the dependent variable defining project success (GAATOTAL) is accounted for

TABLE 5.11

HYPOTHESIS 3

PROJECT SUCCESS ASSESSED BY LEADERSHIP CHARACTERISTICS AND MANAGEMENT CONTROLS

DEPENDENT VARIABLE

GAATOTAL Weighted score of project success

LEADERSHIP CHARACTERISTICS ALONE: n = 55

$R = .43$ $R^2 = .18$ Adj $R^2 = .15$ $F = 5.8$ SIG $F = .0052$

INDEPENDENT VARIABLES

		BETA	SIG
COMPDIR2	Competitive–direct achieving style	–0.40	.00
VICREL9	Vicarious–relational achieving style	0.26	.05

MANAGEMENT CONTROLS ALONE: n = 55

$R = .48$ $R^2 = .23$ Adj $R^2 = .20$ $F = 7.8$ SIG $F = .0011$

INDEPENDENT VARIABLES

		BETA	SIG
GSEFF	Managers' assessment of schedule control effectiveness	0.40	.00
GFP	The project is performed on a FP contract	0.30	.00

LEADERSHIP CHARACTERISTICS AND MANAGEMENT CONTROLS: n = 55

$R = .66$ $R^2 = .44$ Adj $R^2 = .39$ $F = 7.5$ SIG $F < .0001$

INDEPENDENT VARIABLES

		BETA	SIG
VARM31	Managers' effectiveness in supporting organizations' overall mission and goals	–0.33	.00
GFP	The project is performed on a FP contract	0.32	.00
GSEFF	Managers' assessment of schedule control effectiveness	0.31	.01
VARM23	Managers' ability to resolve conflicts	–0.26	.02
GCORP	Project control imposed by the corporation	0.21	.04

by the independent variables. This lends support to this hypothesis that claims the combination of leadership characteristics and management controls will lead to project success greater than that achieved by leadership characteristics or management controls alone.

There are five independent variables which account for the variance. The principal independent variable reflects the managers' effectiveness in supporting the organizations' mission and goals (VARM31) and is negatively related to project success (GAATOTAL). The negative relationship this variable has to project success suggests the managers cannot identify with the organizations' overall mission and goals. Without clearly defined objectives, the managers would have difficulty in guiding a project to a successful conclusion. This may also explain the negative relation which the managers' ability to resolve conflicts (VARM23) has with project success. The managers' ability to resolve conflicts among competing projects for resources or even conflicts within the project organization is severely limited if objectives are unclear or unknown.

The next most significant variables are the performance of the project on a fixed price contract (GFP) and the effectiveness of schedule control on the project (GSEFF). Both variables are positively related to project success (GAATOTAL). These same independent variables explained the variance in GAATOTAL when management controls were considered alone. The last variable which contributes to an explanation of the variance is also positively related to project success. This variable indicates that corporate management controls imposed on the project (GCORP) contribute to project success.

Managers' Rating of Project Success: GJOBR

Leadership Characteristics

The R for this regression, shown in Table 5.12, was 0.66, indicating the independent variables accounted for 44% (R^2) of the variance in project success (GJOBR). There were two achieving styles contributing to the explanation of this variance. The first relates to the managers' reliant instrumental achieving style (RELINST6) and is positively related to project success (GJOBR). This achieving style is associated with those managers who are reliant on others to assume part or all of the responsibility of their assigned task. These managers expect whoever is there, and over whom they have little authority or control, will help complete the task. The managers expect others to help them. If they don't have the authority to demand help, they will resort to requesting help. It also probably means that even though they have the authority to demand help, the managers approach their people in a less authoritarian way. They act as if they are requesting, rather than demanding, assistance. It is an indirect method of signaling equality and partnership.

The second achieving style reflects a competitive direct achieving style (COMPDIR2) and is negatively related to project success (GJOBR). This achieving style is associated with the manager whose overall concern is to outdo others. These managers view every situation as a competitive encounter and derive satisfaction from outperforming others. A manager who frequently uses this achieving style may create a hostile atmosphere in which team members compete for individual recognition, rather than collaborate as a group to achieve project success.

The managers' ability to engage in power and politics to achieve personal and group goals (VARM30) is positively related to project success (GJOBR). This activity, if conducted within the legitimate bounds of power, is conducive to project success. The last independent variable represents the managers' ability to organize and present information clearly and convincingly (VARM13). This variable is negatively related to project success (GJOBR). This variable was seen to affect project success at the lower level of corporate management, i.e., supervisors and non-supervisory professionals, when evaluating the results of Hypothesis 2. The indication here is that an inability to convey important information upward, or even downward, will have a negative effect on project success.

Management Controls

The R in this regression is 0.72, which indicates the independent variables defining management controls account for 51% (R^2) of the variance in project success (GJOBR). All of the variables are positively related to project success. The principal independent variable indicates Performance Evaluation Review Techniques/Critical Path Method (GPERTC) are used on the projects. The next two variables (GBCON and GSEFF) appear related to

GPERTC. Budget control is imposed on the projects (GBCON) and the managers assess the use of schedule control as effective in achieving project success (GSEFF). The implication is that management controls do contribute to project success in so far as budget and schedule controls are concerned.

Leadership Characteristics
and Management Controls

The combination of leadership characteristics and management controls, when regressed against the managers' rating of project success (GJOBR), did not improve R or an explanation of the variance in GJOBR any more than the regression of management controls alone against GJOBR. The question is then asked if the subjective rating of project success (GJOBR) by the managers is insensitive to factors other than the controls imposed on the projects and the results seen from the imposition of these controls? The results of this regression indicate the managers are insensitive to the indirect factors, i.e., leadership characteristics and their impact on project success. The results do indicate, however, that they are more sensitive to the controls placed on the projects and the contribution these controls have in meeting project objectives.

Summary

The results of the regressions performed against the weighted objective score of project success (GAATOTAL) support the hypothesis. This same result was not obtained for the regressions against the managers' subjective rating of project success (GJOBR). The difference suggests that the managers are more sensitive to management controls placed on the projects and the contribution these controls make toward achieving project success. The regressions performed against the independent variables by either measure of project success (GAATOTAL or GJOBR) indicate that the effect of management controls alone on project success are greater than the leadership characteristics alone. This is not totally unexpected as financial controls are frequently considered to be the primary management control technique in project management.

TABLE 5.12

HYPOTHESIS 3

PROJECT SUCCESS ASSESSED BY LEADERSHIP CHARACTERISTICS AND MANAGEMENT CONTROLS

DEPENDENT VARIABLE

GJOBR — Managers' rating of project success

LEADERSHIP CHARACTERISTICS ALONE; n = 55

$R = .66$ $R^2 = .44$ Adj $R^2 = .38$ $F = 7.7$ SIG $F < .0001$

INDEPENDENT VARIABLES

		BETA	SIG
RELINST6	Reliant-instrumental achieving style	0.47	.00
COMPDIR2	Competitive-direct achieving style	–0.42	.00
VARM30	Managers' ability to engage in gamesmanship to achieve objectives	0.41	.00
VARM13	Managers' ability to organize and present information clearly and convincingly	–0.26	.04

MANAGEMENT CONTROLS ALONE; n = 55

$R = .72$ $R^2 = .51$ Adj $R^2 = .48$ $F = 17.8$ SIG $F = .0001$

INDEPENDENT VARIABLES

		BETA	SIG
GPERTC	PERT/C is used for project control	0.32	.03
GBCON	Budget control is exercised on the project	0.29	.03
GSEFF	Managers' assessment of schedule control effectiveness	0.24	.05

LEADERSHIP CHARACTERISTICS AND MANAGEMENT CONTROLS; n = 55

$R = .72$ $R^2 = .51$ Adj $R^2 = .48$ $F = 17.8$ SIG $F = .0001$

INDEPENDENT VARIABLES

		BETA	SIG
GPERTC	PERT/C is used for project control	0.32	.03
GBCON	Budget control is exercised on the project	0.29	.03
GSEFF	Managers' assessment of schedule control effectiveness	0.24	.05

Managerial skills are often overlooked because of the emphasis on financial control. This is seen when the managers' rating of project success (GJOBR) is regressed against the combined independent variables that define leadership characteristics and management controls. The same result is obtained as when GJOBR was regressed against the independent variables defining management controls alone. When, however, the objective weighted score of project success (GAATOTAL) was regressed against the combined set of independent variables slightly different results were obtained. Leadership characteristics did appear in the regression equation which accounted for the variance in GAATOTAL. The hypothesis is supported.

FOOTNOTES

[1] Variables which are almost linear combinations of other independent variables are often called multicollinear. A regression equation in which the independent variables are multicollinear will exhibit a significant R^2 although few of the coefficients are significantly different than zero. If a variable has a large R^2, or equivalently a small tolerance (0.01), the potential exists that the variables are multicollinear. To protect against this occurrence in the small data set, TOLERANCE was set at 0.25.

[2] The parameters PIN and POUT are used in the stepwise entry process to ensure the independent variables which are finally selected (from the full range of candidate variables) for inclusion in the regression equation fall within a specified range of significance. Setting PIN at 0.05 precludes a variable from entering the regression unless its "probability of F–to–enter" is less than or equal to 0.05. Similarly, setting POUT to 0.10 will cause a variable to be removed from the regression if its significance has degraded during the stepwise process.

One final item should be noted. To account for variability in sampling, the number of samples (N) should be large relative to the number of variables (K) used in the statistical process. A general rule of thumb suggests $N > 10K$ to help ensure the resulting solution is stable. See for example, Leonora A. Marasciulo and Joel R. Levin, Multvariate Statistics in the Social Sciences: A Researcher's Guide (Monterey, Ca.:Brooks/Cole Publishing Co., 1983):p. 202. The regression results presented have generally followed this rule of thumb. The statistics for the regression (R, R^2, F, etc.) are those based on the independent variables which remain at the conclusion of the stepwise process, or where $N \approx 10K$.

[3] The identification of a high, low, or middle LPC leadership style is predicated on the score achieved on the self–administered Least Preferred Co–Worker Scale. A relational–oriented leadership style (i.e., high LPC) is said to exist if an individual's score is 94 or above. On the other hand, a task–oriented leadership style (i.e., low LPC) is associated with those individuals who score 54 or below. A relational/task–oriented leadership style is assigned to those whose scores range from 55 to 93.

CHAPTER 6

ANALYTICAL RESULTS

Hypotheses 4 – 6

The analytical results of hypotheses 4 – 6 are presented in this chapter. The first section presents the results of hypothesis 4 which evaluates the effect of project size, technical composition, and technological complexity on project success. The second section presents the results of hypothesis 5 which examines the effect of the managers' training, education, and experience on project success. The final section reviews the results of hypothesis 6 which addresses how the needs for power (n Pow) and achievement (n Ach), achieving styles, and leadership styles affect managers' success.

Hypothesis 4

This hypothesis addresses the project dimensions of size, technical composition, and technological complexity on project success. These three factors were chosen as they represent three most critical characteristics affecting project success. Projects were grouped according to size as either, small, medium, or large as defined in Table 5.1. The projects' technical composition was determined on the basis of software content in the project. The projects' technological complexity was based on the projects' content of hardware and software combined mathematically with the technological complexity of each as rated by the respondents.

The two dependent variables used to evaluate this hypothesis were the weighted score of project success (AATOTAL) and the managers' rating of project success (JOBR). Multiple regressions were run against these variables using the SPSS/X REGRESSION procedure with stepwise entry and forced entry. Single regressions were also run using forced entry. The variables used in the regressions are those outlined in the research design in Table 3.2. To guard against multicollinearity, TOLERANCE is set at 0.25[1]. To ensure significance of results, PIN is set at 0.05 and POUT is set at 0.10[2]. Missing data are handled by pairwise deletion. Correlation among the variables was determined using the SPSS/X PEARSON CORR procedure. The results of the analysis are shown in Tables 6.1 through 6.7.

Project Size, Composition, and Complexity

The independent variables used in this evaluation consisted of the project size (SIZE or JSIZE), the percent of software used on the project (SW), and the overall project complexity (JOBCMP). This latter variable was constructed mathematically as shown in equation 6.1.

6.1 JOBCMP = ((HW*HWCOMP) + (SW*SWCOMP))

The variables comprising this equation are the percent of hardware (HW) and software (SW) which comprise the projects, and the managers' rating of the hardware complexity (HWCOMP) and software complexity (SWCOMP) used on the projects. The results of the regressions of these independent variables on the dependent variables defining project success (AATOTAL and JOBR) are shown in Tables 6.1 through 6.4.

The project size is the driving dimension related to project success whether evaluated by the weighted score of project success (AATOTAL) or the managers' rating of project success (JOBR). When size is determined by the projects' engineering value (VALUEEK), Table 6.1, R for AATOTAL is 0.35 indicating the independent variable defining project size (SIZE) accounts for 12% (R2) of the variance in project success (AATOTAL). When size is determined by the projects' contract value (VALUEJK), Table 6.2, R for AATOTAL is 0.24 indicating the independent variable defining the projects' contract size (JSIZE) accounts for 6% (R^2) of the variance in project success (AATOTAL). The decline in the variance accounted for in the dependent variable is attributed to factors beyond just the variables examined in this research. As the total project value includes the building of prototype or development equipment, this difference is assumed to be related to factors outside of the engineering jurisdiction, i.e., production.

The independent variables defining project size (SIZE and JSIZE) are negatively related to project success. This indicates that as the project size increases, project success declines. A similar negative relationship of the independent variable to project success is seen in Table 6.3. When project size is defined by the projects' engineering value (VALUEEK), R for JOBR is 0.23 indicating the independent variable defining project size (SIZE) accounts for 5% (R^2) of the variance in project success (JOBR). There was no regression on JOBR by the independent variable defining the projects' size (JSIZE) as seen in Table 6.4. The relationship of the project size to project success is illustrated in Table 6.5.

The preceding regressions were performed using stepwise entry of the independent variables. Forced entry to the regression was required to evaluate the effect of software content and technological complexity on project success. The results of these regressions are also shown in Tables 6.1 through 6.4.

In each instance, the forced entry of the independent variables defining the percent of software used on the project (SW) and the project complexity (JOBCMP) with project size (SIZE or JSIZE) reduced the significance of the regression equation against the dependent variables defining project success (AATOTAL and JOBR). The relationship of SW and JOBCMP is negatively related to project success indicating that as software content increases or the projects' technological complexity increases, project success declines. The forced entry of SW and JOBCMP in the regression against project success (AATOTAL or JOBR) only accounted for between 2% to 3% of the variance explained in the dependent variable. There was little significance to these independent variables when accounting for project success. The findings do support the hypothesis that project size is negatively related to project success. The effect, however, on project success of software content and technological complexity would appear to be less significant. This initial analysis is supported by the correlations of SW and JOBCMP to SIZE and JSIZE in Table 6.6. The means of the variables shown in Table 6.7 summarize this analysis of how size affects project success. As project success (SUCCESS) declines from its highest rating (1) to its lowest rating

TABLE 6.1

HYPOTHESIS 4

THE EFFECT OF PROJECT SIZE (VALUEEK)
ON PROJECT SUCCESS

DEPENDENT VARIABLE

AATOTAL Weighted score of project success

$R = .35$ $R^2 = .12$ Adj $R^2 = .11$ $F = 11.9$ SIG $F = .0009$

INDEPENDENT VARIABLE

		BETA	SIG
SIZE	Project size defined by the projects' engineering value	–0.35	.00

FORCED ENTRY OF SW WITH SIZE

$R = .31$ $R^2 = .10$ Adj $R^2 = .08$ $F = 6.5$ SIG $F = .0020$

INDEPENDENT VARIABLE

		BETA	SIG
SIZE	Project size defined by the projects' engineering value	–0.31	.00

FORCED ENTRY OF JOBCMP WITH SIZE

$R = .35$ $R^2 = .12$ Adj $R^2 = .10$ $F = 6.0$ SIG $F = .0037$

INDEPENDENT VARIABLE

		BETA	SIG
SIZE	Project size defined by the projects' engineering value	–0.33	.00

FORCED ENTRY OF SW WITH JOBCMP

$R = .16$ $R^2 = .02$ Adj $R^2 = .01$ $F = 1.5$ SIG $F = .2219$

INDEPENDENT VARIABLES

		BETA	SIG
SW	Project software content	–0.06	.52
JOBCMP	Project's technological complexity	–0.14	.14

TABLE 6.2

HYPOTHESIS 4

THE EFFECT OF PROJECT SIZE (VALUEJK)
ON PROJECT SUCCESS

DEPENDENT VARIABLE

AATOTAL Weighted score of project success

$R = .24$ $R^2 = .06$ Adj $R^2 = .05$ $F = 5.4$ SIG $F = .0223$

INDEPENDENT VARIABLE

		BETA	SIG
JSIZE	Project size defined by the projects' total value	–0.24	.02

FORCED ENTRY OF SW WITH SIZE

$R = .24$ $R^2 = .06$ Adj $R^2 = .04$ $F = 2.8$ SIG $F = .0637$

INDEPENDENT VARIABLE

		BETA	SIG
JSIZE	Project size defined by the projects' total value	–0.23	.03

FORCED ENTRY OF JOBCMP WITH SIZE

$R = .26$ $R^2 = .07$ Adj $R^2 = .05$ $F = 3.1$ SIG $F = .0477$

INDEPENDENT VARIABLE

		BETA	SIG
JSIZE	Project size defined by the projects' total value	–0.21	.06

FORCED ENTRY OF SW WITH JOBCMP

$R = .18$ $R^2 = .03$ Adj $R^2 = .01$ $F = 1.6$ SIG $F = .2128$

INDEPENDENT VARIABLES

		BETA	SIG
SW	Project software content	–0.06	.54
JOBCMP	Project's technological complexity	–0.15	.13

TABLE 6.3

HYPOTHESIS 4

THE EFFECT OF PROJECT SIZE (VALUEEK)
ON PROJECT SUCCESS

DEPENDENT VARIABLE

JOBR Managers' rating of project success

$R = .23$ $R^2 = .05$ Adj $R^2 = .04$ $F = 5.3$ SIG $F = .0238$

INDEPENDENT VARIABLE

		BETA	SIG
SIZE	Project size defined by the projects' engineering budget	–0.23	.02

FORCED ENTRY OF SW WITH SIZE

$R = .22$ $R^2 = .05$ Adj $R^2 = .03$ $F = 3.1$ SIG $F = .0496$

INDEPENDENT VARIABLE

		BETA	SIG
SIZE	Project size defined by the projects' engineering budget	–0.20	.03

FORCED ENTRY OF JOBCMP WITH SIZE

$R = .21$ $R^2 = .05$ Adj $R^2 = .03$ $F = 2.9$ SIG $F = .0600$

INDEPENDENT VARIABLE

		BETA	SIG
SIZE	Project size defined by the projects' engineering budget	–0.19	.04

FORCED ENTRY OF SW WITH JOBCMP

$R = .15$ $R^2 = .02$ Adj $R^2 = .00$ $F = 1.2$ SIG $F = .3165$

INDEPENDENT VARIABLES

		BETA	SIG
SW	Project software content	–0.09	.34
JOBCMP	Project's technological complexity	–0.10	.32

TABLE 6.4

HYPOTHESIS 4

THE EFFECT OF PROJECT SIZE (VALUEJK) ON PROJECT SUCCESS

DEPENDENT VARIABLE

JOBR Managers' rating of project success

INDEPENDENT VARIABLE

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

FORCED ENTRY OF SW WITH JSIZE

$R = .18$ $R^2 = .03$ Adj $R^2 = .01$ $F = 1.8$ SIG $F = .1662$

INDEPENDENT VARIABLE

		BETA	SIG
JSIZE	Project size defined by the projects' total value	–0.13	.14

FORCED ENTRY OF JOBCMP WITH JSIZE

$R = .16$ $R^2 = .03$ Adj $R^2 = .01$ $F = 1.7$ SIG $F = .1913$

INDEPENDENT VARIABLE

		BETA	SIG
JSIZE	Project size defined by the projects' total value	-0.13	.18

FORCED ENTRY OF SW WITH JOBCMP

$R = .14$ $R^2 = .02$ Adj $R^2 = .00$ $F = 1.2$ SIG $F = .3165$

INDEPENDENT VARIABLES

		BETA	SIG
SW	Project software content	–0.09	.34
JOBCMP	Project's technological complexity	–0.10	.32

TABLE 6.5
HYPOTHESIS 4
PROJECT SUCCESS BY PROJECT SIZE

PROJECT SIZE	PROJECT SUCCESS 1[a]	2[b]	3[c]	4[d]
Small	18	5	4	5
Medium	8	4	10	3
Large	7	6	6	15
TOTALS	33	15	20	23

[a]Good to outstanding
[b]Average to good
[c]Marginal to average
[d]Unsatisfactory

(4), project technological complexity (JOBCMP), project size (SIZE and JSIZE), and software content in the project (SW) all increase.

From the author's practical experience, software content and the overall projects' technological complexity appear to have a greater impact on project success than that revealed in the foregoing regressions. To assess if practical experience and intuition were correct, additional regressions were performed. We shall now turn to a discussion of these additional regressions.

Projects' Software Content

The affect of software content on project success (AATOTAL and JOBR) was evaluated using stepwise multiple regressions with the independent variables described in Table 3.2. Missing data were handled using pairwise deletion. A distinction was made as to whether the software constituted more than 30% of the projects' engineering value or was equal to or less than 30% of the projects' engineering value. This division point was chosen

TABLE 6.6
HYPOTHESIS 4
CORRELATIONS

	SUCCESS	AATOTAL	JOBR	SIZE	JSIZE	JOBCMP
SUCCESS[a]	1.00 n(109) .					
AATOTAL[b]	–0.97 n(109) p<.001	1.00 n(109) .				
JOBR[c]	–0.42 n(108) p<.001	0.43 n(108) p<.001	1.00 n(120) .			
SIZE[d]	0.33 n(90) p=.001	–0.35 n(90) p<.001	–0.23 n(95) p=.012	1.00 n(96) .		
JSIZE[e]	0.23 n(92) p=.013	–0.24 n(92) p=.011	–0.16 n(97) p=.055	0.88 n(94) p<.001	1.00 n(99) .	
JOBCMP[f]	0.17 n(100) p=.044	–0.17 n(100) p=.049	–0.11 n(111) p=.117	0.36 n(94) p<.001	0.31 n(97) p=.001	1.00 n(113) .
SW[g]	0.10 n(100) p=.158	–0.19 n(100) p=.184	–0.11 n(110) p=.126	0.18 n(94) p=.039	0.14 n(97) p=.083	0.18 n(112) p=.027

[a] The ranking of project success
[b] Weighted score of projects' success
[c] Managers' rating of project success
[d] Project size based on engineering value
[e] Project size based on contract value
[f] Projects' technological complexity
[g] Projects' software content

TABLE 6.7

HYPOTHESIS 4

MEANS AND STANDARD DEVIATIONS
OF VARIABLES

	SIZE[a]		JOBCMP[b]		SW[c]	
SUCCESS[d]	M	SD	M	SD	M	SD
1	1.71	.82	3.25	1.02	.32	.31
2	2.07	.88	3.33	1.10	.34	.18
3	2.10	.72	3.67	1.16	.38	.24
4	2.41	.85	3.70	1.19	.40	.18
	JSIZE[e]		JOBCMP		SW	
SUCCESS	M	SD	M	SD	M	SD
1	1.87	.82	3.29	1.01	.32	.32
2	2.00	.89	3.29	1.07	.33	.18
3	2.15	.81	3.67	1.16	.38	.24
4	2.33	.87	3.70	1.16	.40	.18

[a] Projects' size based on engineering value

[b] Projects' complexity

[c] Projects' software content

[d] Projects' ranking of success: 1 = Good to outstanding, 2 = Average to good, 3 = Marginal to average, and 4 = Unsatisfactory

[e] Projects' size based on contract value

as it is the median point of software content on the projects evaluated in this research. The results are shown in Tables 6.8 and 6.9.

Project Software Content Equal To or Less Than 30% of Project Engineering Value

When software is equal to or less than 30% of the projects' engineering value, Table 6.8, R for AATOTAL is 0.57 indicating the independent variables account for 32% of the variance in project success (AATOTAL). Two of the three independent variables are negatively related to project success. These are the complexity of the software used on the project (SWCOMP) and the type of software used on the project (OTH). The third independent variable accounting for the variance, which is positively related to project success, is the complexity of the hardware used on the project (HWCOMP). There was no regression of the independent variables against the managers' rating of project success (JOBR).

The results suggest even when software does not constitute a major portion of the project's engineering value, the significance of the software language used and the complexity of the software are probably not understood by the project managers. The managers on these projects have more years experience in hardware design and hardware management then they do in software design and software management. Hardware complexity is not viewed as a problem on these projects and, in fact, as the regressions show, is considered to be positively related to project success. The lack of a regression of these independent variables on the managers' assessment of project success (JOBR) is taken to indicate a lack of awareness by the managers of the significance these variables play on project success.

Project Software Content More than 30% of Project Engineering Value

When software content exceeds 30% of the projects' engineering value, Table 6.9, R for AATOTAL is 0.52 indicating the independent variables account for 27% (R^2) of the variance in the dependent variable. Two independent variables, both negatively related to project success, account for the variance. The first is the complexity of the hardware used on the project (HWCOMP) and the second is the software language used on the project (ADA).

TABLE 6.8

HYPOTHESIS 4

THE EFFECT OF SOFTWARE CONTENT ON PROJECT SUCCESS

SOFTWARE CONTENT LESS THAN OR EQUAL TO 30 PERCENT OF ENGINEERING CONTENT; N = 37

DEPENDENT VARIABLE

AATOTAL Weighted score of project success

$R = .57$ $R^2 = .32$ Adj $R^2 = .18$ $F = 6.8$ SIG $F = .0024$

INDEPENDENT VARIABLES

		BETA	SIG
SWCOMP	Complexity of software used on the project	–0.46	.01
OTH	Software used on the project other than C, ADA, FORTRAN, PASCAL, or ASSEMBLY	–0.36	.02
HWCOMP	Complexity of hardware used on the project	0.33	.04

DEPENDENT VARIABLE

JOBR Managers' rating of job success

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

The negative relationship of HWCOMP to AATOTAL is interpreted to reflect a tendency to increase hardware complexity on projects on the assumption software can be used to overcome the increased hardware complexity. ADA is increasingly being used on DoD procurements which involve software. This language and the tools available for its use are still in their infancy. Until the language achieves the maturity of FORTRAN, or some other commonly used software language, the use of ADA will reflect negatively on project success. Similarly, until the software engineers and their managers become more familiar with ADA, the use of ADA is apt to reflect negatively on project success.

The evaluation of the managers' rating of project success (JOBR) on those projects containing more than 30% software content resulted in an R of 0.28. This indicates the

TABLE 6.9

HYPOTHESIS 4

THE EFFECT OF SOFTWARE CONTENT
ON PROJECT SUCCESS

SOFTWARE CONTENT GREATER THAN 30 PERCENT OF ENGINEERING CONTENT; N = 54

DEPENDENT VARIABLE

AATOTAL Weighted score of project success

$R = .52$ $R^2 = .27$ Adj $R^2 = .24$ $F = 9.6$ SIG $F = .0003$

INDEPENDENT VARIABLES

		BETA	SIG
HWCOMP	Complexity of hardware used on the project	–0.43	.00
ADA	Software used on the project is ADA	–0.39	.00

DEPENDENT VARIABLE

JOBR Managers' rating of job success

$R = .28$ $R^2 = .08$ Adj $R^2 = .06$ $F = 4.7$ SIG $F = .0348$

INDEPENDENT VARIABLE

		BETA	SIG
C	Software used on the project is C	0.28	.03

independent variable which defines the software language used (C) accounts for 8% (R^2) of the variance in the dependent variable JOBR. This independent variable is positively related to project success. In light of the foregoing remarks about ADA, this positive relationship to JOBR is interpreted to mean that C is a more mature software language than ADA and less complex than ADA. Either that, or the use of C is better understood by the software engineers and their managers, resulting in a positive relationship to project success.

Software Content and Relation to Project Success: AATOTAL

The variance explained in project success (AATOTAL) is markedly similar regardless of whether the projects' software content is less than or equal to 30% or more than 30% of the projects' engineering content. For software content less than 30%, R^2 is 32% and for software content greater than 30%, R^2 is 27%. In both instances, variables related to software, i.e., complexity (SWCOMP) and software used (OTH and ADA), are negatively related to project success. The hardware complexity (HWCOMP), however, is positively related to project success when software constitutes less than 30% of the projects' value, but negatively related to project success when software constitutes 30% or more of the projects' value. A possible explanation for this finding is that the percent of the projects' software and the projects' hardware complexity are related, i.e., the more complex the hardware, the more dependent the project is on software to overcome the hardware complexity. The result would be seen as an increased portion of the projects' engineering budget devoted to software. Additional regressions were performed to determine at what point the hardware complexity (HWCOMP) changed from a positive to negative relationship with project success.

An SPSS/X FREQUENCIES procedure was performed on the projects evaluated in this research. The purpose of performing this procedure was to divide the projects into multiple classes, defined by software content, to provide a sufficient number of projects in each class on which to perform a regression analysis. This analysis resulted in four distinct project classes. These were identified as projects in which software was less than 20%, more than 20% and less than 40%, more than 40% and less than 60%, and equal to or more than 60% of the projects' engineering content. The results of the regressions are shown in Table 6.10. The results indicate that, for this research, hardware complexity assumes a negative relation to project success when the projects' software content equals or exceeds 60% of the projects' engineering value.

TABLE 6.10

HYPOTHESIS 4

THE RELATION OF PROJECT SOFTWARE CONTENT AND HARDWARE COMPLEXITY TO PROJECT SUCCESS

DEPENDENT VARIABLE

AATOTAL Weighted score of project success

SOFTWARE LT 20% OF PROJECT CONTENT; n = 28

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

SOFTWARE GE 20% AND LT 40% OF PROJECT CONTENT; n = 30

R = .50 R^2 = .25 Adj R^2 = .22 F = 8.7 SIG F = .0067

INDEPENDENT VARIABLE

		BETA	SIG
OTH	Software other than ADA, FORTRAN, PASCAL, C or ASSEMBLY used on project	–0.50	.01

SOFTWARE GE 40% AND LT 60% OF PROJECT CONTENT; n = 31

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

SOFTWARE GE 60% OF PROJECT CONTENT; n = 23

R = .60 R^2 = .36 Adj R^2 = .32 F = 9.6 SIG F = .0066

INDEPENDENT VARIABLE

		BETA	SIG
HWCOMP	Complexity of the hardware used on the project	–0.60	.01

Project Technological Complexity

The impact of technological complexity on project success was evaluated using stepwise multiple regressions on the dependent variables defining project success (AATOTAL and JOBR) with the independent variables described in Table 3.2. Missing data were handled using pairwise deletion. A distinction was made as to whether the projects' technological complexity was equal to or greater than 3.6 or less than 3.6. This division point was chosen as it was the median point of the technological complexity on the projects evaluated in this research. The results are shown in Table 6.11.

Project Complexity Greater Than the Median Value

On those projects whose technological complexity exceeds 3.6, R for AATOTAL is 0.46, indicating the independent variables account for 21% (R^2) of the variance in the dependent variable. The two independent variables accounting for the variance are the software language used (ADA) and the software complexity (SWCOMP). Both variables are negatively related to project success. The first independent variable is not unexpected as it was also negatively related to project success when controlling for software content. Table 6.12 depicts the relationship between software complexity (SWCOMP), the software language used (ADA), and the relative ranking of project success SUCCESS). The least successful projects (SUCCESS=4) are characterized as having the most complex software (SWCOMP; $\underline{M}=3.35$) and the highest proportion of ADA software used (ADA; $\underline{M}=1.35$). There was no regression on the managers' rating of job success (JOBR).

Project Complexity Less Than the Median Value

Little insight was provided from the regressions on project success (AATOTAL and JOBR) when the projects' technological complexity was less than 3.6. There was no regression of the independent variables on AATOTAL. The regression on JOBR resulted in an R of 0.36 indicating the independent variable accounted for 13% (R^2) of the variance in the dependent variable. The independent variable representing the projects' engineering value (VALUEEK) is negatively related to project success (JOBR). This supports the earlier finding that project size is a significant determinant to project success. If all other factors remain constant, increased project size alone will result in less successful projects.

TABLE 6.11

HYPOTHESIS 4

THE EFFECT OF JOB COMPLEXITY
ON PROJECT SUCCESS

JOB COMPLEXITY EQUAL TO, OR GREATER THAN, THE MEDIAN VALUE OF 3.6; n = 45

DEPENDENT VARIABLE

AATOTAL Weighted score of project success

$R = .46$ $R^2 = .21$ Adj $R^2 = .17$ $F = 5.7$ SIG $F = .0064$

INDEPENDENT VARIABLES

		BETA	SIG
ADA	Software used on the project is ADA	–0.31	.03
SWCOMP	Complexity of the software used on the project	–0.29	.04

DEPENDENT VARIABLE

JOBR Managers' rating of job success

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

JOB COMPLEXITY LESS THAN THE MEDIAN VALUE OF 3.6; n = 45

DEPENDENT VARIABLE

AATOTAL Weighted score of project success

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

DEPENDENT VARIABLE

JOBR Managers' rating of job success

$R = .36$ $R^2 = .13$ Adj $R^2 = .11$ $F = 6.4$ SIG $F = .0151$

INDEPENDENT VARIABLE

		BETA	SIG
VALUEEK	Project size related to the engineering budget	–0.36	.02

TABLE 6.12

HYPOTHESIS 4

MEANS AND STANDARD DEVIATIONS OF VARIABLES

	VALUEEK[a]		HWCOMP[b]		SWCOMP[c]	
SUCCESS[d]	M	SD	M	SD	M	SD
1	6,562	21,672	3.07	1.34	2.30	1.50
2	52,821	211,996	3.32	1.32	3.00	1.57
3	7,745	9,693	3.68	1.25	3.32	1.65
4	34,864	107,734	3.58	1.52	3.35	1.64
	HW[e]		SW[f]		SWENV[g]	
SUCCESS	M	SD	M	SD	M	SD
1	.60	.37	.27	.30	.87	.65
2	.54	.31	.28	.21	1.04	.21
3	.64	.25	.36	.25	1.00	.57
4	.57	.24	.36	.21	.87	.34
	ADA[h]		C[i]		PASC[j]	
SUCCESS	M	SD	M	SD	M	SD
1	1.11	.45	1.15	.55	1.02	.26
2	1.09	.53	1.27	.77	1.00	.31
3	1.12	.44	1.16	.55	1.08	.40
4	1.35	.88	1.10	.54	0.93	.25
	ASSEM[k]		FORT[l]		OTH[m]	
SUCCESS	M	SD	M	SD	M	SD
1	1.65	.82	1.43	.78	1.04	.29
2	1.73	.88	1.55	.91	1.18	.66
3	1.92	.76	1.76	.93	1.08	.40
4	1.97	.91	1.39	.84	1.06	.44

TABLE 6.12 (Cont'd)
HYPOTHESIS 4
MEANS AND STANDARD DEVIATIONS
OF VARIABLES

[a]Projects' size based on project engineering value (thousands of dollars)

[b]Projects' hardware complexity

[c]Projects' software complexity

[d]Projects' ranking of success: 1 = Good to outstanding, 2 = Average to good, 3 = Marginal to average, and 4 = Unsatisfactory

[e]Percent of project comprised of hardware

[f]Percent of project comprised of software

[g]Software environment: batch or real-time

[h-m]Software language used: ADA, C, PASCAL, ASSEMBLY, FORTRAN, or OTHER

Summary

The results of the analyses performed generally support the hypothesis that project size, technical composition, and technological complexity are determinants of project success. Each of the independent variables related to these project dimensions has been demonstrated to have a negative relation to project success. The regression of project size reflects negatively on either measure of project success (AATOTAL or JOBR). The summary in Table 6.5 depicts this relationship. As projects become larger, there is a definite trend to less successful results.

The regressions performed on project success when controlling for software content also reflect a negative relation of software to project success. In particular, the software language (ADA) is negatively related to project success as is the complexity of the software used (SWCOMP). We do see that, if the software content is less than 30% of the projects' engineering content, the hardware complexity is positively related to project success. This is attributed to the project managers' ability to guide hardware oriented projects to success. Their background and training are more attuned to hardware projects. Nevertheless, on projects whose engineering content contained more than 30% software, hardware complexity (HWCOMP) was negatively related to project success. This was coupled with a negative relationship between the software language ADA and project success. We also found that, for this research, hardware complexity became negatively related to project success when software constituted more than 60% of the projects' engineering value. This suggests that, as projects become more complex, there is a tendency to rely more on software with an attendant decline in project success.

Table 6.12 summarizes the results of the analyses performed in evaluating this hypothesis. The most successful projects are the smallest in size (VALUEEK), have the least complexity (HWCOMP and SWCOMP), and contain the least software (SW). The least successful projects, on the other hand, have the highest software complexity (SWCOMP) and contain the most software (SW). Proportionately the least successful projects used more ADA and assembly language than the other projects, 35% and 97% respectively. The hypothesis is supported.

Hypothesis 5

This hypothesis addresses the effect training, education, and experience have on project success. These factors were examined in relation to the software content of the projects evaluated in this research. Two analytical methods were used to evaluate this hypothesis. The first was a series of multiple regressions designed to evaluate the effect the managers' education, training, and experience have on project success. The second was a discriminant analysis chosen to evaluate the variables' ability to predict the projects' success.

Multiple Regressions

The dependent variables used to evaluate this hypothesis were the weighted score of project success (AATOTAL) and the managers' rating of project success (JOBR). Multiple regressions were run against these variables using the SPSS/X REGRESSION procedure with stepwise entry. The variables used in the regressions are those outlined in Table 3.2. To guard against multicollinearity, TOLERANCE is set at 0.25. To ensure significance of results, PIN is set at 0.05 and POUT is set at 0.10. The significance of the parameters TOLERANCE, PIN, and POUT is defined in notes 1 and 2 at the end of this chapter. Missing data are handled by pairwise deletion.

Three sets of regressions were performed. The first set evaluated the project managers' professional background as it related to project success without considering the projects' software content. The results are shown in Table 6.13. The second and third set of

TABLE 6.13
HYPOTHESIS 5
THE EFFECT OF THE MANAGERS' TRAINING AND EXPERIENCE ON PROJECT SUCCESS

DEPENDENT VARIABLE			
AATOTAL	Weighted score of project success		
$R = .29$ $R^2 = .08$ Adj $R^2 = .06$ $F = 4.3$ SIG $F = .0160$			
INDEPENDENT VARIABLES		BETA	SIG
TIMERD	Time spent on project business	–0.23	.02
YRSBS	Years since bachelors degree	0.20	.04
DEPENDENT VARIABLE			
JOBR	Managers' rating of project success		
$R = .22$ $R^2 = .05$ Adj $R^2 = .04$ $F = 5.3$ SIG $F = .0236$			
INDEPENDENT VARIABLE		BETA	SIG
ADVDEG	Project manager has an advanced degree	–0.22	.02

regressions evaluated the project managers' professional background when controlling for the projects' software content. The differentiation in the projects' software content was the same as that made when testing hypothesis 4. The results of these regression are shown in Tables 6.14 and 6.15.

Project Success Without Control for Software Content

The regression on project success (AATOTAL) resulted in an R of .29 as shown in Table 6.13. This indicates that the time spent by the project managers on project tasks (TIMERD) and the years since the project managers received their bachelors degree (YRSBS) account for 8% (R^2) of the variance in project success. The independent variable TIMERD is negatively related to project success (AATOTAL). This relationship is explained when evaluating the variable means in Table 6.18. The less successful projects (SPROJ = 2) simply require more of the project managers' time. The independent variable YRSBS is positively related to project success (AATOTAL). The number of years since receipt of a bachelors degree is related to the years of professional experience. The means shown in Table 6.18 do indicate that the project managers with the most experience (YRPEX) and the most years since receipt of their bachelors degree (YRSBS) are associated with the most successful projects (SPROJ = 1).

The regression of the independent variables against project success (JOBR) resulted in an R of .22. This indicates that 5% (R^2) of the variance in JOBR is explained by the independent variable which defines the project manager has an advanced degree (ADVDEG). This independent variable is negatively related to project success (JOBR).

Software Content Controlled At the Median Point of Its Project Engineering Value

When software constituted 30% or less of the projects' engineering value, there were no regressions of the independent variables on either measure of project success (AATOTAL or JOBR). When software constituted more than 30% of the projects'

TABLE 6.14

HYPOTHESIS 5

THE EFFECT OF THE MANAGERS' TRAINING AND EXPERIENCE ON PROJECT SUCCESS

FOR SOFTWARE LESS THAN 30 PERCENT OF THE ENGINEERING BUDGET

DEPENDENT VARIABLE

AATOTAL Weighted score of project success

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

DEPENDENT VARIABLE

JOBR Managers' rating of project success

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

FOR SOFTWARE EQUAL TO 30 PERCENT OR MORE OF THE ENGINEERING BUDGET; $n = 56$

DEPENDENT VARIABLE

AATOTAL Weighted score of project success

$R = .32$ $R^2 = .10$ Adj $R^2 = .08$ $F = 5.6$ SIG $F = .0213$

INDEPENDENT VARIABLE

		BETA	SIG
TIMERD	Time spent on project by the project manager	–0.32	.02

DEPENDENT VARIABLE

JOBR Managers' rating of project success

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

engineering value, a regression resulted for AATOTAL only. These results are shown in Table 6.14.

The regressions for AATOTAL resulted in an R of 0.32, indicating that 10% (R^2) of the variance in AATOTAL was accounted for by the independent variable representing the time the project managers spend on project related tasks (TIMERD). The variable is negatively related to project success (AATOTAL). The means shown in Table 6.18 provide an insight as to why there is a negative relationship to project success. The less successful projects (SPROJ=2) simply require more of the project managers' time. If a project encounters difficulty, the project manager presumably devotes more time to the project to aid in solving project problems.

Software Content Controlled for Different Levels of Project Engineering Content

The regressions on the weighted score of project success (AATOTAL) only occurred at the extremes of the projects' software content. When the projects' software content is less than 20%, Table 6.15, R is .43 indicating that the independent variable accounted for 18% (R^2) of the variance in project success. This variable, which is positively related to project success, signifies the project managers' years of hardware experience (YRSHW). When the projects' software content is equal to or greater than 60% of the projects' engineering content, R is .78. This indicates that the independent variables account for 62% (R^2) of the variance in project success. These variables, both of which are positively related to project success, relate to the project managers' years of software experience (YRSSW) and hardware experience (YRSHW).

The regressions on the managers' rating of project success (JOBR) occurred only at the upper extremes of project software content. When software is greater than 40%, but less than 60% of the projects' engineering value, Table 6.16, R is .40 indicating that the independent variable accounts for 16% (R^2) of the variance in project success (JOBR). This variable, which is negatively related to project success, represents the project managers' years of experience as a program manager (EXPPGM). When software is equal to or more

TABLE 6.15

HYPOTHESIS 5

RELATION OF EXPERIENCE AND EDUCATION TO PROJECT SUCCESS

DEPENDENT VARIABLE

AATOTAL   Weighted score of project success

SOFTWARE LT 20% OF PROJECT CONTENT; n = 28

$R = .43$ $R^2 = .18$ Adj $R^2 = .15$ $F = 5.8$ SIG $F = .0237$

INDEPENDENT VARIABLE

		BETA	SIG
YRSSW	Years of software experience	0.43	.02

SOFTWARE GE 20% AND LE 40% OF PROJECT CONTENT; n = 30

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

SOFTWARE GT 40% AND LT 60% OF PROJECT CONTENT; n = 31

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

SOFTWARE GE 60% OF PROJECT CONTENT; n = 23

$R = .78$ $R^2 = .62$ Adj $R^2 = .58$ $F = 15.9$ SIG $F = .0001$

INDEPENDENT VARIABLE

		BETA	SIG
YRSSW	Years of software experience	0.78	.00
YRSHW	Years of hardware experience	0.44	.01

than 60% of the projects' engineering content, R is .60 indicating the independent variables account for 36% (R^2) of the variance in project success. There are two variables which account for the variance. The first is positively related to project success and represents the project managers' years of software experience (YRSSW). The second is negatively related to project success and relates to the project managers' change in responsibility on assuming their current position (RESP).

TABLE 6.16

HYPOTHESIS 5

RELATION OF EXPERIENCE AND
EDUCATION TO PROJECT SUCCESS

DEPENDENT VARIABLE

JOBR Managers' rating of project success

SOFTWARE LT 20% OF PROJECT CONTENT; n = 28

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

SOFTWARE GE 20% AND LE 40% OF PROJECT CONTENT; n = 30

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

SOFTWARE GT 40% AND LT 60% OF PROJECT CONTENT; n = 31

$R = .40$ $R^2 = .16$ Adj $R^2 = .13$ $F = 5.6$ SIG $F = .0249$

INDEPENDENT VARIABLE

		BETA	SIG
EXPPGM	Experience as program manager	–0.40	.02

SOFTWARE GE 60% OF PROJECT CONTENT; n = 23

$R = .60$ $R^2 = .36$ Adj $R^2 = .29$ $F = 5.4$ SIG $F = .0140$

INDEPENDENT VARIABLE

		BETA	SIG
YRSSW	Years of software experience	0.78	.00
RESP	Change in responsibility on assuming present position	–0.51	.04

This finding suggests the project managers were given increased responsibility on assuming their current position without proper preparation, prior experience, additional training, and, possibly, additional authority. This added responsibility may have been in the form of larger projects, additional projects, projects composed of elements with which they weren't familiar, increased administrative duties, or any combination of the foregoing.

Discriminant Analysis

A discriminant analysis was performed on the two groupings of project success (SPROJ). This analysis was performed using the SPSS/X DISCRIMINANT procedure with stepwise entry. This procedure was conducted using data file 1 described in Chapter 4. There are 124 projects in this data file. Pairwise deletion resulted in only 87 of the projects being evaluated. Consequently, the variables' mean values were substituted for the missing data points. This resulted in 109 projects being evaluated. The results are shown in Table 6.17.

The discriminant function was able to correctly classify 70% of the projects. This is better than if we had simply classified all projects as being successful using either the proportional chance or maximum chance criterion. If the discriminating variables (education, tenure with firm, training, etc.) cannot distinguish between successful and unsuccessful projects, we can expect to get a proportion (p) correctly classified if we classify all projects as successful. For example, let us assume a population with only two types of projects: those which are successful (p) and those which are not successful (1–p). Thus, if we know a priori that $p > .5$ we would classify all projects as successful. If $p < .5$ we would classify all projects as unsuccessful. The purpose of this research is not simply to maximize the percentage of projects correctly classified but, rather, to identify those variables related to the managers' professional background which can discriminate between successful and unsuccessful projects.[3]

The discriminant function shows that the project managers' years since their bachelors degree (YRSBS), years of software experience (YRSSW), and change in responsibility on assuming their current position (RESP) are all positively related to discriminating between successful and unsuccessful projects. On the other hand, their years of education (EDYRS), their years of hardware experience (YRSHW), and their time spent on project business (TIMERD) are negatively related to discriminating between successful and unsuccessful projects. These findings suggest the project managers' education and experience are not always matched to the assignments which they are given. This, in turn, may require these managers to spend more time on their projects than would be necessary if their backgrounds were better matched to their assignments.

TABLE 6.17

HYPOTHESIS 5

DISCRIMINANT ANALYSIS

	Eigenvalue	Wilks' Lambda	SIG
Func1	0.19	0.84	.0058

Variable		Structure Coefficents	Standard Form Func1	Classification Coefficients Success	Classification Coefficients Non-Success
EDYRS	Years of education	–0.11	–0.76	6.57	6.91
YRSBS	Years since BS	0.46	1.22	– 0.51	– 0.61
YRSSW	Years of software experience	0.30	0.32	– 0.36	– 0.41
YRSHW	Years of hardware experience	0.11	– 0.32	0.47	0.49
RESP	Change in managers' responsibility	0.33	0.38	11.53	11.05
TIMERD	Time spent on project business	–0.38	–0.43	8.26	9.29
	Constant			–80.99	–83.90

Classification of Projects by the Discriminant Function

Group[1]	Actual Number	Percent	Correctly Classified	Percent
1	62	57	50	81
0	47	43	26	55
TOTAL	109	100	76	70

[1] Projects classified in terms of success: 1 = Successful, 0 = Unsuccessful

TABLE 6.18

HYPOTHESIS 5

MEANS AND STANDARD DEVIATIONS

	EDYRS[a]		YRSBS[b]		YRPEX[c]		YRSSW[d]	
SPROJ[e]	M	SD	M	SD	M	SD	M	SD
1	17.1	2.2	20.9	11.6	24.2	7.9	7.0	7.3
0	17.4	1.6	17.2	10.7	20.8	8.6	5.0	6.1
	YRSHW[f]		YRWPEM[g]		EXPPGM[h]		EXPPJM[i]	
SPROJ	M	SD	M	SD	M	SD	M	SD
1	16.9	12.6	13.8	8.0	3.5	5.3	3.7	4.5
0	14.2	10.0	13.4	7.4	3.8	5.9	3.9	4.3
	EXPPE[j]		RESP[k]		PROMO[l]		ADVDEG[m]	
SPROJ	M	SD	M	SD	M	SD	M	SD
1	7.5	6.2	4.3	.70	.50	.50	.36	.49
0	6.5	5.1	4.2	.73	.70	.50	.38	.49
	TIMERD[n]		NODEG[o]					
SPROJ	M	SD	M	SD				
1	.39	.39	1.4	.80				
0	.54	.39	1.4	.80				

[a]Years of education
[b]Years since bachelor's degree
[c]Years of professional experience
[d]Years of software design or management experience
[e]Project success classification: 1 = average to outstanding, 0 = Unsatisfactory to average
[f]Years of hardware design or management experience
[g]Years with present employer
[h]Years program management experience
[i]Years project management experience
[j]Years project engineering experience
[k]Change in responsibility on assuming present position
[l]Promoted within past four years?: 1 = yes, 2 = no.
[m]Has respondent an advanced degree? 1 = yes, 0 = no
[n]Time required (percent) by project manager on project
[o]Number of degrees held by manager

Regression Analyses When Controlling For Project Size

The negative relation of the project managers' years of education (EDYRS) to project success seen in the discriminant analysis was not expected. The correlations to the measures of project success for the independent variables related to education are shown in Table 6.19. We note that the project managers' years of education (EDYRS), number of degrees held (NODEG), and holding of an advanced degree (ADVDEG) are negatively related to all measures of project success.

Additional regressions were performed to evaluate the effect the managers' professional characteristics had on project success when controlling for project size. The intent was to determine what additional insight, if any, might be provided about the variables pertaining to education and their relation to project success. For these regressions, project size was defined as small, medium, and large as shown in Table 5.1. The results of these regressions are shown in Table 6.20.

Regressions Against Project Success (AATOTAL)

The regressions against the weighted score of project success (AATOTAL) for small projects resulted in R=.49. This indicates that the independent variable defining years of professional experience (YRSPEX) accounts for 24% (R^2) of the variance in project success. The relationship of professional experience to project success is positive.

For medium size projects, R=.46 indicating that the independent variable defining years of hardware experience (YRSHW) accounts for 21% (R^2) of the variance in project success. The relation of hardware experience to project success is also positive. There was no significant regression of the independent variables on project success for the large projects.

Regressions Against Project Success (JOBR)

The regressions against the managers' rating of project success for small projects results in R=.47. This indicates that the independent variables defining years of

TABLE 6.19

HYPOTHESIS 5

CORRELATIONS OF EDUCATION TO PROJECT SUCCESS

	JOBR	EDYRS	ADVDEG	NODEG
AATOTAL[a]	0.43 n(108) p<.001	–0.06 n(109) p=.270	<–0.00 n(109) p=.490	–0.02 n(109) p=.425
JOBR[b]	1.00 n(120) .	–0.14 n(120) p=.062	–0.22 n(120) p=.007	–0.16 n(120) p=.042
EDYRS[c]	–0.14 n(120) p=.062	1.00 n(124) .	0.72 n(124) p<.001	0.89 n(124) p<.001
ADVDEG[d]	–0.22 n(120) p=.007	0.72 n(124) p<.001	1.00 n(124) .	0.87 n(124) p<.001
NODEG[e]	–0.16 n(120) p=.042	0.89 n(124) p<.001	0.87 n(124) p<.001	1.00 n(124) .
SPROJ[f]	– – –	–0.05 n(109) p=.303	–0.04 n(109) p=.344	<–0.00 n(109) p=.485

[a] Weighted score of project success

[b] Managers' rating of project success

[c] Managers' years of education

[d] Manager holds an advanced degree (Yes=1,No=2)

[e] Number of degrees

[f] Classification of projects (1=Successful, 0=Unsuccessful)

professional experience (YRSPEX) accounts for 22% of the variance in project success. This relationship is positive.

For medium size projects, R = .56 indicating that the independent variable defining years of education (YRSED) accounts for 31% (R^2) of the variance in project success. The relationship of years of education to project success is negative. There was no significant regression of the independent variables on project success for large projects.

Summary

The results of the analyses support the hypothesis that the project managers' professional background is a factor in determining project success. The regressions on project success (AATOTAL and JOBR) indicate that the project managers' hardware and software experience are contributing factors to project success. This is particularly true when software is either a small (LT 20%) or large (GE 60%) part of the projects' engineering content. For projects in which software is about half of the engineering content (GE 40% and LT 60%), we found that experience as a program manager was negatively related to project success. This is attributed to both a lack of program management experience and software experience.

We also saw that, without controlling for software content, having an advanced degree was negatively related to project success. The discriminant analysis revealed that the project managers' years of education are negatively related to project success. These findings were further explored by performing additional regressions on project success when controlling for project size. These additional regressions show that both years of hardware experience and professional experience are positive contributors to project success on small and medium size projects. There is also an indication that years of education is negatively related to project success on medium size projects.

The results of the regression, correlation, and discriminant analyses might suggest that the project managers having the most education, number of degrees, and holding advanced degrees are either over specialized for their assignments or their education is not related to the project management positions to which they have been assigned. The maxim that a good technical leader does not necessarily make a good manager is an example of over

TABLE 6.20

HYPOTHESIS 5

PROJECT MANAGERS' PROFESSIONAL BACKGROUND
AND PROJECT SUCCESS CONTROLLING FOR PROJECT SIZE

DEPENDENT VARIABLE

AATOTAL Weighted score of project success

PROJECT SIZE (Small): n = 28

R = .49 R^2 = .24 Adj R^2 = .21 F = 8.4 SIG F = .0076

INDEPENDENT VARIABLE

		BETA	SIG
YRSPEX	Years of professional experience	0.49	.01

PROJECT SIZE (Medium): n = 24

R = .46 R^2 = .21 Adj R^2 = .18 F = 5.9 SIG F = .0233

INDEPENDENT VARIABLE

		BETA	SIG
YRSHW	Years of hardware experience	0.46	.02

PROJECT SIZE (Large)

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

DEPENDENT VARIABLE

JOBR Managers' rating of project success

PROJECT SIZE (Small): n = 29

R = .47 R^2 = .22 Adj R^2 = .20 F = 7.8 SIG F = .0094

INDEPENDENT VARIABLE

		BETA	SIG
YRSPEX	Years of professional experience	0.47	.01

PROJECT SIZE (Medium): n = 26

R = .56 R^2 = .31 Adj R^2 = .29 F = 11.0 SIG F = .0029

INDEPENDENT VARIABLE

		BETA	SIG
EDYRS	Years of education	–0.56	00

PROJECT SIZE (Large)

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

specialization. Similarly, if the emphasis is on project financial control, the assignment of a project manager having an extensive business background to a technical project may result in poor technical decisions, technical direction, and project failure. The hypothesis is supported.

Hypothesis 6

This hypothesis examines the effect leadership characteristics have on project manager success. The leadership characteristics examined relate to the project managers' needs for power and achievement, their achieving styles, and their leadership style. Also evaluated were the project managers' expressed needs to control the budget, schedule, and technical criteria related to the projects.

There were three analytical methods used to evaluate this hypothesis. The first was a multiple regression to evaluate the project managers' need for both achievement (n Ach) and power (n Pow). The second was another multiple regression of the independent variables against the rating of the project managers' success (GATOTAL). Finally, a discriminant analysis was performed to determine the variables' ability to predict the managers' success.

Needs for Achievement (n Ach) and Power (n Pow)

The managers in this study were grouped into four classifications of success ranging from unsatisfactory to outstanding based on their weighted score of managers' success (GATOTAL). Recall from Chapter 4 that GATOTAL was constructed from the managers' rating of their own performance. These groups were in turn compared to Stahl's ranking of managerial motivation.[4] The results are shown in Table 6.21.

Among the 39 managers rated as successful, i.e., average to outstanding, there were 36 managers who were rated from the results of the Job Choice Exercise as having medium to high managerial motivation. Of these 36, 23 scored themselves as having high managerial motivation. These results are interpreted to indicate that successful project managers are likely to have high needs for both power and achievement.

The results of the correlation analysis, however, indicate there is no correlation between Stahl's managerial motivation measure and the ranking of the managers' success (GMGRSUC) in this research. Further, there is no correlation between Stahl's managerial motivation measure and the managers' rating of their own performance (GTOTAL) or the weighted score of their performance (GATOTAL).

Regression of Independent Variables on GATOTAL

A multiple regression was performed using the SPSS/X REGRESSION procedure with stepwise entry. To guard against multicollinearity, TOLERANCE is set at 0.25. To ensure significance of results, PIN is set at 0.05 and POUT is set at 0.10. The variables used in the regressions are those outlined in the research design in Table 3.2. The significance of the parameters TOLERANCE, PIN, and POUT is defined in notes 1 and 2 at the end of this chapter. Missing data are handled by pairwise deletion. The results of the regression are shown in Table 6.22.

The regression resulted in an R of 0.61 indicating that 38% (R2) of the variance in project success (GATOTAL) was accounted for by three independent variables. These independent variables represented one achieving style from each of the three domains defined by the Achieving Styles Inventory. This is addressed in the summary.

Discriminant Analysis

A discriminant analysis was performed on the two groupings of manager success (GMGRSUC). This analysis was performed using SPSS/X DISCRIMINANT procedure with stepwise entry. The results, shown in Table 6.23, indicate that the discriminant function correctly classified 71% of the managers. This is better than if we had simply classified all project managers as being successful using the proportional chance criterion and the same as if we had used the maximum chance criterion.[5]

If the discriminating variables cannot distinguish between successful and unsuccessful projects, we can expect to get a proportion p correctly classified if we classify all projects as successful. For example, let us assume a population with only two classes of project managers: those who are successful (p) and those who are not successful (1–p).

TABLE 6.21
HYPOTHESIS 6
MANAGEMENT MOTIVATION VERSUS MANAGERS' SUCCESS AND ITS CORRELATION TO MANAGERS' SUCCESS

GMGRSUC[b]	MMOT[a]			
	-1	0	1	TOTAL
1	1	7	11	19
2	2	6	12	20
3	–	8	6	14
4	–	1	1	2
TOTAL	3	22	30	55

CORRELATION OF MANAGERIAL MOTIVATION TO MANAGERS' SUCCESS

	GMGRSUC	GTOTAL[c]	GATOTAL[d]
MMOT	-0.01 n(55) p=.48	-0.06 n(55) p=.32	-0.05 n(55) p=.35

[a] Management motivation: -1 = low, 0 = medium, 1 = high

[b] Ranking of project managers' success: 1 = Good to outstanding, 2 = Average to good, 3 = Marginal to average, 4 = Unsatisfactory

[c] Managers' rating of their success

[d] Weighted score of managers' success

Thus, if we know a priori that $p > .5$ we would classify all project managers as successful. If $p < .5$ we would classify all project managers as unsuccessful. The purpose of this research is not simply to maximize the percentage of project managers correctly classified but, rather, to identify those variables related to the managers' professional background which can discriminate between successful and unsuccessful project managers.

TABLE 6.22

HYPOTHESIS 6

RELATION OF MANAGERS' NEEDS, ACHIEVING STYLE, AND LEADERSHIP STYLE TO MANAGERS' SUCCESS

DEPENDENT VARIABLE

GATOTAL Weighted score of project managers' success

$R=.61$ $R^2=.38$ Adj $R^2=.33$ $F=7.5$ SIG $F=.0001$

INDEPENDENT VARIABLES

		BETA	SIG
COMPDIR2	Competitive–direct achieving style	–0.35	.00
COLLREL7	Collaborative–relational achieving style	0.34	.01
PERINST4	Personal–instrumental achieving style	0.29	.01

The variables which contribute the most to the discriminant function are the managers' need for affiliation (BAFF) and their intrinsic direct achieving style (INTDIR1). The two variables initially appear as contrasts. People who prefer the direct achieving style rely primarily on themselves and take satisfaction from doing the task very well. Nevertheless, people can be high intrinsic direct achievers and also like, need, and work well with others, particularly if they also have high relational/instrumental achieving style scores. This is true in this research as shown in tables 8.3 and 8.4. The need for budget control (GBNEC) and its negative relation to the discriminant function may indicate the emphasis which non technical project managers place on financial controls.

Leadership Style

The variable, derived from the Least Preferred Co–Worker Scale, which defines leadership style (LPCD1), did not appear as an independent variable in the regression on GATOTAL. Nor was it seen in the discriminant analysis as a variable in the discriminant function. Nevertheless, the hypothesis stated that the successful managers would have a middle LPC leadership style. The results obtained from the Least Preferred Co–Worker Scale reveal the 55 respondents' scores ($\underline{M}=70.8$, $\underline{SD}=8.5$) are within the range of 55 to 93

TABLE 6.23

HYPOTHESIS 6

DISCRIMINANT ANALYSIS

		Eigenvalue	Wilks' Lambda		SIG
	Func1	0.13	0.88		.0955

Variable		Structure Coefficients	Standard Form Func1	Classification Coefficients Success	Classification Coefficients Non–Success
BAFF	Need for affiliation	0.63	0.80	18.37	20.72
GBNEC	Need for budget control	–0.48	–0.47	1.30	1.03
INTDIR1	Intrinsic–direct achieving style	0.37	0.73	15.48	16.36
	Constant			–49.42	–55.28

Classification of Managers' Success by the Discriminant Function

Group[a]	Actual Number	Percent	Correctly Classified	Percent
1	39	71	36	92
2	16	29	3	19
TOTAL	55	100	39	71

[a] Managers classified in terms of success: 1 = average to outstanding, 2 = unsatisfactory to marginal

normally associated with a middle LPC leadership style. The lone manager not exhibiting a middle LPC leadership style was identified as having a task–oriented leadership style.

Summary

The results of the analyses performed in testing this hypothesis support the hypothesis that successful project managers have high needs for both achievement (n Ach) and power (n Pow). Further, the results supported the hypothesis that successful managers have multiple dominant achieving styles and that they have middle LPC achieving styles.

Of the 36 project managers having medium to high managerial motivation (MMOT), 23 of these managers were classified as being average to outstanding. There is no significant correlation, however, to the measures of the managers' success as defined in this research to Stahl's measure of managerial motivation. This indicates that the Job Choice Exercise may identify high managerial motivation, but is not sufficient to identify successful managers.

The regressions of the managers' success (GATOTAL) against the independent variable examined in this hypothesis resulted in three achieving styles accounting for the variance in GATOTAL. These were the competivite direct (COMPDIR2), personal instrumental (PERINST4), and collaborative relational (COLLREL7) achieving styles. The first of these, the competitive direct achieving style (COMPDIR2), is negatively related to GATOTAL.

A manager with a competitive direct achieving style views all situations competitively. For such managers, winning is their driving concern. They compete against everyone and measure themselves against all relevant others and everyone against their own performance. On projects, where group performance is essential to success, the use of this particular achieving style is not conducive to project success.

Managers, who use this achieving style predominantly to the exclusion of all others, are likely viewed by their colleagues to be uncooperative, as they would always place their colleagues in a "win-lose" position. Managers who compete with their own people may, rather than encourage cooperation, create competition and hostility among the project members and discourage the project members from trying to succeed. This achieving style, if used exclusively, would cause considerable conflict between the project managers and those from whom they need support. Managers who are competitive may set such high standards for themselves and others that it is difficult for them to see themselves as successful enough to meet these standards.

The other independent variables are the collaborative relational achieving style (COLLREL7) and the personal instrumental achieving style (PERINST4). Both are positively related to GATOTAL. The first (COLLREL7) is associated with an individual having an inclination to accomplish tasks through group efforts. Managers who are collaborative achievers may be less focused on their own performance. They may count how well they are able to get others to collaborate in achieving task objectives in their self-assessment of success. The collaborative-relational achiever prefers to work in groups. Such individuals associate with and like to work within a group context to achieve group objectives. This is key to project success. Project managers exhibiting this characteristic are usually considered team players.

The second variable (PERINST4) requires some interpretation. Instrumental achievers evaluate themselves and their relationships with others in terms of their usefulness in promoting the instrumental achievers' accomplishments. The connotation is political. The personal instrumental achievers are usually skillful negotiators and usually excel in bargaining. They exude self-confidence, are often charismatic, and use attributes of the self to persuade others to their point of view. Their charismatic efforts engage the commitment of others. As project managers, the personal instrumental achievers are frequently required to bargain and negotiate terms related to the project as they affect budget, schedule, or technical parameters. These project managers will frequently exert political influence within legitimate constraints to achieve their objectives. The success the personal instrumental achievers have in the exercise of their skills is reflected in their self-perceived success as project managers.

The discriminant analysis revealed a discriminant function having three discriminating variables. Two of these were positively related to the discriminating function and were the managers' need for affiliation (BAFF) and their intrinsic direct achieving style (INTDIR1). The discriminant function was able to correctly classify 71% of the managers as either being successful or nonsuccessful.

With one exception, all the managers in this analysis had a middle LPC leadership style. The lone exception exhibited a task-oriented achieving style. The hypothesis is supported.

FOOTNOTES

[1] Variables which are almost linear combinations of other independent variables are often called multicollinear. A regression equation in which the independent variables are multicollinear will exhibit a significant R^2 although few of the coefficients are significantly different than zero. If a variable has a large R^2, or equivalently a small tolerance (0.01), the potential exists that the variables are multicollinear. To protect against this occurrence in the small data set, TOLERANCE was set at 0.25.

[2] The parameters PIN and POUT are used in the stepwise entry process to ensure the independent variables which are finally selected (from the full range of candidate variables) for inclusion in the regression equation fall within a specified range of significance. Setting PIN at 0.05 precludes a variable from entering the regression unless its "probability of F-to-enter" is less than or equal to 0.05. Similarly, setting POUT to 0.10 will cause a variable to be removed from the regression if its significance has degraded during the stepwise process.

One final item should be noted. To account for variability in sampling, the number of samples (N) should be large relative to the number of variables (K) used in the statistical process. A general rule of thumb suggests $N > 10K$ to help ensure the resulting solution is stable. See for example, Leonora A. Marasciulo and Joel R. Levin, Multvariate Statistics in the Social Sciences: A Researcher's Guide (Monterey, Ca.:Brooks/Cole Publishing Co., 1983):p. 202. The regression results presented have generally followed this rule of thumb. The statistics for the regression (R, R^2, F, etc.) are those based on the independent variables which remain at the conclusion of the stepwise process, or where $N \approx 10K$.

[3] A distinction is made between the proportional chance criterion and the maximum chance criterion in determining if the discriminant function is successful in distinguishing between successful and unsuccessful projects. The proportional chance criterion is expressed as

$$C_{pro.} = \alpha^2 + (1-\alpha)^2,$$

where

α is the proportion of successful projects
$1-\alpha$ is the proportion of unsuccessful projects

For this research $\alpha = .57$ so that $C_{pro.} = (.57)^2 + (.43)^2$ or .50. The maximum chance criterion is expressed as

$$C_{max.} = \max(\alpha, 1-\alpha)$$

For the projects examined in this research, the maximum chance criterion is .58. As noted, however, we are not interested in maximizing the number of projects correctly classified, but in correctly classifying if projects are successful or unsuccessful. We were able to correctly classify 70% of the projects examined in this research based on variables that relate to the managers' education and professional background. This is considerably better than either the proportional chance criterion would have predicted or a simple project classification based on the a priori knowledge that more than half of the projects were successful. An excellent discussion on the use of discriminant analysis can be found in Donald G. Morrison, "On the Interpretation of Discriminant Analysis", Journal of Marketing Research Vol. VI (May 1969): pp.156–63

[4]M.J. Stahl, "Achievement, Power and Managerial Motivation: Selecting Managerial Talent with the Job Choice Exercise," Personnel Psychology 36 (1983): 779. In his work Stahl has labeled those subjects, whose average beta scores on the 24 regressions on job choice were higher than 0.314 and n Pow and 0.464 on n Ach, as high in managerial motivation. A subject who scored lower than or equal to 0.314 on n Pow and less than or equal to 0.464 on n Ach was labeled as low in managerial motivation. All others were labeled as medium in managerial motivation.

[5]A priori, we know that alpha is .71. Consequently, the proportional chance criterion is $(.71)^2 + (.29)^2$ or .58. The maximum chance criterion is the maximum of α or $1-\alpha$ or .71.

CHAPTER 7

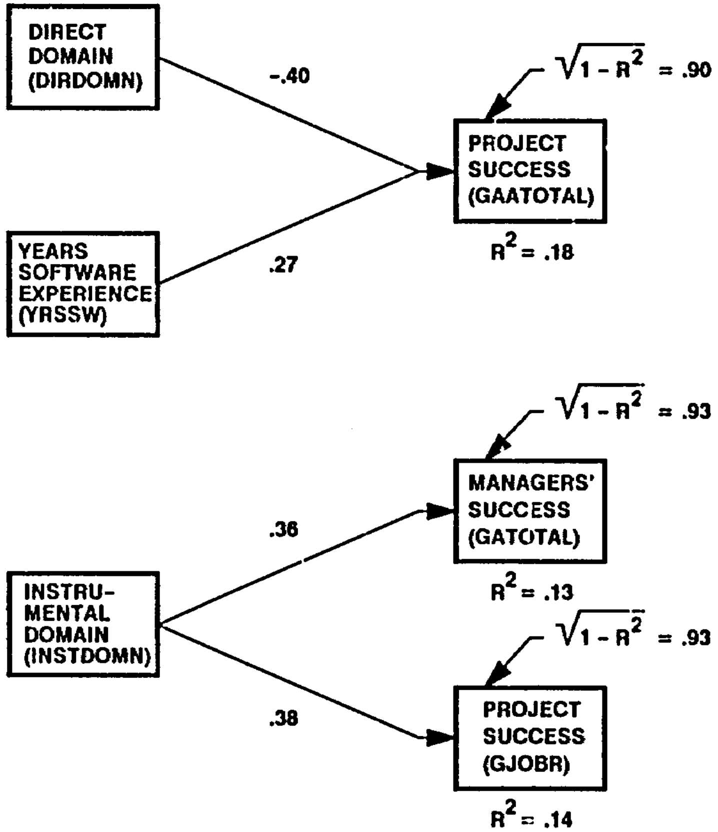
PATH ANALYSIS RESULTS

The analytical results of hypothesis 7 are presented in this chapter. The analysis consisted of several path analyses introduced to evaluate the effect leadership characteristics, management controls, and project characteristics have on project success and project manager success. These dimensions were analyzed individually and in combination. The results of the individual analyses are presented in Figures 7.1 through 7.3 and Tables 7.1 through 7.6. The results of the combined path analyses are shown in Figure 7.4 and in Tables 7.7 and 7.8.

Leadership Characteristics

The leadership characteristics and the path model used in this analysis are shown in Figure 3.2. The variables shown in the path model were selected principally on the basis of prior research. For example, the direct relation of the needs for power and achievement and the importance of leadership styles to manager's success have been exhaustively studied and reported in the literature. The achieving styles used by the managers were considered as important factors which would contribute to their success. The managers' experience, education, and tenure with the organization should enable them, either directly or indirectly, to use this background to achieve success.

These dimensions pertaining to the managers' background were then evaluated to assess the causal relation they had to the weighted score of project success (GAATOTAL), the managers weighted score of success (GATOTAL), and the managers' rating of project success (GJOBR). The results of this path analysis are shown in Figure 7.1. Leadership characteristics account for 18% ($\underline{R}^2 = .18, F(2,52) = 5.8$) of the variance in the weighted score



Path Analyses Leadership Characteristics
Figure 7.1

of project success (GAATOTAL) in the path model. The predictors are the direct domain of achieving styles (DIRDOMN) and the years of software experience (YRSSW).

The reconstructed correlations of the exogenous variables to the endogenous variables compared favorably to the observed values. This is shown in Table 7.1. The observed values are displayed above the diagonal and the reconstructed values are displayed below the diagonal. The differences between the reconstructed values and the observed values are attributed to correlations among the residuals, errors, or variables missing from the path analysis.

Leadership characteristics account for 14% ($R^2 = .14$, $F(1,53) = 8.8$) of the variance in the weighted score of the managers' success (GATOTAL) in the path model. The predictor is the instrumental domain of achieving styles (INSTDOMN). Similarly, INSTDOMN accounts for 13% ($R^2 = .13$, $F(1,53) = 7.7$) of the variance in the path model of the managers' rating of project success (GJOBR). The significance of the independent variables on the dependent variable is shown in Table 7.2.

Management Control

The management control functions and the path model used in this analysis are shown in Figure 3.3. The variables shown in the path model were chosen principally as management control is generally considered a necessary factor that contributes to project

TABLE 7.1

RECONSTRUCTED AND OBSERVED CORRELATIONS OF LEADERSHIPCHARACTERISTICS ON PROJECT SUCCESS: GAATOTAL

	GAATOTAL[a]	DIRDOMN[b]	YRSSW[c]
GAATOTAL	1.00	–0.34	0.17
DIRDOMN	–0.39	1.00	0.27
YRSSW	0.25	–	1.00

[a] Weighted score of project success
[b] Direct domain achieving styles
[c] Managers' years of software experience

TABLE 7.2
HYPOTHESIS 7
LEADERSHIP CHARACTERISTICS
PATH ANALYTICAL MODEL

DEPENDENT VARIABLE

GATOTAL — Weighted score of project success

$R = .43$ $R^2 = .18$ Adj $R^2 = .5$ $F = 6.3$ SIG $F = .0119$

INDEPENDENT VARIABLES

		B	BETA	SIG
DIRDOMN	Direct domain of achieving styles	–0.74	–0.40	.00
YRSSW	Years of software experience	0.05	0.27	.04
	Constant	6.59		

DEPENDENT VARIABLE

GJOBR — Managers' rating of project success

$R = .38$ $R^2 = .14$ Adj $R^2 = .13$ $F = 8.8$ SIG $F = .0045$

INDEPENDENT VARIABLE

		B	BETA	SIG
INSTDOMN	Instrumental domain of achieving styles	0.53	0.38	.00
	Constant	1.49		

DEPENDENT VARIABLE

GATOTAL — Weighted score of managers' success

$R = .36$ $R^2 = .13$ Adj $R^2 = .11$ $F = 7.7$ SIG $F = .0075$

INDEPENDENT VARIABLE

		B	BETA	SIG
INSTDOMN	Instrumental domain of achieving styles	0.45	0.36	.01
	Constant	1.49		

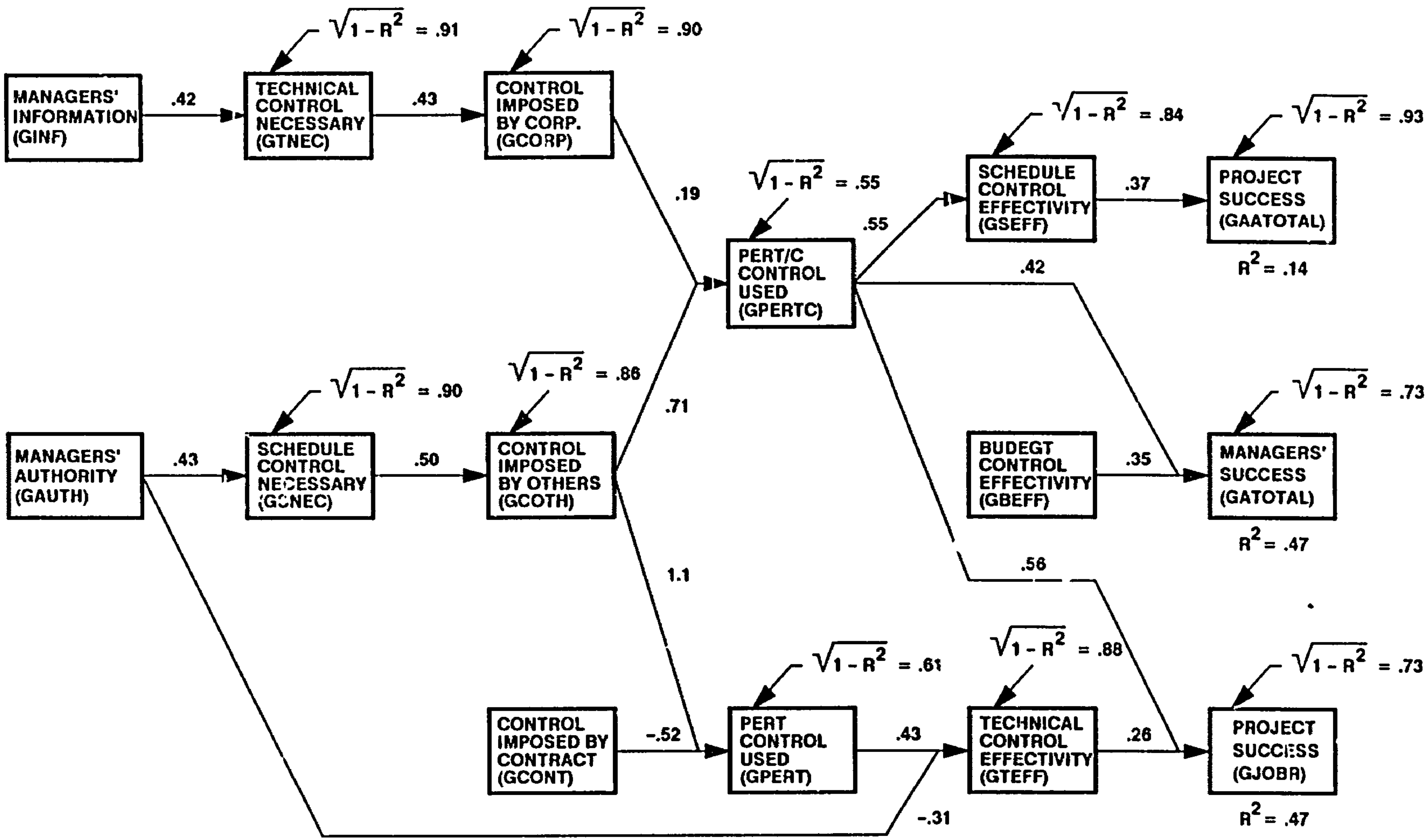
success. The direct effects considered were the management control methods imposed and the managers' rating of how effective these controls were to them. The reasoning was that if the managers felt the controls were effective, they would use them as an aid in achieving project success.

The indirect effects reflect how the controls were imposed. These are usually imposed by contract or by corporate policy. The managers' expressed need for control and their authority could cause specific controls placed on the projects beyond those required by contract or by the corporation. The results of the path analyses are shown in Figure 7.2.

Management control functions account for 14% ($R^2 = .14$, $F(1,53) = 8.6$) of the variance in the path model for the weighted score of project success (GAATOTAL). This variance is accounted for by the direct effect of schedule control effectiveness (GSEFF) on project success. Numerous indirect effects also have a bearing on project success. These include the use of PERT/CPM as a method of project control (PERT/C), the imposition by the corporation or others of project management controls (GCORP and GCOTH), and the managers' need for schedule and technical control on the project (GSNEC and GTNEC). The managers are also an indirect effect on project success through the authority they exercise on the project (GAUTH) and the information which they have about the project (GINF). The indirect effects are all positively related to the dependent variables with one exception. The exception is the relation the managers' authority (GAUTH) has with the technical effectiveness of project control (GTEFF).

Management control functions account for 47% ($R^2 = .47$, $F(2,52) = 22.9$) of the variance in the path model for the weighted score of project manager success (GATOTAL). This variance is accounted for by the direct effect of budget control effectiveness (GBEFF) and the use of PERT/CPM for project control (GPERTC). The indirect affects on the managers' success (GATOTAL) are the same as those for the projects' success (GAATOTAL).

Management control functions account for 47% ($R^2 = .47$, $F(2,52) = 22.7$) of the variance in the path model for the managers' rating of project success (GJOBR). This variance is accounted for by the direct effect of technical control effectiveness (GTEFF) and



Path Analyses Control Functions
Figure 7.2

the use of PERT/CPM for management control (GPERTC). The indirect effects on project success include the use of PERT (GPERT), whether the corporation or others imposed the management control (GCORP and GCOTH), the managers' need for schedule and technical control (GSNEC and GTNEC), and the managers' information about and authority on the project (GINF and GAUTH).

A reconstruction of the correlations between the variables directly contributing to the explanation of the variance in the weighted score of project success (GAATOTAL), the weighted score of project managers' success (GATOTAL), and the managers' rating of project success (GJOBR) is shown in Table 7.3. The observed values are displayed above the diagonal and the reconstructed values below the diagonal. The differences between the reconstructed values and the observed values are attributed to correlations among the residuals, errors, or variables missing from the path analysis. The significance of the independent variables on the dependent variables is shown in Table 7.4.

TABLE 7.3

HYPOTHESIS 7

RECONSTRUCTED AND OBSERVED CORRELATIONS OF MANAGEMENT CONTROLS ON MANAGERS SUCCESS (GATOTAL) AND PROJECT SUCCESS (GJOBR)

	GATOTAL	GJOBR	GPERTC[a]	GBEFF[b]	GTEFF[c]
GATOTAL	1.00	0.80	0.62	0.59	0.39
GJOBR	–	1.00	0.43	0.53	0.64
GPERTC	.74	0.43	1.00	0.34	0.37
GBEFF	–	–	0.67	1.00	0.34
GTEFF	–	0.64	--	–	1.00

[a] PERT/CPM used as management control system

[b] Managers consider budget control effective

[c] Managers consider technical control effective

TABLE 7.4
HYPOTHESIS 7
MANAGEMENT CONTROL FUNCTIONS
PATH ANALYTICAL MODEL

DEPENDENT VARIABLE

GAATOTAL Weighted score of project success

$R = .37$ $R^2 = .14$ Adj $R^2 = .12$ $F = 8.6$ SIG $F = .0049$

INDEPENDENT VARIABLES

		B	BETA	SIG
GSEFF	Effectiveness of schedule control	0.41	0.37	.00
	Constant	1.96		

DEPENDENT VARIABLE

GJOBR Managers' rating of project success

$R = .68$ $R^2 = .47$ Adj $R^2 = .45$ $F = 22.9$ SIG $F < .0001$

INDEPENDENT VARIABLES

		B	BETA	SIG
GPERTC	PERT/CPM used as management tool	1.93	0.55	.00
GTEFF	Effectiveness of technical control	0.17	0.26	.02
	Constant	1.23		

DEPENDENT VARIABLE

GATOTAL Weighted score of managers' success

$R = .68$ $R^2 = .47$ Adj $R^2 = .45$ $F = 22.7$ SIG $F < .0001$

INDEPENDENT VARIABLES

		B	BETA	SIG
GPERTC	PERT/CPM used as management tool	1.31	0.42	.00
GBEFF	Effectiveness of budget control	0.25	0.35	.01
	Constant	1.52		

Project Characteristics

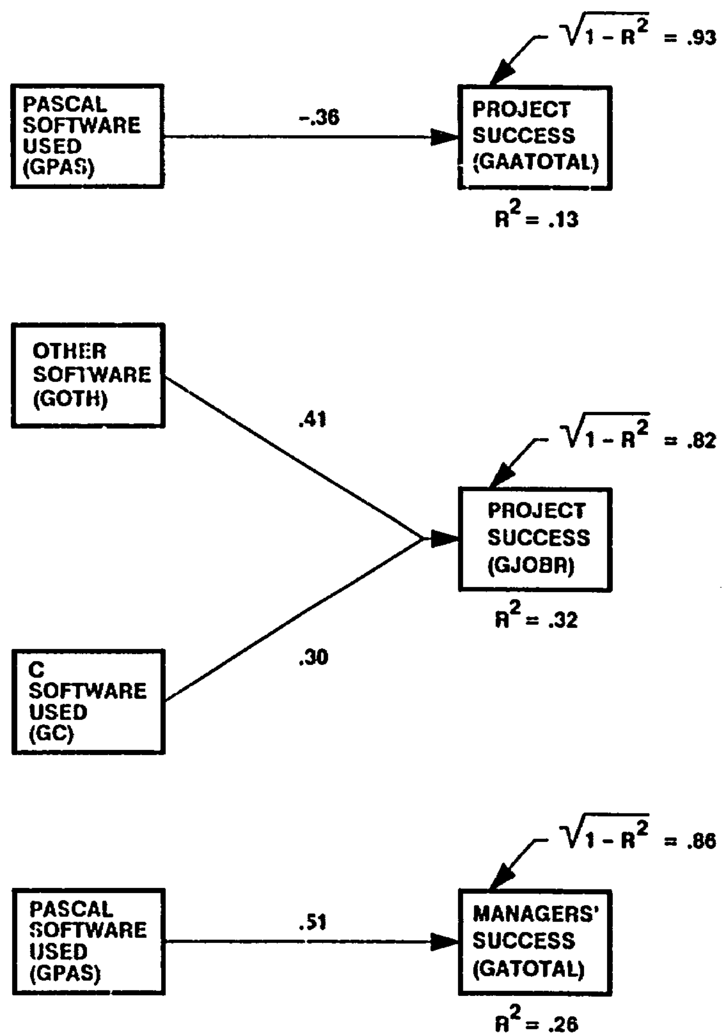
The project characteristics and the path model used in this analysis are shown in Figure 3.4. The variables shown in the path model were selected on the basis that the type of software used, the project complexity, and the proportion of hardware and software used in the project would directly effect project success. The indirect effects reflect how the software language used is a measure of the software complexity, and how the hardware complexity might require the use of specific software languages. The results of the path analysis are shown in Figure 7.3.

Project characteristics account for 13% ($R^2 = .13, F(1,53) = 8.1$) of the variance in the path model for the weighted score of project success (GAATOTAL). This variance is accounted for by the use of PASCAL software in the project (GPAS).

Project characteristics account for 32% ($R^2 = .32, F(2,52) = 12.3$) of the variance in the path model for the weighted score of the project managers' success (GJOBR). This variance is accounted for by the direct effect of several types of software used on the projects. The most significant is the use of a software language other than ADA, FORTRAN, PASCAL, C, or ASSEMBLY in the project (GOTH). The other independent variable represents the use of the software language C in the project (GC).

Project characteristics account for 20% ($R^2 = .26, F(1,53) = 18.4$) of the variance in the managers' rating of project success (GJOBR). The variance is accounted for by the use of PASCAL software in the project (GPAS).

A reconstruction of the correlations between the variables directly contributing to the explanation of the variance in GJOBR is shown in Table 7.5. The observed values are displayed above the diagonal and the reconstructed values are displayed below the diagonal. There are no differences between the reconstructed values and the observed values. The significance of the independent variables on the dependent variables is shown in Table 7.6.



Path Analyses Project Characteristics
Figure 7.3

TABLE 7.5

HYPOTHESIS 7

RECONSTRUCTED AND OBSERVED CORRELATIONS OF CHARACTERISTICS ON PROJECT SUCCESS (GJOBR)

	GJOBR	GOTH[a]	GC[b]
GJOBR	1.00	0.49	0.41
GOTH	0.49	1.00	0.27
GC	0.41	–	1.00

[a] Other software used on project besides ADA, FORTRAN, C, PASCAL, or ASSEMBLY

[b] Software used on project is C

Leadership Characteristics, Management Controls, and Project Characteristics

This analysis was performed to assess the causal relations of leadership characteristics, management control functions, and project characteristics on the three measures of success. The analysis did not consider the indirect effects which various combinations of leadership characteristics, management control functions, or project characteristics may have on each other. The analysis combined the path models in Figure 3.2 through 3.4 into one model to assess the causal relation these combined models have on the three measures of success. The results are shown in Figure 7.4.

The combined characteristics account for 28% (R^2 =.28, F(3,51) = 6.6) of the variance in the weighted score of project success (GAATOTAL) in the path model. There are three variables directly accounting for the explanation of variance. Two of these are positively related to project success and one is negatively related to project success. The two positive relations are exhibited by the effectiveness of schedule control (GSEFF) and a method of management control (GSOTH) other than the specific methods of CSCS, CSSR, PERT, or PERT/CPM. The negatively related variable is the direct domain of achieving styles (DIRDOMN).

TABLE 7.6

HYPOTHESIS 7

PROJECT CHARACTERISTICS
PATH ANALYTICAL MODEL

DEPENDENT VARIABLE

GAATOTAL Weighted score of project success

$R = .36$ $R^2 = .13$ Adj $R^2 = .12$ $F = 8.1$ SIG $F = .0063$

INDEPENDENT VARIABLES

		B	BETA	SIG
GPAS	PASCAL software used on project	1.77	0.36	.01
	Constant	1.29		

DEPENDENT VARIABLE

GJOBR Managers' rating of project success

$R = .57$ $R^2 = .32$ Adj $R^2 = .30$ $F = 12.3$ SIG $F < .0001$

INDEPENDENT VARIABLES

		B	BETA	SIG
GOTH	Software other than ADA, FORTRAN, PASCAL, C, or ASSEMBLY used on project	1.10	0.41	.00
GPAS	PASCAL software used on project	0.49	0.30	.01
	Constant	1.76		

DEPENDENT VARIABLE

GATOTAL Weighted score of managers' success

$R = .51$ $R^2 = .26$ Adj $R^2 = .24$ $F = 18.4$ SIG $F < .0001$

INDEPENDENT VARIABLES

		B	BETA	SIG
GPAS	PASCAL software used on project	1.61	0.51	.00
	Constant	1.94		

TABLE 7.7

THE RECONSTRUCTED AND OBSERVED CORRELATIONS OF LEADERSHIP CHARACTERISTICS, MANAGEMENT CONTROLS, AND PROJECT CHARACTERISTICS ON DIMENSIONS OF SUCCESS

	GAATOTAL	GATOTAL	GJOBR	DIRDOMN	GSOTH	GSEFF	GPAS	GPERTC	GBEFF	GTEFF
GAATOTAL[a]	1.00	–	–	–0.29	0.36	0.37	–	–	–	–
GATOTAL[b]	–	1.00	–				0.51	0.62	0.59	–
GJOBR[c]	–	–	1.00	–	–	–	–	0.64	–	0.44
DIRDOMN[d]	–0.29	–	–	1.00	–	–	–	–	–	–
GSOTH[e]	0.36	–	–	–	1.00	–	–	–	–	–
GSEFF[f]	0.38	–	–	–	–	1.00	–	–	–	–
GPAS[g]	–	0.51	–	–	–	–	1.00	–	–	–
GPERTC[h]	–	0.62	0.64	–	–	–	–	1.00	–	–
GBEFF[i]	–	0.59	–	–	–	–	–	–	1.00	–
GTEFF[j]	–	–	0.44	–	–	–	–	–	–	1.00

[a] Weighted score of project success
[b] Weighted score of managers' success
[c] Managers' rating of project success
[d] Direct domain of achieving styles
[e] Method of management control other than CSCS, CSSR, PERT, or PERT/CPM
[f] Managers' rating of schedule control effectiveness
[g] PASCAL software is used in the project
[h] PERT/CPM is the management control system used on the project
[i] Managers' rating of budget control effectiveness
[j] Managers' rating of technical control effectiveness

The variables which indirectly affect the weighted score of project success (GAATOTAL) are all positively related to project success. These variables include the use of PERT/CPM for management control (GPERT/C), the imposition of management controls by the corporation or others (GCORP and GCOTH), the managers' need for both schedule and technical control (GSNEC and GTNEC), and the managers' information about and authority on the project (GINF and GAUTH).

The combined characteristics account for 53% ($R^2 = .53$, $F(3,51) = 19.5$) of the variance in the weighted score of the managers' success (GATOTAL) in the path model. There are three variables directly accounting for the explanation of variance and are all positively related to GATOTAL. These are the use of PASCAL software language on the project (GPAS), the use of PERT/CPM for management control (GPERTC), and the effectiveness of budget control on the project (GBEFF).

The variables contributing to the indirect effect are also all positively related to the managers' success (GATOTAL). These variables identify whether the corporation or others imposed management control on the project (GCORP and GCOTH), the managers' need for schedule and technical control on the project (GSNEC and GTNEC), and the managers' information about and authority on the project (GINF and GAUTH).

The combined characteristics account for 47% ($R^2 = .47$, $F(2,52) = 22.8$) of the variance in the managers' rating of project success (GJOBR). There are two variables directly accounting for this explanation of variance, both of which are positively related to GJOBR. The first is the use of PERT/CPM for project control (GPERTC), and the second is the effectiveness of technical control on the project (GTEFF).

The variables contributing to the indirect effect on project success are similar to those encountered for both GAATOTAL and GATOTAL. One distinct difference is noted. The managers' authority (GAUTH) has a positive relation to the managers' need for schedule control (GSNEC), but has a negative relation to the effectiveness of technical control on the project (GTEFF). The implication, in so far as technical control is concerned, is that the managers in this research may have their authority usurped in regard to technical matters related to the project.

A reconstruction of the correlations between the variables directly contributing to the explanation of variance in the three measures of success GAATOTAL, GATOTAL, and GJOBR is shown in Table 7.7. The observed values are displayed above the diagonal and the reconstructed variables are displayed below the diagonal. The differences between the reconstructed values and the observed values are attributed to correlations among the residuals, errors, or variables missing from the path analysis. The significance of the independent variables on the dependent variables is shown in Table 7.8.

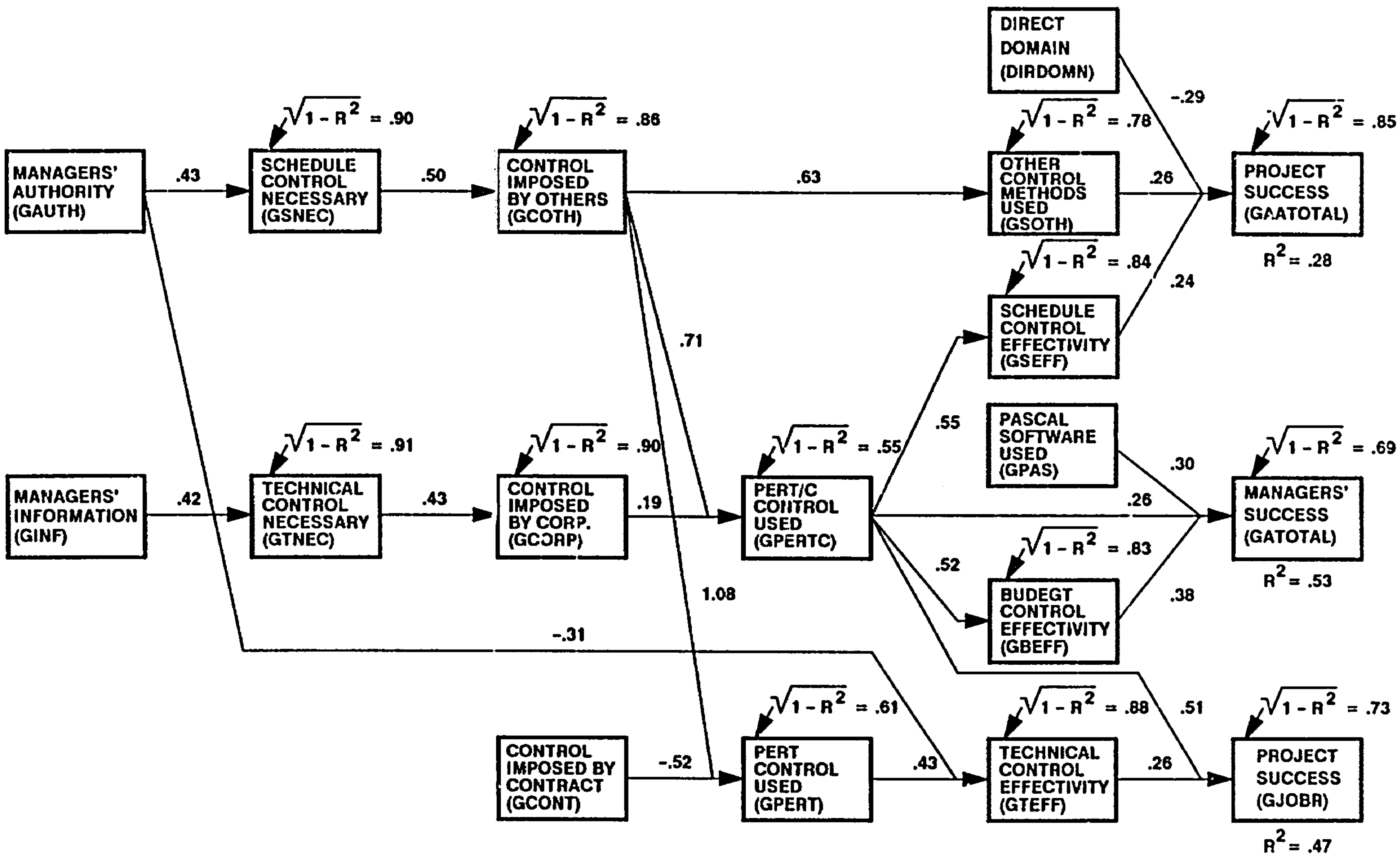
Summary

The results of the path analyses do show the causal relationships which exist between leadership characteristics, management control functions, project characteristics, and the measures of success, GAATOTAL, GATOTAL, and GJOBR. The principal factors affecting the measures of success, as seen in Figure 7.4, are those related to management control functions.

We do see some minor effect on project success with regard the achieving styles employed by the project manager. These are negatively related to project success. This same relationship was seen in the analysis of hypothesis 3 where the competitive direct achieving style was negatively related to project success (GAATOTAL).

There is very little effect on success caused by project characteristics. What little effect occurs is the result of using the software language PASCAL on the projects (GPAS). The use of PASCAL is positively related to the project managers' success rather than to the projects' success. There were no other project characteristics in the path model related to any measure of success.

The results do not support the hypothesis that the causal effects of leadership characteristics contribute more to project success than the causal effects of management controls contribute to project manager success. We do see, however, that the combination of leadership characteristics and management controls and their contribution to to success are better than either taken individually. The use of and effectiveness of management controls, however, appears as the major contributor to success for the projects and the project



Path Analyses Leadership, Management Control, and
Project Characteristics on Project and Manager Success
Figure 7.4

TABLE 7.8

HYPOTHESIS 7

LEADERSHIP CHARACTERISTICS, MANAGEMENT CONTROL FUNCTIONS, AND PROJECT CHARACTERISTICS PATH ANALYTICAL MODEL

DEPENDENT VARIABLE

GAATOTAL Weighted score of project success

$R = .53$ $R^2 = .28$ Adj $R^2 = .24$ $F = 6.6$ SIG $F = .0007$

INDEPENDENT VARIABLES

		B	BETA	SIG
DIRDOMN	Direct domain of achieving styles	–0.53	0.22	.02
GSOTH	Other methods of management control	0.77	0.26	.05
GSEFF	Effectiveness of schedule control	0.26	0.24	.06
	Constant	4.25		

DEPENDENT VARIABLE

GJOBR Managers' rating of project success

$R = .68$ $R^2 = .47$ Adj $R^2 = .45$ $F = 22.9$ SIG $F < .0001$

INDEPENDENT VARIABLES

		B	BETA	SIG
GPERTC	PERT/CPM used as management tool	1.93	0.55	.00
GTEFF	Effectiveness of technical control	0.17	0.26	.02
	Constant	1.23		

DEPENDENT VARIABLE

GATOTAL Weighted score of managers' success

$R = .73$ $R^2 = .53$ Adj $R^2 = .51$ $F = 19.5$ SIG $F < .0001$

INDEPENDENT VARIABLES

		B	BETA	SIG
GBEFF	Effectiveness of budget control	0.26	0.38	.00
GPAS	PASCAL software used on project	0.95	0.30	.01
GPERTC	PERT/CPM used as management tool	0.80	0.26	.05
	Constant	2.91		

managers studied in this research. Nevertheless, it is interesting to note that the managers' authority and information about the projects indirectly affect project and project manager success. This would indicate that the managers information about and the authority they feel they have on their projects would make the managers more effective in applying the management controls. The hypothesis was not proven.

CHAPTER 8

SUMMARY AND SUGGESTIONS FOR FUTURE RESEARCH

Chapters 4 through 7 presented the analytical results of this research and the findings for each hypothesis. This chapter summarizes these findings, relates the findings to other research, and explores the theoretical and practical implications. The limitations of the research will also be presented, together with suggestions for future research and concluding remarks.

Summary of Factors Analyzed

Seven hypotheses were explored relating to leadership characteristics, management control functions, and project characteristics. These factors were examined in relation to project success and project management success. There were three measures of success used in this research. Two of these measured project success. These were the managers' subjective rating of project success (JOBR or GJOBR) and a weighted objective score of project success (AATOTAL or GAATOTAL). The only distinction between the two variables used for each measure of success is the data file with which they are used. The variables AATOTAL and JOBR are used with the project data file, and the variables GAATOTAL and GJOBR are used with the personal (managers) data file. The third measure of success was the project managers' weighted objective score of success (ATOTAL or GATOTAL). The distinction between the two variables is again dependent on the data file used.

The specific leadership characteristics examined related to the project managers' leadership style, achieving styles, needs for power and achievement, their educational background, experience, time in current position, and tenure with the firm. These leadership characteristics were evaluated in terms of their contribution to the projects' success and the project managers' success.

The management control functions explored included the managers' needs for control, the controls employed, who imposed the controls (contract, corporate, department, etc.), the effectiveness of the imposed controls, and the role played by the managers in the imposition of the controls. These management control functions were assessed in relation to their contribution to the projects' and the project managers' success. The management control functions, combined with the leadership characteristics, were then evaluated in terms of their contribution to the measures of success.

The project characteristics evaluated included the projects size, technical composition, and technological complexity. Two determinants of project size were established: the size as determined by the projects' engineering budget and the size determined by the projects' contract value. These were then grouped into three categories identified as small, medium, or large for further evaluation. The projects' technical composition was evaluated based on the software content in the projects' engineering budget. The median point was initially chosen for this evaluation, i.e., projects containing 30% or more software and projects containing less than 30% software. The variance explained in project success for either case was markedly similar. Two additional evaluations were performed: 1) no control of software content was considered: and 2) four distinct classes of software content were considered. The projects technological complexity was also dichotomized into two groups predicated on the median value of technological complexity.

A path analysis provided the final evaluation of these three characteristics and their relation to the three dimensions of success. Four path models were evaluated. Three path models examined the relationship which leadership characteristics, management control functions, and project characteristics, taken individually, had on the three measures of success. The set of leadership, management control, and project characteristics were then combined. Their joint effect on the three measures of success constituted the fourth path model.

Results of Analyses

A summary of the results obtained in this research is presented in Table 8.1. The hypotheses are restated for reference and the analytical method used in the analysis is identified. The principal dependent variables used in the analysis are referenced and the key results provided. We will now discuss the findings for each of the hypothesis examined in this research.

Discussion of Results

Hypothesis 1

The results of the regressions indicate that as project size increased, the variance accounted for in the dependent variable either increased or stayed about the same. As project size increased, the sign of the independent variables which accounted for the variance in project success change as do the variables themselves.

The independent variables on small and medium size projects, with one exception, are positively related to project success. The variables in turn are those which define the management control method and the type of contract on which the project is performed. The management control method used is PERT and its use is imposed by the corporation. The type of contract is a cost plus incentive contract (CPIF). The indication is that cost plus incentive contracts are not as much concern, or problem, as are the fixed price incentive (FPIF) contracts that are negatively related to project success. Fixed price (FP) and cost plus (CPFF) projects did not appear in the regressions. The project managers also feel they have sufficient authority on the small projects to achieve their objectives.

Control imposed by the corporation on medium size projects is positively related to project success. Control imposed by the department in which the project is performed, however, is negatively related to project success. There are several plausible explanations. Either the corporate controls are not complied with at the department level, or the department controls, if used, are inadequate. The results suggest a combination of both.

TABLE 8.1

ANALYTICAL RESULTS OF HYPOTHESIS EVALUATION

Hypothesis	Analytical Method	Dependent Variables	Results			
			SIZE		JSIZE	
			R^2	Ad R^2	R^2	Ad R^2
1. Effectiveness of management controls is dependent on project size. The larger the project the less effective management controls are in ensuring project success.	Multiple regression controlling for project size.	AATOTAL				
		Size=Small	.13	.10	-	-
		Size=Medium	.17	.14	.46	.42
		Size=Large	.26	.22	.31	.26
		JOBR				
		Size=Small	.37	.33	.42	.36
		Size=Medium	.35	.32	.25	.20
		Size=Large	.37	.35	.39	.35
			Proj. Level		Corp. Level	
			R^2	Ad R^2	R^2	Ad R^2
2. The effectiveness of leadership characteristics on project success is dependent on the management level of the project manager. The higher the management level,the less effective leadership characteristics alone are on project success.	Multiple regression controlling for management level.	GAATOTAL				
		Level=1	-	-	.50	.44
		Level=2	.18	.15	.15	.13
		Level=3	NA	NA	-	-
		GJOBR				
		Level=1	.48	.43	.47	.43
		Level=2	.44	.38	.50	.45
		Level=3	NA	NA	.56	.49

TABLE 8.1 (Cont'd)

ANALYTICAL RESULTS OF HYPOTHESIS EVALUATION

Hypothesis	Analytical Method	Variables Defining	Results			
			GAATOTAL		GJOBR	
			R^2	Ad R^2	R^2	Ad R^2
3. Leadership characteristics coupled with management controls will lead to project success greater than that achieved by leadership characteristics or management controls alone.	Multiple regression	Leadership characteristics	.18	.15	.44	.38
		Management controls	.23	.20	.51	.48
		Leadership and management controls	.44	.39	.51	.48
			AATOTAL		JOBR	
			R^2	Ad R^2	R^2	Ad R^2
4. Project size, technical compc sition, and technological complexity are determinants of project suc:ess. As project size, proportion of so ware in project composition, and tecl nological complexity, increase, singly or in combination, project success will decline.	Multiple regression	Project Characteristics:				
		Engineering size	.12	.11	.05	.04
		Total project size	.06	.05	.03	.01
		Software Content:				
		LE 30%	.32	.18	-	-
		GT 30%	.27	.24 .	08	.06
		Technological complexity:				
		GT 3.6	.21	.17	-	-
		LE 3.6	-	-	.13	.11

TABLE 8.1 (Cont'd)

ANALYTICAL RESULTS OF HYPOTHESIS EVALUATION

Hypothesis	Analytical Method	Variables Defining	Results: AATOTAL R^2	AATOTAL Ad R^2	JOBR R^2	JOBR Ad R^2
5. Projects will be more successful when led by managers having the most experience, tenure, and cross-discipline training in the disciplines comprising the project. This will be more pronounced on those projects on which software comprises a significant portion of the engineering budget.	Multiple regression	Software Content:				
		No control for	.08	.06	.05	.04
		LT 20%	.18	.15	-	-
		GE 20%, LT 40%	-	-	-	-
		GE 40%, LT 60%	-	-	.16	.13
		GE 60%	.62	.58	.36	.29
	Discriminant analysis	Project Success: SUCCESS=1 SUCCESS=0	Correctly classified 81% of successful projects (1) and 55% of unsuccessful projects (0).			
6. Project management success is dependent on project managers with high motivational needs for both high power and achievement, multiple dominant achieving styles, and with middle LPC leadership styles.	Multiple regression	Need for power and achievement	MMOT = 1 n=30 MMOT = 0 n=22 MMOT =-1 n=03			
			GATOTAL			
	Multiple regression	Leadership characteristics	R^2 =.38		Ad R^2 =.33	
	Mean of test result	Leadership style	M=70.8		SD=8.5	
	Discriminant analysis	Managers' success MGRSUC=1 MGRSUC=0	Correctly classified 90% of successful managers (1) and 19% of unsuccessful managers (0).			

TABLE 8.1 (Cont'd)

ANALYTICAL RESULTS OF HYPOTHESIS EVALUATION

Hypothesis	Analytical Method	Variables Defining	Results	R^2	Ad R^2
7. There is a causal relationship between management controls, project characteristics, and project success. A similar causal relationship also exists between leadership charteristics and project management success. The leadership characteristics so defined will have more effect on project success than the management controls have on project management success.	Path analyses	Leadership characteristics	GAATOTAL	.18	.15
			GJOBR	.14	.13
			GATOTAL	.13	.11
		Management controls	GAATOTAL	.14	.12
			GJOBR	.47	.45
			GATOTAL	.47	.45
		Project characteristics	GAATOTAL	.13	.12
			GJOBR	.32	.30
			GATOTAL	.26	.24
		All characteristics	GAATOTAL	.28	.24
			GJOBR	.47	.45
			GATOTAL	.53	.51

The small and medium size projects examined in this research are small enough to escape the intensive Cost/Schedule Control System controls imposed on development contracts valued at $25 million or more. For the medium size projects we see corporate control, if used, is positively related to project success. This suggests that standardization of control and reporting methods are employed across all departments when complying with corporate standards. If each department uses its own control methods, this standardization of control and reporting is lost. There is no unity in the control system, and all common grounds by which problems, when encountered, can be resolved are no longer available to the project managers.

The large projects in this research are sufficiently large to warrant the use of CSCS control methods. The success of this control method, as is the case in many others, is dependent on how well the work breakdown structure (WBS) is defined, department tasks are assigned, and how these tasks are budgeted. Ideally, each department (cost center) is tasked and budgeted for the elements of work in their purview. Nevertheless, if project managers are charged with responsibility for budgets over which they have no control, the project managers may not view contract imposed project control as very effective. The same effect will occur if the project managers are charged with budget responsibility in departments in which they have no authority.

This effect is seen in the regressions on project success of the independent variables related to management control. The project managers in this research indicate that budget control is effective. The results indicate, however, that budget control and the contract imposed control system are negatively related to project success. A frequent complaint aired in the project managers' responses to the project management questionnaire was the lack of timeliness and usefulness in project budget reports. We also see that the project managers feel they have little authority on the large projects. Presumably this also relates to their control and authority over budgets.

This negative relationship is seen somewhat in the responses to the Profile of Organizational Characteristics in Appendix E. The project managers in this research view the control functions as relatively concentrated in upper management with only minimal delegation downward of this responsibility. On the other hand they desire to see a greater delegation of the control function to lower levels of management.

The hypothesis is supported. Control functions are demonstrated to be positively related to project success on small size projects. As project size increases, the positive relationship of management control functions to project success declines and becomes negative.

Hypothesis 2

The results of the analysis support the hypothesis. The regressions performed in this analysis indicate that leadership characteristics account for a greater percent of the variance in project success for the lower, as opposed to the upper, tiers of corporate and project management. The leadership characteristics which explain the variance differ depending on which measure of project success (GAATOTAL or GJOBR) is evaluated.

The regressions against the weighted objective score of project success (GAATOTAL) suggest task–oriented leadership characteristics are negatively related to project success. The regressions against the managers' subjective rating of project success (GJOBR) suggest a relational or political management style is conducive to project success. The leadership characteristics which regressed against GAATOTAL had a predominant negative relation to project success. The converse was true for the leadership characteristics which regressed against GJOBR.

Kemp (1982), in a study of project management on high technology projects, hypothesized that project success is determined by the project managers' rank. The respondents in his study consisted of 68 military officers in the Army, Navy, and Air Force at senior or flag rank, and 63 industry leaders at director or vice–president rank. He found a very weak relationship between project managers' rank and project success and concluded the hypothesis was not proven. The findings in this study indicate that, the higher the managers' rank in the firms' hierarchy, the less positive effect they have on project success.

Regressions against GAATOTAL

Corporate Management Level

The regressions against GAATOTAL, when controlling for corporate management level, show that the upper tier corporate managers leadership style (LPCD1) and effectiveness in guiding a group to its goal (VARM16) significantly detract from project success. These managers' leadership style was shown in Chapter 5 to be more task–oriented than relational–oriented. Their leadership style and inability to guide a group to its goal are characteristic of managers who have high direct achieving style scores. These managers may feel the project goals are inadequate or do not meet the exacting standards which they, as direct achievers, would have established. Rather than accept the project's goals as their own and work toward these goals, these managers tend to impose their own standards on the project and members of the project group.

The upper level corporate managers do, however, exhibit a vicarious relational achieving style which is positively related to project success. Although they may not directly contribute to a project, their praise, encouragement, or simple recognition of project members may contribute indirectly to project success.

The lower tier corporate managers also exhibit a direct achieving style through their desire and ability to initiate independent action (VARM12). The negative effect on project success is not as significant as that seen for the upper level corporate managers.

Project Management Level

The negative relationship leadership characteristics have to project success is repeated when controlling for project management level. The program managers' leadership style (LPCD1) and the project engineers' competitive direct achieving style (COMPDIR2) are again indicative of a task–oriented management style. Both leadership characteristics detract from project success, the latter more so than the former.

Project engineers desire for independence is markedly similar to individuals who prefer a direct achieving style. Direct achievers seek to determine their own goals and the means for pursuing them. Individuals who use a direct achieving style seek out, select, and/or initiate activities that are in direct conflict with the task. Project engineers exhibiting these characteristics, on projects with preestablished goals, would severely detract from project success.

Regressions against GJOBR

Corporate Management Level

The regressions against GJOBR, when controlling for corporate management level, provide a sharper contrast to the effect of leadership characteristics on project success. The upper tier corporate managers' collaborative relational achieving style is positively related to project success. Collaborative relational achievers are characterized by an inclination to accomplish tasks through group goals. They expect to share both the rewards and responsibilities for the groups' accomplishments. They usually strive to achieve smooth working relationships with team members. They also tend to accept the group's goal, but may or may not determine the means by which they contribute to the group's goal.

The use of a competitive direct achieving style by the upper tier corporate managers is negatively related to project success. This particular achieving style appears in two of the management subsets created for this analysis. The common management level in these two management subsets is the middle manager. The competitive direct achiever not only tries to perform tasks well, but to outperform all other contenders. They have high internal standards of excellence, but are more concerned with external standards of excellence by which they may be compared to other competitors. They define situations as competitive and others as competitors, whether working in a group or alone. For them, competitive situations are exciting.

The results suggest there are three other distinct leadership characteristics associated with the middle managers. These are: 1) reliant instrumental achieving style; 2) personal instrumental achieving style; and 3) the ability to engage in power and politics. These three characteristics do not appear in the regressions for either the corporate management subset of senior, upper, and middle level managers, or the corporate management set of supervisors and non-supervisors. They only appear in the regressions for the management subset of middle managers, supervisors, and non-supervisors. Consequently, these three leadership characteristics are attributed to the middle level managers.

The combination of these leadership characteristics may distinguish these people as charismatic leaders. Recall the words of Zaleznik previously cited in Chapter 2.

> One often hears leaders referred to in adjectives rich in emotional content. Leaders attract strong feelings of identity and indifference or of love and hate. Human relations in leader dominated structures often appear turbulent, tense, and at times disorganized. [1]

He went on to say that the leaders' attitude toward goals is:

> To change the way people think about what is desirable, possible, and necessary. . .Where managers act to limit choices, leaders work in the opposite direction to develop fresh approaches to long standing problems and to open issues for new options. Leaders create excitement in work. [2]

The use of the competitive direct achieving style can create excitement in work if properly channeled. The managers' use of the personal instrumental style reflects their efforts to project their charisma and, by so doing, draw others into their orbit as well as to their tasks. They avoid arousing hostility, and, in fact, attempt to stimulate whole hearted commitment from subordinates by treating them as peers on whose efforts they depend.

The managers' ability to engage in power and politics is consistent with prior findings (Mintzberg, 1983). Mintzberg does caution that without authority, ideology, and a system of expertise to integrate the organization members to achieve coordination and consensus, a system of power outside the legal constraints will arise. In this context he defines politics as:

> Individual or group behavior that is informal, ostensibly parochial, typically divisive, and above all, in the technical sense illegitimate – sanctioned neither by formal authority, accepted ideology, nor certified expertise. [3]

The corporate management subset of supervisors and non-supervisory professionals exhibit an aspect of the personal relational achieving style in their ability to effectively coordinate work. This corporate management subset contains a large number of project engineers (i.e., 21) who have high intrinsic direct achieving style scores. This may explain why this management subset's contributory relational achieving style is negatively related to project success.

Intrinsic direct style achievers prefer to rely primarily on themselves. They prefer to set their own goals and the means to achieve them. On the other hand, contributory relational achievers contribute actively and directly to another's accomplishment. They also accept as their own the goals defined by the other achiever. The implication here is that the high intrinsic direct achievers in this group perform to their own internal standards of excellence and do not recognize the importance their work has to the group.

The intrinsic direct achievers may become so involved in doing the task well they fail to recognize when objectives are met. The pursuit of their own goals detracts from their contribution to the project. This, in turn, may explain why, at this management level, the managers' ability to organize and present information clearly and convincingly is negatively related to project success. They may have become so engrossed in the minute details of their own tasks that they have lost perspective on the larger task at hand and, thus, cannot communicate how their part relates to the whole.

Project Management Level

The regressions against GJOBR, when controlling for project management level reveal a strong relational and political management style that is positively related to project success. The managers in the management subset of program and project managers are effective in coordinating personal and group work structure, processes, and tasks. This ability may reflect their high collaborative relational achieving style scores. The collaborative relational achievers have an inclination to accomplish tasks through group effort and believe their best accomplishments occur in group settings.

This management subset also has high power direct achieving style scores. Their ability to coordinate groups may also reflect some attributes of their power direct achieving style. Power direct achievers have a predilection for taking charge, controlling and/or organizing other individuals, resources, and situations related to task accomplishments. The project managers who use this achieving style relish situations which permit controlling and/or organizing people.

We also see this project management subset's reliant instrumental achieving style is positively related to project success. The reliant instrumental achieving style is marked by a reliance upon others to assume part or all of the responsibility for one's own successful task completion. They perceive virtually everyone as natural resources from whom to draw help in accomplishing their tasks. They routinely look to others to advise, encourage, or otherwise help them accomplish their tasks.

This management subset has difficulty in organizing and presenting information clearly and convincingly. They do not appear very adept at communicating their needs to others. The problem appears associated with the program managers whose personal instrumental achieving style is negatively related to project success. This suggests that the program managers in this research are not very effective in their interpersonal skills and persuasiveness to achieve their objectives. Either that or they are too far removed from the projects for their interpersonal skills and persuasiveness to be effective. They may rely more on their position power (i.e., use of their power direct achieving style) to direct others to task accomplishment.

The regressions against project success for the management subset of project managers and project engineers indicate their reliant and personal instrumental achieving styles are positively related to project success. Their competitive direct achieving styles are negatively related to project success. These results are markedly similar to those obtained for the corporate management subset of middle managers, supervisors, and non-supervisory professionals.

The reliant instrumental achieving style appears related to the project managers. This achieving style appears in both management subsets which share project managers as a common management level. Similar reasoning indicates the competitive direct achieving style is also associated with the project managers. This achieving style does not appear in either the regressions for program managers or project engineers alone.

The personal instrumental achieving style in this management subset appears principally related to the project engineers. This same achieving style appears in the regressions for project engineers alone together with the variable representing their skill in reacting to the needs of others. The project engineers in this research are the lowest management level in the project management hierarchy. They do not wield the authority of either the program or project managers. The results suggest they rely on their interpersonal skills and their sensitivity to other's needs to accomplish their tasks.

Hypothesis 3

The results of the analysis support the hypothesis. Taken separately, leadership characteristics and management controls account for less of the variance in project success then when these two factors are combined.

Leadership Characteristics

The leadership characteristics that are positively related to project success are the managers' reliant instrumental and vicarious relational achieving styles, and their ability to exercise political influence on the projects. On the other hand, their competitive direct achieving style and inability to communicate clearly and convincingly are negatively related to project success.

The three positive factors contributing to project success are interrelated. The reliant instrumental achievers may have considerable personal self–confidence with regard to the task at hand, but the structure of the role they occupy may demand they rely on others to assume part or all of the responsibility of their own task completion. The project manager may also be an expert in the disciplines upon which the project team is working, but must rely on those who are performing the task. They may define the projects' goals, but may or may not be able to maintain control over their implementation. The managers may give direction, but are reliant on the project team to accomplish the task.

The vicarious relational achievers take pride and satisfaction from the achievements of others, including organizations, as if these accomplishments were their own. They do not participate directly in the tasks of the group or organization which they admire, but may help indirectly by offering praise, encouragement, or even advise. This role is frequently filled by the project manager who is charged with overseeing the work of others. The project manager is frequently heard as a voice in the praise of a particular group or organization which performs well and with whom the project manager is associated.

The use of political influence and its relation to project success is best described by Mintzberg (1983) who refers to a political game he calls the alliance-building game.

> This game to build a power base is played among peers – often managers of the middle line, sometimes professional in the staff or operating functions – who negotiate implicit contracts of support for each other. [4]

Mintzberg cited another study in which the author states:

> The middle manager attempts to develop a network of social relations with others in strategic positions and to surround himself with allies in a position to support him with resources such as information. . . With this help of allies, the middle manager is able to expand his influence and thus overcome the structural limitations of his role. [5]

The project managers dependency on others to aid and abet them in achieving their objectives would support the use of politics to accomplish their task. This is particularly important if they must establish alliances with their peers to obtain the necessary resources and/or support to enable them to complete their projects.

The project manager with a competitive direct achieving style views all situations competitively. For such managers, winning is their driving concern. On projects, where group performance is essential to success, this particular achieving style is not amenable to project success. Managers who use this style exclusively would cause considerable conflict between themselves and those from whom they need support.

The lack of communication effectiveness was also seen in Hypothesis 2 and is primarily associated with the supervisors and non-supervisory personnel who are charged as project engineers. This problem is depicted in the results of the Profile of Organizational Characteristics in Appendix E. The project managers in this research believe that information flow is generally downward and their superiors are not that familiar with the project managers' problems, i.e., lack of upward information flow. This is not consistent with the importance placed on communications in the work environment on successful projects. If there is a difficulty in the communications flow, then perhaps as Tushman and Scanlon suggest,

> Management . . . must create the climate in which it is legitimate to ask for assistance, in which providing this expertise is recognized, valued, and rewarded. Norms must evolve so that those with the relevant task expertise, whether they be supervisors or peers, are encouraged to provide work related assistance to their colleagues.[6]

Management Control Functions

Management controls alone account for a greater percent of the variance in project success than do leadership characteristics alone. The management control variables are all positively related to project success. The variables are associated with the method of management control used (PERT/CPM), the use of budget control on the project, and the managers' assessment of schedule control effectiveness. These controls are imposed on fixed price projects. The implication is that budget and schedule control on fixed price projects do contribute to project success.

Leadership Characteristics and Management Control Functions

The combination of management controls and leadership characteristics does account for a greater percent of the variance in project success then either factor alone. The regression of the combined factors against the weighted score of project success (GAATOTAL) result in a different set of leadership characteristics then when leadership characteristics alone were regressed against GAATOTAL. No leadership characteristics appeared in the regression of the combined factors against the managers' rating of project success (GJOBR).

The regression of the independent variables against GAATOTAL resulted in two leadership characteristics negatively related to project success. These were the managers effectiveness in supporting the organization's goals and missions and their ability to resolve conflicts.

An explanation of these findings is offered based on a study performed by Dill and Pearson (1984). Their study addressed the effectiveness of project managers in the context of an organizational politics model. The organizational politics model which they propose stresses that individual and group goals are not necessarily consistent with organizational goals. They believe that the career interests of the project managers may be the cause for the apparent dysfunctional behavior in project management systems. They suggest that the project managers are more interested in their own careers and the recognition they receive from their colleagues and peers than in tying their wagon to the organization's objectives. They state:

> In a functional structure, matrix structure, and a pure project structure, the status and career progression of the project manager is either limited (functional) or uncertain (matrix, project). Project managers often express concern that the closure of a project may lead to their return to a subordinate position with corresponding loss of authority, esteem, and status.[7]

The indication is that these individuals are more interested in their careers and the recognition they receive from their peers and colleagues. Another possible explanation is that these managers are unable to operationalize the organization's goals to be in consonance with the project's goals. This would then explain the project managers' inability to resolve conflict. They simply may be caught between a rock and a hard spot.

The variables defining management control functions were all positively related to project success. The independent variables indicate that corporate imposed management control tool (PERT/CPM) on fixed price projects, requires the projects to use budget control, and is effective in schedule control.

Hypothesis 4

The effect of project size, technical composition, and technological complexity on project success is aptly illustrated in Tables 6.5 and 6.7. From Table 6.5 we can see that as project size increases there is a corresponding decline in the proportion of successful projects. This fact is further illustrated in Table 6.7 as is the effect of technical composition and technological complexity on project success. We note that as the percent of software (SW) in the project increases there is a corresponding decline in project success. A similar relationship also exists between technological complexity and project success.

The regressions of project size, technical composition, and technological complexity on project success accounted for little of the variance in project success. The only independent variable in the regression equation was project size. It is negatively related to project success indicating support for the hypothesis that project size does negatively relate to project success, i.e., the larger the project, the less successful the project.

When controlling for the percent content of software in the project, and the software content was less than 30%, two variables were negatively related to project success (AATOTAL). These were the complexity of the software used on the project (SWCOMP) and the software language used on the project (OTH). The hardware complexity on the project was positively related to project success.

The results suggest even when software does not constitute a major portion of the project's engineering value, the significance of the software language used and the complexity of the software are probably not understood by the project managers. The managers on these projects have more years experience in hardware design and hardware management then they do in software design and software management. Hardware complexity is not viewed as a problem on these projects and, in fact, as the regressions show, is considered to be positively related to project success.

When software comprised more than 30% of the project, the hardware complexity (HWCOMP) and the use of the ADA programming language (ADA) were both negatively related to project success. The software language C was positively related to the managers' rating of project success (JOBR).

The negative relationship of HWCOMP to AATOTAL is interpreted to reflect a tendency to increase hardware complexity on projects on the assumption software can be used to overcome the increased hardware complexity. ADA is increasingly being used on DoD procurements which involve software. This language and the tools available for its use are still in their infancy. Until the language achieves the maturity of FORTRAN, or some other commonly used software language, the use of ADA will reflect negatively on project success. Similarly, until the software engineers and their managers become more familiar with ADA, the use of ADA is apt to reflect negatively on project success.

The marked similarity of the variance explained in project success when controlling for software content at the median value of 30% was interesting. More so in that the software variables which explained the variance in either instance, more or less than 30%, were negatively related to project success. On the other hand, hardware complexity was positively related to project success when software was equal to or less than 30% of the projects' engineering value, but was negatively related to project success when the software content was greater than 30% of the projects engineering value.

Further regressions demonstrated that hardware complexity did not become negatively related to project success until the software content was equal to or greater than 60% of the projects' engineering value. This finding does suggest that there is an increased reliance on software as the hardware becomes more complex. This, in turn, will drive software requirements and thus, cost. Software then becomes an increasingly large portion of the engineering budget. This is particularly true as the hardware uses more and more embedded software to assume tasks formerly performed by the hardware. This is seen, for example, in flight hardware where weight reduction is critical to an aircraft's performance. Similarly, sophisticated fire control systems in land-based vehicles are using more powerful microprocessors. The use of these microprocessors enables the design of a more accurate and high performance fire control system. These dividends are counterbalanced by the increased complexity and cost of the software.

When controlling for the projects' technological complexity, there were two variables accounting for the variance in project success (AATOTAL) on the most complex projects and were the software complexity and the use of the software language ADA. For the least complex projects, the project size (VALUEEK), as measured by the engineering budget, was negatively related to project success and was the only independent variable accounting for the variance in project success.

Table 6.12 illustrates this finding. We note that the less successful projects (SUCCESS = 3 and 4) contain the most complex software (SWCOMP). Further, the least successful projects (SUCCESS = 4) not only have the most complex software, but use the highest proportion of ADA and ASSEMBLY language software. The use of ASSEMBLY language is normally associated with embedded software and is frequently referred to as machine language or firmware. It resides in the microprocessor memories in the hardware. As hardware technology becomes more complex, the requirements for more complex software increase. The results are increased costs, and when success is measured by cost and schedule variables, less successful projects.

There is an increasing awareness that the growing dependency on software in major DOD procurements has an impact on project success, De Roze and Nyman (1977). Thayer (1981) noted the shortcomings in industry management to handle large software projects. He also suggested that academia could do a better job in preparing students to meet the demands of the practical world. Concern has been expressed about predicting and managing software costs (Warburton, 1983), the importance of estimating software costs (Smith and Mandakovic, 1985), improving the environment of software development (Stuebing, 1984), and controlling software costs through quality control (Hollocker, 1986).

The results of this hypothesis indicate there is a relation between the amount of software on a project and the projects' success. Similarly, the results show that the technological complexity of the project has a bearing on the project success. These factors would indicate the project managers' backgrounds as they relate to experience, education, tenure with the firm, etc. should have a direct bearing on project success.

Hypothesis 5

The analyses performed on this hypothesis supported the hypothesis that the project managers' professional background contributed to project success. A particularly important finding is that the independent variables defining the project managers' educational background are negatively related to project success.

The negative relation of variables defining education to project success appeared in several places. When we did not control for the projects' software content or size, we found that the project managers with an advanced degree are negatively related to the managers' subjective rating of project success (JOBR). When controlling for project size, the number of years education is negatively related to the managers' subjective rating of project success (JOBR) on medium size projects. The project managers' years of education is a negative discriminating variable in the discriminant function derived to distinguish between successful and unsuccessful projects.

The results suggest that the project managers having the most education, number of degrees, and holding advanced degrees are either over-specialized for their assignments, or their education is not related to the project management positions to which they have been assigned. For example, program managers may be MBAs who emphasize financial control without a grasp of the technical issues. Also, project engineers, for example, may have advanced degrees in hardware engineering and know very little about software engineering. Prior success on projects containing little or no software would not qualify these project engineers to direct projects containing large amounts of software.

This was noted by Cooper (1977) in the literature review in Chapter 2. He lamented the lack of corporate managers with computer related experience. Similarly, program managers with extensive backgrounds in financial management are not necessarily the best qualified managers on technically sophisticated projects that require frequent interfaces with the projects' technical managers.

When controlling for the software content in the projects' engineering budget, we found that the project managers' years of software experience was positively related to the weighted objective score of project success (AATOTAL) on projects containing less than 20% software. This is consistent with the findings in hypothesis 4. On projects in which software constituted 60% or more of the projects' engineering budget, the project managers' years of hardware and software experience were both positively related to project success. This also supports the findings in hypothesis 4, which suggests the most experienced project managers should be assigned to those projects having the most sophisticated hardware and software. There were no regressions on project success

(AATOTAL) when software was more than 20% or less than 60% of the projects' engineering budget.

The regressions on the managers' subjective rating of project success (JOBR), when controlling for the projects' software content, showed that experience as a program manager was negatively related to project success. This occurred when software was greater than 40% and less than 60% of the projects' engineering value. The program managers on the least successful projects have more program management experience than their peers on the most successful projects, but 40% less software experience. When software constituted 60% or more of the projects' engineering value, the project managers' years of software experience were positively related to project success. The change in the project managers' responsibility on assuming their current position was negatively related to project success. This might suggest support of the previously mentioned finding related to educational qualifications, that the task and the project managers' qualifications were not properly matched on assuming their current position.

The regressions on the weighted objective score of project success (AATOTAL), when controlling for project size, also resulted in positive relations to project success on the small and medium size projects studied in this research. The project managers' years of professional experience were positively related to project success on small projects. Their years of hardware experience were positively related to project success on medium size projects. There was no significant regression on project success for large size projects.

The regressions on the managers' subjective rating of project success (JOBR), when controlling for project size, showed that years of professional experience were positively related to project success on small projects. The regressions on project success for medium size projects showed that the project managers' years of education were negatively related to project success. For the medium size projects studied in this research, this finding may indicate that project managers, who have become over specialized in a specific discipline, are detrimental to project success.

The discriminant analysis performed in testing this hypothesis was able to correctly classify 70% of the projects when grouped as either successful or unsuccessful. The positive discriminating variables were the project managers' years since their BS (experience), years of software experience, and change in responsibility on assuming their current position. The negative discriminating variables were their years of education, years of hardware experience, and time spent on project business.

The positive relation of years since BS, which is related to professional experience, and years of software experience were also seen as contributors to project success in the regressions performed on project success. The positive relation of a change in responsibility in the discriminant function is interpreted to mean the change is related to success. For example, the increased responsibility is either reflective of additional work being assigned to the project manager, based on past performance, or that the project manager was promoted, based on past performance, and assumed greater responsibility.

The negative relation of years of education and time spent on project business in the discriminant function have been previously encountered in the regressions on project success. The first, years of education, is related to project managers' who are either over specialized in their positions or whose educational background is not in consonance with their assignment. The second, time spent on project business, is associated with those less successful projects which require significant time of the project managers. The negative relation the project managers' years of hardware experience has to the discriminant function, indicates the growing importance of assigning project managers' with software experience to projects which contain software.

Hypothesis 6

Managers' Needs for Both Power and Achievement

Multiple regressions were performed on the project managers' response to the Job Choice Exercise to assess the project managers' needs for both achievement and power. These results were then compared to the weighted objective score of the project managers' success (GATOTAL) which had been categorized into four classifications of success. These classifications ranked the managers as 1 = Good to outstanding, 2 = Average to good, 3 = Marginal to average, and 4 = unsatisfactory. A prior discussion of this ranking is provided in chapter 4. Thirty–nine of the project managers in this research were classified by this method as average to outstanding.

The results of the regressions indicate that 23 of the 39 successful project managers had high needs for both power and achievement. An additional 13 had either a high need for power or a high need for achievement. Only three of the project managers in this group had a high need for neither achievement nor a high need for power. The intensity of the project managers' needs for both power and achievement is shown in Table 8.2. These findings are similar to those found by prior researchers and discussed in chapter 2.

TABLE 8.2

MANAGERIAL NEEDS FOR POWER AND ACHIEVEMENT

Project Position	BETA Ach		BETA Pow	
	M	SD	M	SD
Program Manager (n = 22)	0.51	0.28	0.44	0.19
Project Manager (n = 11)	0.61	0.26	0.42	0.25
Project Engineer (n = 21)	0.61	0.25	0.28	0.25

There was no significant correlation, however, of the project managers' managerial motivation to the measures of project managers' success used in this research. In fact, the measure of managerial motivation (MMOT) is negatively correlated to the project managers' measure of success. The results suggest that successful project managers may have both high needs for power and achievement, but these conditions alone are not sufficient to predict project managers' success.

Project Managers' Achieving Styles

The regressions of the managers' success (GATOTAL) against the independent variable examined in this hypothesis resulted in three achieving styles accounting for the variance in GATOTAL. These were the competitive direct (COMPDIR2), personal instrumental (PERINST4), and collaborative relational (COLLREL7) achieving styles. The first of these, the competitive direct achieving style (COMPDIR2), is negatively related to GATOTAL.

A manager with a competitive direct achieving style views all situations competitively. For such managers, winning is their driving concern. They compete against everyone and measure everyone against their own performance. Managers, who use this achieving style predominantly to the exclusion of all others, are likely viewed by their colleagues to be uncooperative, as they would always place their colleagues in a "win-lose" position. This achieving style, if used exclusively, would cause considerable conflict between the project managers and those from whom they need support.

The other independent variables are the collaborative relational achieving style (COLLREL7) and the personal instrumental achieving style (PERINST4). Both are positively related to GATOTAL. The first (COLLREL7) is associated with an individual having an inclination to associate with and work within a group context to achieve group objectives. Project managers exhibiting this characteristic are usually considered team players.

The second variable (PERINST4) has a political connotation. Personal instrumental achievers project their own attributes to promote their own ends. Project managers who exhibit this achieving style will frequently exert political influence to achieve their objectives. They are promoters. They exude self-confidence, exhibit both negotiating and bargaining skills, and use attributes of the self to persuade and entice others to their point of view.

Table 8.3 summarizes the achieving styles of the project management hierarchy studied in this research. The results are tabulated by the three sets or domains of achieving styles: the direct, instrumental, and relational domains. As a group, the respondents have a wide range of achieving styles and exhibit medium to high intensity in all achieving styles. The results do reflect that the project managers' have considerable flexibility in their achieving styles and exhibit a situational leadership style.

TABLE 8.3

MANAGERS' ACHIEVING STYLES

Management Level	DIRECT DOMAIN					
	Intrinsic		Competitive		Power	
	M	SD	M	SD	M	SD
Program Manager[a]	5.65	0.73	4.90	0.88	5.50	1.10
Project Manager[b]	5.87	0.44	5.04	0.69	5.38	0.78
Project Engineer[c]	5.65	0.64	4.27	0.91	5.00	1.15
Management Level	**INSTRUMENTAL DOMAIN**					
	Personal		Social		Reliant	
	M	SD	M	SD	M	SD
Program Manager	4.96	1.06	4.36	0.93	4.66	0.99
Project Manager	4.53	1.13	3.89	0.63	4.58	0.98
Project Engineer	4.98	1.05	3.86	0.81	4.72	0.97
Management Level	**RELATIONAL DOMAIN**					
	Collaborative		Contributory		Vicarious	
	M	SD	M	SD	M	SD
Program Manager	5.40	0.96	5.20	0.72	4.93	0.61
Project Manager	5.29	1.06	5.15	0.89	5.16	0.72
Project Engineer	5.21	0.93	4.87	0.81	4.97	0.66

[a] n = 22
[b] n = 11
[c] n = 21

Table 8.4 regroups the results by project management level in a ranking by intensity level of the nine achieving styles. We note that the three principal achieving styles used by the respondents in this study are the same for each management level although not ranked in the same order. These are the intrinsic direct, power direct, and collaborative relational achieving styles. The results are quite similar to those obtained from the LPC, which indicated that the managers were task/relational oriented. The achieving styles least used by the project managers are the reliant and social instrumental achieving styles. The social instrumental achieving style is marked by individuals' use of relationships to further their own goals. The reliant instrumental style is characterized by the reliance of the individual upon others to assume part or all of the responsibility for one's own successful task completion.

TABLE 8.4

RANKING OF ACHIEVING STYLES BY INTENSITY LEVEL

Program Managers N = 22		Project Managers N = 11		Project Engineers N = 21	
INTDIR	5.65	INTDIR	5.87	INTDIR	5.65
PWRDIR	5.50	PWRDIR	5.38	COLLREL	5.21
COLLREL	5.40	COLLREL	5.29	PWRDIR	5.00
CONTREL	5.20	VICREL	5.16	PERINST	4.98
PERINST	4.96	CONTREL	5.15	VICREL	4.97
VICREL	4.93	COMPDIR	5.04	CONTREL	4.87
COMPDIR	4.90	RELINST	4.58	RELINST	4.72
RELINST	4.66	PERINST	4.53	COMPDIR	4.27
SOCINST	4.36	SOCINST	3.89	SOCINST	3.86

The social instrumental achieving style, if used predominantly, would lend even further support to the Dill and Pearson organizational politics model to explain the project managers inability to support the organization's goals. The ranking of the reliant instrumental achieving style would belie the project managers' dependence on others for task accomplishment. The relative ranking of the personal instrumental achieving style indicates the program managers and the project engineers do rely to some degree on their personal attributes and past achievements to obtain their objectives.

Project Managers' Leadership Style

The leadership style of the project managers in this research was overwhelmingly task–relational oriented or middle LPC: 54 of the 55 project managers in this research were identified as middle LPC. The single manager that did not score in the middle LPC range exhibited a task–oriented leadership style. There was no relationship found between the project managers' leadership style and the project managers' success in either the regression analysis or discriminant analysis performed to test this hypothesis.

The only variable examined in testing this hypothesis to which the project managers' leadership style is significantly correlated is the project managers' need for power (BPOW; $\underline{R} = .70, p < .01$). The variable defining leadership style (LPCD1) was, in fact, negatively correlated to the managers' subjective rating of their success (GTOTAL; $\underline{R} = -.01$, $p < .50$), and somewhat positively correlated to the managers' objective weighted rating of their success (GATOTAL; $\underline{R} > .00, p < .50$).

The results obtained using the Least Preferred Co–Worker Scale suggest the instrument is best used in a longitudinal study. This would permit an assessment of the project managers leadership style over the project lifecycle. The instrument, as applied in this research, provided a snapshot in time of project managers who reported on more than one project. Their leadership styles may vary from project to project or even over the project life–cycle, but the instrument is not sufficiently sensitive to distinguish among the leadership styles used by the project managers on a given project. The fact that most of the respondents did exhibit a middle LPC leadership style might suggest that the project managers in this research are sufficiently flexible to enable them to change their leadership style to match the project situation. The middle LPC leadership style does permit a wide range in which the project managers leadership style can vary: from the task–oriented to the relational–oriented.

Hypothesis 7

The results of the path analysis do not support the general hypothesis that leadership characteristics will have a greater effect on project success than management controls will have on project manager success. Nevertheless, the results of these analyses do provide insight into the direct and indirect effects the variables studied in this research have on the three defined measures of success (i.e., GAATOTAL, GATOTAL, and GJOBR).

Leadership Characteristics

The leadership characteristics directly contributing to the weighted objective score of project success were the project managers' direct domain or set of achieving styles (DIRDOMN) and their years of software experience (YRSSW). The former is negatively related to project success. The direct set of achieving styles is characterized "by a propensity to seek out, select, and/or initiate activities which permit direct confrontation with the task."[6] The emphasis is on the task, and the project managers who use these styles are concerned primarily with how well they perform the task. They wish to determine their own goals and usually the means to achieve them.

The direct achievers also are very competitive and try not only to perform tasks well, but better than all other contenders. They may have high internal standards of excellence by which they may be compared to other competitors. This characteristic was seen in the analysis of Hypothesis 2. The managers who use this achieving style may cause conflict in their environment. If this conflict is not exhibited as a healthy competition to project team members, the result will be detrimental to project success.

Another aspect of the direct achievers is their use of power. Power direct achievers are characterized by their predilection for taking charge, controlling and/or organizing other individuals and situations related to task accomplishment. If this power direct achieving style is exercised without the commensurate authority or in an overly authoritarian manner, the result will negatively affect project success. A positive aspect of this achieving style was seen in Hypothesis 2. The program managers exhibited this style indirectly through their ability to coordinate work structures and processes.

The project managers' software experience has previously been shown (i.e., hypothesis 5) to be a contributing factor to project success. This was notable on those projects in which software comprised a large percent of the projects' engineering value.

There was only one variable (i.e., INSTDOMN) which directly affected the managers' rating of project success (GJOBR). This same variable is the only variable which directly effects the managers' weighted objective score of success (GATOTAL). In both instances this variable, the instrumental domain of achieving styles (INSTDOMN), is positively related to success. This set of achieving styles is characterized by

> a propensity to seek out, select, and/or initiate activities which permit the use of personal attributes, accomplishments, and/or relationships with others as conduits to still other achievements. People who prefer these styles are primarily oriented toward the problems involved in human interaction and social systems as groups in relation to the self.[9]

The results do have a political connotation, particularly in light of the quote previously cited from Mintzberg (1983), and the effectiveness of the project managers in this study to engage in power and politics.

The results obtained in Hypothesis 2 reflect the positive effect achieved through the use of the instrumental achieving styles. We saw that the middle managers were very effective in their use of the reliant and personal instrumental achieving styles. These managers may have the authority to use power, but instead rely on requesting help (i.e., reliant instrumental) or persuading others (i.e., personal instrumental) to help achieve the managers' goals. These managers probably more effectively motivate the people they lead, and receive greater response from those they are dependent on, than those managers who rely principally on their position power to achieve their goals.

Management Control

The only management control function directly contributing to the weighted objective score of project success (AATOTAL) was the managers' rating of project schedule control effectiveness (GSEFF) and was positively related to project success. The indirect effects contributing to project success were the use of the management control system PERT/CPM imposed by the corporation (GCORP), based on the project managers' information about the project (GINF), indicating technical control was necessary (GTNEC). These indirect effects were positively related to project success (AATOTAL).

The management control functions directly contributing to the weighted objective score of project managers' success (GATOTAL) were the use of the management control system PERT/CPM (GPERTC), and the project managers' rating of the project budget control effectiveness (GBEFF). Both were positively related to the project managers' success.

The indirect effects followed two paths which were related to the use of PERT/CPM. The first path was the control imposed by the corporation (GCORP), based on the project managers' information about the project (GINF), and the project managers' need for technical control (GTNEC). The second path reflected the control imposed by others (GOTH), based on the project managers' authority (GAUTH), and the project managers' need for schedule control (GSNEC).

The management control functions which directly effect the managers' rating of project success (GJOBR) were the managers' rating of the projects' technical control effectiveness (GTEFF), and the use of the management control tool PERT/CPM (GPERTC). Both were positively related to project success. The indirect effects followed multiple paths. Two of these paths were indirectly related to project success through the use of PERT/CPM (GPERTC). These were the same paths that indirectly contributed to the managers' weighted objective score of success (GATOTAL). Two additional paths were indirectly related to project success through the managers' rating of the projects technical control effectiveness.

The first path indicates that the project management control system PERT (GPERT) was either imposed on the project by others (GOTH), based on the managers' authority (GAUTH) and the project managers' need for schedule control, or by the contract (GCONT). The control imposed by the managers' authority is positively related to the use of PERT and project success. The control imposed by the contract is negatively related to the use of PERT and project success. Several reasons are offered. The first reason is the managers/ real or perceived dislike with the reporting structure required by the contract. The administrative burden to prepare the reports required by the contract may be considered by the project managers to provide less return than the administrative cost and time required to prepare the reports. The second reason is that the PERT management control system imposed by others (i.e., managers) is not as stringent as that imposed by the contract.

The second path indicates the managers' authority (GAUTH) is negatively related to the projects' technical control affectivity and thus, to project success. Previous research has reported similar findings. Might and Fischer (1985) found that technical monitoring as a project management control system was negatively related to project success.

> The use of technical monitoring as a project management control system stands out from among all the rest in the uniformly strongly negative association between its use and project success over all success criteria.[8]

This comment was based on a study they performed on 96 different projects in 30 firms. They did acknowledge, however, that the negative relationship might reflect the technical monitoring required on those projects either already in trouble technically or felt to be on the verge of technical difficulty. More will be said of this later.

Project Characteristics

The only project characteristics which directly affect any measure of success were those which related to the software language used on the projects. All were positively related to project success. The use of PASCAL software (GPAS) was directly related to both the weighted objective score of project success (GAATOTAL) and to the weighted objective score of project managers' success (GATOTAL). In both instances the relationship is positive. Two software languages directly effected the managers subjective rating of project success (GJOBR) and were C (GC) and a software language other than ADA, PASCAL, FORTRAN, or ASSEMBLY (GOTH).

The results do need some interpretation. The use of PASCAL is not a contributor to project success, but, rather, its non use contributes to project succe~s. This is apparent when considering the number of projects examined in this research (i.e., 124) which used PASCAL. There were only three. A similar conclusion might be drawn about the use of other software languages. Only 10 of the 124 projects reported using a software language (i.e., GOTH) other than C, ADA, PASCAL, FORTRAN, or ASSEMBLY. A summary is provided in Table 8.5 of the frequency with which software languages were used on the projects in this research.

Leadership Characteristics, Management Controls, and Project Characteristics

The path analysis using the combined variables describing leadership characteristics, management control functions, and project characteristics indicate the most frequent dimension directly affecting the measures of success in this research are those variables related to management control. The project managers' authority on (GAUTH) and information about (GINF) the projects indirectly effects the projects' weighted objective score of project success (GAATOTAL) and the weighted objective score of the managers' success (GATOTAL) through the indirect imposition of controls placed on the project.

TABLE 8.5

FREQUENCY OF SOFTWARE USED ON PROJECTS

Software Language	Projects Used On
ADA	21
ASSEMBLY	99
C	20
FORTRAN	77
OTH	10
PASCAL	3

The combination of all variables in the path analysis resulted in only one additional variable, beyond those previously discussed, that directly affected any measure of success. This variable (GSOTH), which defines the use of a management control method other than CSCS, CSSR, PERT, or PERT/CPM, is directly related to the weighted objective score of project success (GAATOTAL). This control function is positively related to project success. The indirect effects on GAATOTAL related to this management control variable are the management controls imposed by others (GOTH), based on the project managers' authority (GAUTH) and the project managers' need for schedule control (GTNEC).

Other Findings

The purpose of this research was to identify the leadership characteristics of project managers and the contribution these characteristics made to successful project management. The testing of hypothesis 6 did reveal certain characteristics about the project managers which may lend insight into some of the findings in this research. The independent variables examined in hypothesis 6 were related to the project mangers needs for both power and achievement, their achieving styles, their leadership styles, and, finally, their needs for control over the projects' budget, schedule, and technical criteria.

We saw that most of the project managers in this research exhibited a task–relational or middle LPC leadership style. We also saw (i.e., Table 8.2) that the program managers had the highest need for power and the lowest need for achievement. Conversely, the project engineers had the highest need for achievement and the lowest need for power. We noted, in the path analysis of hypothesis 7, that the intrinsic domain or set of achieving styles is negatively related to the weighted objective score of project success (AATOTAL). The instrumental domain or set of achieving styles, however, is positively related to the managers' subjective rating of project success (GJOBR) and to the weighted objective score of managers' success (GATOTAL). Finally, we saw in hypothesis 7 that the managers' needs for schedule and technical control were an indirect effect on the three measures of success used in this research.

These findings can be related to specific management levels in the program/project management hierarchy. The managers' needs for project control of budget, schedule, and technical criteria are shown in Table 8.6.

TABLE 8.6

MANAGERS' NEED TO CONTROL PERFORMANCE CRITERIA

Project Position	Budget Control		Schedule Control		Technical Control	
	M	SD	M	SD	M	SD
Program Manager	4.02	0.93	3.96	0.83	3.52	1.12
Project Manager	3.82	1.40	3.82	1.66	4.00	1.48
Project Engineer	3.05	1.69	3.19	1.63	4.12	1.22

We note that the program managers are more concerned with budget and schedule control than they are about technical control. Conversely, the project engineers are more concerned about technical control than they are about budget and schedule control. The project managers appear to concern themselves with all criteria without a distinct leaning toward one or the other. We can, from the results shown in Table 8.2, see that the program managers have a high need for power and a relatively low need for technical control on the projects. On the other hand, we see that the project engineers have a low need for power, but a high need for achievement, as well as a need for technical control on the project. These contrasting perspectives form a dichotomy.

The high need for technical control by the project engineers and their low position in the project management hierarchy may explain the negative relationship of the managers' authority to the technical control effectiveness seen in the path model in Figure 7.4. Remember what Cooper (1977) said in the literature review in chapter 2. He noted that customer project managers, their staff, and even their contractors wished to use the latest and greatest so called "state–of–the art" to produce elegant systems. He also noted that the industry project managers were all too often reluctant to say no to the customer's request for a change or a new feature.

What does this do to the project engineer charged with the project completion? We saw earlier they have problems communicating upward. If they cannot convince their management of the necessity of a particular technical approach or solution to a technical problem, or even why a particular technology should not be used, they are likely to be overruled and view technical control as largely ineffective. Further, if their management, at the request of the customer, requests a change without a technical risk assessment and the change is incorporated in the project, the project engineers are apt to view their authority to maintain project technical control as being ineffective.

There are several other findings in this research to which the foregoing might relate. We saw that the project managers had difficulty relating to the organization's missions and goals. If the project managers, on one hand, are striving for technical excellence, at the risk of additional cost and schedule impact, and their managers, on the other hand, are concerned about the firm's profitability, then an immediate conflict is apparent. This might account for the dysfunctional behavior observed in project managers which Dill and Pearson (1984) observed.

There is also a possibility that the educational backgrounds of the project managers' in this research are misapplied to the tasks to which they have been assigned. A project manager with a propensity for dealing with technical problems may have a limited perspective to other matters related to the project. They simply may not see the necessity for budget and schedule control, and when imposed, view the control as onerous. Their training and experience is not related to financial control. We also see that the upper levels of project management are more attuned to financial control and less concerned about technical control. The upper levels of project management may be over–specialized in financial control and less concerned about the projects' technical aspects.

A discriminant analysis was performed on the three levels of project management examined in this research. The intent was to evaluate how effective the variables examined in hypothesis 6 were in discriminating between the multiple levels of project management. The results are shown in Table 8.7. The results do lend support to the foregoing discussion.

TABLE 8.7

DISCRIMINANT ANALYSIS
PROGRAM/PROJECT MANAGEMENT LEVEL

	Eigenvalue	Wilks' Lambda	SIG
Func1	1.08	0.41	.0004
Func2	0.18	0.85	.3700

VARIABLES		Structure Coefficients		Standard Form		Classification Coefficients		
		Func1	Func2	Func1	Func2	Prog. Mgr.	Proj. Mgr.	Proj. Engr.
BPOW	Need for power	0.32	0.18	0.32	0.08	5.37	4.56	2.19
BACH	Need for achievement	-0.16	0.24	-0.32	0.06	6.71	7.97	9.46
GBNEC	Need for budget control	0.32	0.12	1.19	-0.08	-0.44	-1.19	-2.36
GTNEC	Need for technical control	-0.20	0.20	-1.10	0.45	1.56	2.69	3.59
INTDIR1	Intrinsic direct achieving style	0.02	0.34	-0.28	0.40	10.47	11.48	11.49
COMPDIR2	Competitive directachieving style	0.34	0.42	0.48	0.73	0.09	0.51	-1.08
SOCINST5	Social instrumental achieving style	0.25	-0.33	0.25	-0.83	4.54	3.24	3.77
LPCD1	Leadership style	-0.09	-0.30	-0.24	-0.56	0.73	0.69	0.79
	Constant					-71.56	-72.49	-73.89

Classification of the Managers' Position by the Discriminant Function

Group	Actual Number	Percent	Correctly Classified	Percent
Prog. Mgr.	21	40	16	76
Proj. Mgr.	11	20	6	55
Proj. Engr.	21	40	17	81
TOTAL	53	100	39	74

The principal discriminating variables are the project managers' needs for budget and technical control. The former is positively related to the discriminant function, and the latter is negatively related to the discriminant function. From our previous discussion, these variables are related to the program managers and the project engineers respectively.

The competitive direct achieving style is a positive discriminating variable. We see that, in classifying the management levels, it is a positive classification coefficient for the program and project managers, but negative for the project engineers. The competitive direct achievers feel that doing well is not enough. They derive their satisfaction from outperforming others. This achieving style, if used exclusively by the project managers, would be detrimental to group performance. For the case in point, this positive relation to the discriminant function is interpreted to reflect the program and project managers perspective in ranking their own contribution relative to that made by others. They may be responsible for many projects and feel competition among projects contributes to project success. To this end, they may encourage competition among projects to achieve higher standards of performance.

The project managers' needs for power and achievement are positively and negatively related respectively to the discriminant function. Those with a strong need for power are usually viewed by others as forceful and demanding, frequently outspoken and often argumentative. Those with a strong need for achievement seek opportunities for challenge where there is some risk, but the risk is not so great they cannot overcome it by their own efforts. This negative relation to the discriminant function is not unlike that of the intrinsic direct achievers, who focus on task mastery, and achieve a "high" from performances which meet their own internal standards of excellence.

The remaining discriminant variables relate to the managers' social instrumental achieving style (SOCINST5) and their leadership style (LPCD1). The social instrumental achievers are keenly sensitive to the political arena in which they operate. They establish relationships that will aid them in their accomplishments. As Mintzberg (1983) suggests, they engage in building alliances to achieve their goals. This achieving style is positively related to the principal discriminant function (Func1). Leadership styles are negatively related to the discriminant function. Kennedy (1982) suggests that the "middle LPC manager... who is least concerned with the task and the opinion of others, appears to be the most capable of performing leadership tasks in an effective manner, regardless of the situation."[11] We have found, however, that the project managers must be concerned with the task and the opinion of others.

The findings in this study appear to contrast with prior research conducted by Kemp (1983) and Lang (1987). Their research was similar, although not totally related, to the subject matter in this study. We will now turn to a comparative review of the findings in this research to the findings in the research of Kemp and Lang.

Comparative Review of Prior Research

The research conducted by Kemp addressed the management of high technology projects. The respondents in his study consisted of 68 senior military leaders and 63 senior aerospace industry leaders. The research conducted by Lang addressed technology–induced cost growth in the defense system acquisition process, specifically that of the U.S. Navy. The respondents in his study consisted of 36 senior industry leaders, 17 senior military personnel, and 21 civilian government personnel. Note, that these two studies addressed senior members of the civilian government/military/industry complex. The respondents in these two studies are the decision makers responsible for the definition of, selection of, and delivery of the weapon systems procured by the DoD.

In contrast, this research is more limited in scope. This study focused on the leadership characteristics of project managers within the microcosm of the aerospace industry, the firm. The respondents consisted of 55 members of the project management hierarchy from six different firms. The respondents included decision makers within the firm, but are principally the individuals who must implement decisions made by others in the higher reaches of the government/military/industry complex.

This comparison will address the general management control function findings by Kemp, the control of technology risk by Lang, and the project managers' leadership characteristics described by both Kemp and Lang. Although contrasts do exist, there are marked similarities. This comparison assumes that the findings in the microcosm of the firm can be transposed to the more global aspect of the government/military/industry complex.

Management Control

Among the 12 significant variables which Kemp found to contribute to project success was the use of C/SCS control methods (ranked fourth) and validation by the customer of the contractor's primary control system (ranked tenth).[12] Technical monitoring or control was not ranked among these 12 variables. He did state, however, ". . .the technology must be in hand at the initiation of the project and a political advocacy must be present in support of the project (to provide the funding stability), as prerequisites for success."[13]

The contribution of a validated C/SCS control method to success is questionable. It is a necessary condition only on development projects valued in excess of $25 million. It is doubtful that, for the level of the respondents in Kemp's study, there would be any disagreement as to the significance the management control system has to project success. Without a validated control system, the Government will not award a contract, nor will the aerospace firm receive a contract. Further, if the control system fails subsequent customer validation reviews, the customer may suspend work on the contract or disallow any charges made against the contract.

By contrast, this research found that, with the exception of small and medium size projects (i.e, less than $10 million), there was no significant positive relation of any management control system to project success. This included PERT, PERT/CPM, CSSR, and CSCS. This research did not examine whether the management control system in place, and used by the contractor, had been validated. Large scale development contracts in work imply the use of a validated program management control system. The findings in this research are not significantly different then those reported by Gerloff (1973), Might (1984), Might and Fischer (1985), and Peck (1962).

Control of Technical Risk

Lang's work suggests that the formal program controls used to oversee technical risk are largely ineffective. He states, "Controls implemented to restrict technology development during FSD are not effective despite the improving sophistication of program controls." He went on to say,

> The apparent reason is that there exists tacit agreement among the participants to circumvent the process. The participants believe that it is both necessary and acceptable to circumvent the system in order to keep their program alive. Apparently, they are willing to accept the poor cost and schedule performance which ensues as a result.
>
> These shared values and strong incentives combine to inhibit the effective implementation of the formal control system. The acquisition committee is beating the system because everyone wants to—the incentives for beating the system are stronger than the formal controls.[14]

He proposed nine recommendations intended to reduce cost and schedule growth due to technological changes during full scale development (FSD). Four of these recommendations are repeated here.

> Put the investment decisions where the information is, in the organizational hierarchy at the point where the decisions have to be implemented.
>
> Enforce the use of formal risk monitoring and reduction processes during all program phases, and independent non-advocate risk monitoring and reporting at program transitions.
>
> Raise the threshold of technology maturity for transition to FSD and support this with a more disciplined application of formal program controls and adequate funding in the early phases of program development. These policies will permit the use of more Firm Fixed Price Contracts during FSD.
>
> Apply increasingly rigid change controls to system requirements and design development during FSD.[15]

Similar findings and recommendations were made in a report prepared by the Comptroller General, and submitted to the Committee on Government Affairs, United States Senate in April 1986. This report, prepared by the Government Accounting Office, reviewed the effectiveness of technical risk assessment on 25 major DoD programs. These programs included 5 Army, 11 Navy, and 9 Air Force systems. The 25 program management offices responsible for these systems were also evaluated. The GAO examined the processes the program management offices used in technical risk assessment, both before and during full scale development (FSD).

The GAO conducted the study to determine the degree to which technical risk was being evaluated in compliance to the decree issued by the Deputy Secretary of Defense in 1981, that the services increase their efforts to quantify technical risk. This decree, known as initiative 11, required each service to quantify technical risks on development systems and allocate funds to deal with these risks. Some of the findings in the GAO report are noteworthy. For example,

> No program management office has quantified and budgeted for technical risk as called for by initiative 11. Although the program offices for all 25 systems have made an effort to identify their technical risks, only 3 conducted risk efforts that meet our criteria for technical risk assessment. [16]

The report also identified four problems in the services' risk reports. Three are summarized here.

> Few program staff could cite a DoD or service definition of risk, nor could they say that any definition was formally used in their offices.
>
> Complete information on technical risk was not provided to decision makers at the program management levels or at the higher levels of review. . . The documentation and briefings describing technical risks did not present risk adequately for the use of managers and other reviewers.
>
> Training in technical risk assessment was generally lacking. Where risk was discussed in the service schools, the focus was typically on program risk. [17]

Six recommendations were made to the Secretary of Defense. The second of these was

> Require that risk efforts focus explicitly on technical risk and be prospective, planned, and repeated at least twice, early and late, in each acquisition phase. [18]

The response from the Undersecretary of Defense, Research and Engineering, included as an appendix to the CAO report, did not concur with this recommendation.

> The DoD. . . does not agree with the GAO's emphasis on technical risk, without concomitant consideration of cost and schedule risk. The relationship of all three (cost, schedule, and technical risk) must be recognized and balanced in the management of overall program risk.[19]

One further reference is cited.

A press release made by the Subcommittee on Defense Industry and Technology of the Senate Armed Services Committee, included a report prepared by the Defense Industry Advisory Group which addressed many issues in the defense acquisition process. One of the issues addressed in this report was titled, Shifting Undue Risk to the Contractor. The issue was stated as follows:

> The DoD is now employing procurement methods which shift unreasonable risks to contractors in three different ways. First, subcontractors are being required to pay a portion, sometimes substantial, of the development cost of Defense Department systems under a practice called "cost sharing". Second, contractors are being required to enter fixed-price contracts early in development, when the uncertainty is so substantial, that it is virtually impossible to know the precise costs of new systems. Third, contractors are being asked to provide the Defense Department with priced production options before full scale development has begun.[20]

The advisory committee offered several suggestions to improve the acquisition process. These were:

> First, it is not suggested by industry that open-ended commitments be made. The responsibility to manage a development program within the available funds should be equally shared by the government and the contractor. This can be accomplished by assignment of qualified government program managers and acquisition personnel.
>
> Second, contractors can be motivated through incentive provision and statements of work which require cost trade-offs between various technical solutions. Further, contractors well recognize their ability to survive downstream production competition is dependent upon their ability to offer innovative and cost-effective development solutions.

A solution to the problem was offered by the advisory committee.

> As a general rule, only cost-type contracts should be used for development. . . the concurrence of the Secretary of Defense should be obtained before a fixed-price development

> contract is used. In addition, DoD should be prohibited to provide fixed price production options until after two years of initial production of the system.[21]

If we can transpose the results of this research beyond the microcosm in which it was focused, and reflect on the literature just cited, then several factors emerge. Lang suggested that investment decisions be placed where the information is, at the point where the decisions have to be implemented.

We found in this research that the individuals most concerned about technology were at the lowest level of project management in the firm's project management hierarchy. These were the people who had to implement the decisions made by those above them. We found that, in the firm's higher levels of project management hierarchy, there was a greater concern about budget and schedule criteria then the technical criteria. This same paradox may also exist in higher reaches of government and industry. This is underscored by another issue which concerned the Defense Industry Advisory Group: the declining profitability of defense business.

Lang also suggested that formal risk monitoring and reduction process be enforced. The GAO found, in the program management offices they evaluated, the staff were not qualified to perform risk assessment. A further issue advanced by the Defense Industry Advisory Group was the "Quality of Procurement Workforce/Attracting Competence in Key Positions."[22] They addressed the need for the government procurement offices to seek a highly motivated, college educated work force that would be exposed to specialized training and career management after recruitment.

In contrast to Lang's findings, this research found a negative relation to the projects' technical control effectiveness caused by the project managers' authority. Might and Fischer (1985) found that technical monitoring had a significant negative relationship to project success. A further finding of this research supports the findings of the GAO and the concerns expressed by the Defense Industry Advisory Group. The findings in this research suggest that, within the firm, project managers may be over specialized for the positions which they hold, or that their educational backgrounds are not in consonance with the positions to which they have been assigned.

The emphasis has been on technical risk control on the assumption that the technology was not available at the time the programs enter FSD. Kemp noted that a prerequisite to success was to have the technology "inhand." The House Armed Services Committee chairman, Senator Aspin (D–Wis.), attributed the success of the Trident D-5 program to, among others, the avoidance of novelty. He stated, "The Navy program is disciplined to settle for evolution when it's good enough, and not reach for revolution when it isn't necessary."[23]

Leadership

Kemp noted the need for political advocacy as a prerequisite for success. Lang spoke of tacit agreement among those charged with technical monitoring to circumvent the system in order to keep programs alive. Kemp found that the charisma of the customer project leader, and the charisma of the contractor's project leader were the first and fourth most significant factors in his list of the 12 significant variables that contributed to success. This was based on the response to a single question which asked the respondents to rate these respective leaders' charisma on a scale of 1 to 10.

Lang did not address leadership directly in his research. Nevertheless, the two programs which Lang presented as case studies would indicate a consensus existed in the constituency associated with the programs. This is evidenced by the length of time these programs were permitted to continue before completion or cancellation. One of the programs took fourteen years to complete. The other program languished for eighteen years before it was cancelled. This certainly speaks of an alliance within the constituency comprised of the civilian government, the military, and industry, and suggests a strong political advocacy that supported these programs.

By comparison, an alliance of the constituents comprising the firm, is found in this research. This is exhibited by the project managers' use of the instrumental domain achieving styles and gamesmanship in striving for project success. At the global level, the terminology may be "political advocacy"; a consensus of the government/military/

industrial complex. At the micro level of the firm, the terminology may more aptly be "consensus," an alliance of the constituents in the firm.

Limitations of Research

Several limitations characterize this research. They include primarily the sample size, the instrumentation, and additional research questions. The principal limitation in this research is the sample size. The sample size (55 respondents, 124 projects) precluded the use of subsets to explore the principal hypotheses in greater detail. The number of respondents, for example, precluded an examination of how the individual project management and corporate management levels contributed to project success. The examination of project software content and its relation to project success was limited. There were insufficient data points within the subsets of software content to compare with the different levels of project success.

The choice of the instrument used in the research, The Least Preferred Co-Worker Scale, to determine a manager's leadership style was unsatisfactory. The instrument is better suited for longitudinal studies as it cannot distinguish the subtleties in the manager's leadership style at one point in time. Leadership styles reflect the managers motivational and needs structure which do not change significantly over time. The instrument does not indicate a range of styles which the manager might employ when confronted with different situations.

Although the research did reveal some relation between project technical composition and project success, the Program/Project Questionnaire may have been more effective if the respondents had made a distinction as to the principal type of hardware that was used on the project. A relationship might then have been established between the hardware type and complexity as well as the project composition of software and hardware. The variables defining hardware and software complexity were quite subjective. A metric needs to be defined that can be applied consistently across all subsequent research.

Additional information related to the metrics of measuring project success would have been useful. The Program/Project Management Questionnaire should have included questions related to how well the initial estimates for design time compared to actual performance. Another interesting set of data would have been the actual lines of software code which were required at design completion compared to the initial estimates.

Consideration had not been given in the research design to the finding that the project managers would not relate the project objectives to the organizational objectives. In retrospect, there was sufficient evidence in the literature that this might occur and that there might be a negative relation to project success. Consideration should have been given to exploring this possibility.

A more objective measure of the project managers' success should have been devised. The respondents were asked to rate the performance of their peers and colleagues, but having granted them anonynymity, there was no way to relate their responses to the other respondents or to the projects on which these individuals performed. The only result which could be derived from this data was a comparison of how well the rating of their peers and colleagues correlated to the managers' rating of themselves.

Conclusions

Leadership Characteristics

Positive Factors

The data analysis in this research did reveal several key leadership characteristics that contribute to project and project manager success. These vary, however, dependent on the management level which is evaluated. Principal among these leadership characteristics are the managers achieving styles, their professional experience, their years of software and hardware experience, and their ability to exercise power.

At the senior and upper levels of corporate and project management, the significant variables related to success are their ability to coordinate effectively group work structures, processes, and tasks. Their ability to work in and with a group, their willingness to rely on others to aid them achieve their objectives, and their role as mentors in praising and recognizing the achievements of others contribute to project success. The middle level of corporate and project management affectively use aspects of the self (e.g., charm, persuasion, wit, intelligence, etc.) to enlist the aid of others to achieve project success. The lower tiers of corporate and project management are effective coordinators and are sensitive to others' needs in applying aspects of the self to achieve project success.

The project managers' years of experience in hardware and software are significant factors in project success, particularly on those projects in which software constitutes more than 60% of the projects' engineering budget. The project managers' years of software experience are a significant variable contributing to project success on projects in which software constitutes less than 20% of the projects' engineering budget.

Negative Factors

The are several negative factors identified in this research that are detrimental to project success. Chief among these is the inability of the project managers to align themselves with the organization's mission and goals. The assignment of either over-specialized or underqualified people to project management positions is also detrimental to project success. Finally, the assignment of a task-oriented individual, identified in this research as a direct domain achiever, to a project management position is not conducive to achieving project success.

Management Control Functions

Positive Factors

The results of this research suggest that the use of corporate management control techniques applied uniformly across the organization contribute to project management success on projects valued less than $20 million. The use of the management tools PERT and PERT/CPM, when required by the corporation, are positively related to project success. Project managers assess budget, schedule, and technical controls which are imposed by the corporation to be effective measures contributing to project success.

The results also suggest that explicit lines of responsibility and authority must be defined when using contract imposed management control systems. The managers who are held responsible for budgets must also have sufficient authority to control the budgets.

Negative Factors

The research indicates that the use of contract imposed management control systems is negatively related to project success. The results suggest that the delegation of budget and schedule responsibility to the lower tier project managers does not result in effective budget and schedule control. This is attributed to the administrative burden placed on those project managers that are not schooled in financial management.

Conversely, the results indicate that project technical control is relegated to upper tier project managers who are better trained in financial management.

Project Characteristics

Positive Factors

The results of this research suggest that projects, in which software is used, require the assigned project managers have previous experience in software, either as software managers or software designers. As the projects' software content increases, the assigned project managers should have experience in both hardware and software management or design.

Negative Factors

The results indicate, not surprisingly, that the larger the project, the less likelihood of success. This suggests large projects should be divided into smaller tasks. There is also an indication the more complex hardware projects have an increased reliance on software. The research results also suggest that, the combination of increasing hardware complexity and increased use of software, are significant factors which detract from project success.

Theoretical and Practical Implications

The inability of the project managers to identify with the organizations' goals supports not only the work of Dill and Pearson, but that of March and Simon (1958). March and Simon advocate that organizational equilibrium is achieved when inducements offered to the organizational participants are felt by the participants to be equal to or greater than the contributions made by the participant to the organization. A corollary to this basic hypothesis is that these inducements are also equal to or greater than the alternative inducements that can be achieved elsewhere.

The results in this research imply that the individual achievements of the project managers and the recognition received from their colleagues and peers are more important to the project managers than the corporate and group goals. There is some indication that this recognition is viewed by the project managers as an inducement offered by the firm that cannot be achieved elsewhere.

The results of this research do support a general theme in the literature that an adaptive leadership style is important to project success. The successful project managers should be capable of adjusting to the environment and situations that arise over the life-cycle of the project. The results of this research indicate that the successful project managers do use several achieving styles. These instrumental achieving styles aid them in building alliances with their peers and colleagues to achieve project success. The results also suggest, however, that a task oriented achieving style, signified by the use of the direct domain achieving styles, if employed consistently by the project managers, is not amenable to project success.

The use of management controls to achieve project success should be tempered with defining explicit lines of responsibility and authority. This is particularly true when contract management control systems are imposed on the project. Contract imposed management control systems result in the delegation of the responsibility for budget and schedule control to lower tiers of project managers. We have previously seen these lower tier project managers are more concerned with the projects' technical criteria than they are with budget and schedule criteria. Further, these lower tier managers are possibly required to interface with department managers or directors higher in the management hierarchy than the project manager and better trained or sensitive to the use of financial control systems.

The project manager is at an immediate disadvantage not only because of managerial rank, but also from a possible lack of an adequate financial background. There is certainly a strong possibility of conflict in this area unless the lines of responsibility and authority are clearly defined.

This places a requirement on the corporation to define the methods by which corporate policies and procedures will be applied throughout the corporation in the administration of the contract management control system. The aforementioned problem is less apparent when corporate management controls are used. The alliance building practiced by the project managers may be sufficient to overcome conflicts of responsibility when using corporate control systems. Either that, or corporate control systems uniformly applied to all operating departments are standardized and well understood by the project managers.

The project characteristics do have an effect on project success. The larger the project, the less likely it will be successful. Similarly, the greater the software content is of the projects' engineering budget, the less likelihood of success. There appears to be a relationship to the type of software used and project success: the more complex the software language, the less likelihood of project success. The research indicates that the use of software requires the assignment of project managers' having previous software experience. The larger the project and the more complex the hardware technology, coupled with increased use of software, places extreme demands on the project managers which they may be unable to meet. Certainly the firm, and the industry at large, must commence preparing and training their project managers for the increasing complex systems they will be required to manage in the future.

Suggestions for Future Research

There are a number of factors that should be investigated in future research related to project management. Certainly, subsequent research should investigate the relationship between the project managers' personal objectives, the organizational objectives, and the effect this has on project success. There should be some technique by which these objectives can be better correlated to the mutual benefit of the organization and the project manager.

This research suggests that technical controls may be negatively related to project success. In an era of increased fixed price contracting, the aerospace contractors' need to ensure that the project technical objectives are met, no more no less. To over–design a project will incur unforeseen expenses either in direct material or schedule delays that will contribute to overruns.

Considerable attention is given to financial controls in both the literature and in practice. On the other hand, very little attention is given to technical controls. Additional research should be direct toward identifying why technical control is adversely related to project success. Research should be applied toward examining the use of life–cycle cost analyses, benefit–cost analyses, and technical risk analyses to determine their effectiveness in selecting technical approaches to achieving project success. The methods used to analyze technical risk, and the controls imposed to ensure project objectives were achieved with minimal technical risk, would be of interest to the project management community at large.

Project managers' personal characteristics including education, experience, additional training, tenure with the firm, and past performance should be further investigated in relation to project success. There should be some method of data capture that can relate these characteristics to managerial success. Certainly if studies can relate performance on the SAT and high school GPA to the likelihood of college success, a similar set of characteristics can be defined that relate past experiences and training to the likelihood of project management success.

Concluding Remarks

This research has explored the relationship that leadership characteristics have to project management success. In addition, the effectiveness of management controls on project management success was examined. Finally, the impact project characteristics have on project management success was investigated. This study was limited to the microcosm of the aerospace industry, the firm. This limitation, however, should not restrict application of the findings to similar project management elements found in the civilian government/military/industry complex.

There are project management groups in each organizational element which comprise this complex. These project management groups are markedly similar. The problems confronted by each are similar. The differences which exist are those of perspective, created by the position which the different project management groups occupy in the government/military/industry complex. The motives exhibited by each project management group, as applied to the projects they manage, are also similar. The government and military project managers wish to maximize the return on the investments they have made for weapon systems. Further, they wish to reduce the risks associated with their investment. They impose management control systems on their contractors intended to monitor the contracts awarded their contractors and provide early warning if anything should go awry.

Conversely, the industry project managers wish to maximize the return on their investment with minimum risk. Industry also imposes controls, either those required by their customer or their own, to monitor and control the risks in the contracts they have undertaken.

The men and women charged as project managers in either the government or industry will perform their tasks as conscientiously as they can. The manner or approach these project managers use to discharge their tasks will reflect the perspective of the organization or agency with whom they are employed.

This research found there may be a dysfunctional relationship exhibited by the project managers in the firm between project and organizational objectives. This finding suggests that the project managers are more interested in their careers and the recognition they achieve from their peers and colleagues than in promoting the organization's goals. This finding, when viewed in a more global aspect, suggests care should be exercised in the selection and assignment of project managers to positions which command extreme power and authority. Those who primarily serve their own interests may not best serve their organization.

The management controls imposed to monitor and control programmatic risk may not serve the purpose for which they were intended. The blind imposition of management controls on large projects is no guarantee that project success will be achieved. The results derived in this research suggest that large programs should be broken down into smaller elements that are amenable to less complex control systems, or compatible to the position power of the project manager. Fiedler (1967) suggested the task should be engineered for the manager. Might (1985) suggested the control system be engineered to the managers' capabilities.

The former is the more palatable of the two suggestions. Breaking projects into smaller elements would require, however, a project manager, who can orchestrate the synthesis of projects from the elements into which it was broken. This research indicated the use of different management control systems in the firm were negatively related to project success. There is no standard by which all elements of the project can be compared. The same is undoubtably true on a more global basis. The same methods of control, or means of reporting, should be applied across major programs.

The increasing sophistication of weapon systems and their counter measures requires continued advances in technology, or applications of advanced technology, to retain the status quo. This research suggests that the increased complexity of weapon systems will result in less successful projects, as measured by budget, schedule, and technical criteria. Software will continue to become an increasingly larger percent of the DoD's weapon systems development costs. This research indicated that as software became an increasingly large percent of the projects' engineering budget, there was less likelihood of project success. There is an increasing need in both the government and industry to implement more effective tools to evaluate cost trade–offs in arriving at the most effective combination of software and hardware to reduce cost, schedule, and technical programmatic risks.

This research examined an infinitesimally small section of project management. There remains much that can be done to aid in the education, training, and ultimate selection of qualified program managers that will improve program management. The management field in general, and the project management field specifically, continues to be a fertile field for research. This research examined many variables which play a part in successful project management, and the results may be of help to those who act as project managers. This author hopes that the omissions and errors made in this research will be successfully avoided by others and that the results and suggestions for future research may act as guideposts for those who continue the research.

FOOTNOTES

[1] Abraham Zaleznik, "Managers and Leaders; Are They Different?" Harvard Business Review. May–June 1975: 74.

[2] Ibid.: 70–72.

[3] Henry Mintzberg, Power in and Around Organizations, (Englewood Cliffs, N.J.: Prentice–Hall, Inc., 1983): p. 172.

[4] Ibid.: p. 194.

[5] Ibid.: p. 194 cited from D. N. Izraeli, "The Middle manager and the Tactics of Power Expansion: A Case Study," Sloan Management Review, Winter 1975: 60.

[6] Michael L. Tushman and Thomas J. Scanlon, "Boundary Spanning Individuals: Their Role in Information Transfer and Their Antecedents, Academy of Management Journal, 24 (June 1981): 303.

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[11] John F. Kennedy, Jr. "Middle LPC Leaders and the Contingency Model of Leadership Effectiveness,," Organizational Behavior and Human Performance 30 (August 1982): 7–9.

[12] Robert M. Kemp, "Effective Management of High Technology Projects," (PH. D. dissertation, Claremont Graduate School, 1983), pp. 101–102.

[13] Ibid.: p. 103.

[14] William H. Lang, "Technology Induced Cost Growth and Schedule Delays in U.S. Naval Defense System Acquisition Process," (Ph. D. dissertation, Claremont Graduate School, 1987): p. 198.

[15] Ibid.: pp. 202–207.

[16]U.S., Congress, Senate, Committee on Government Affairs, Report to the Chairman, Technical Risk Assessment: The Status of Current DOD Efforts, GAO/PEMD-86-5 (Washington, D.C,: United States Government Accounting Office, April 1986), p.51.

[17]Ibid.: p. 71.

[18]Ibid.: p. 77.

[19]Ibid.: p. 113.

[20]U.S., Congress, Senate, Committee on Armed Services, (Washington, D.C.: Press Release, February 5, 1988): p. (B-11).

[21]Ibid.: p. (B-12).

[22]Ibid.: pp. (A-1) – (A-2).

[23]U.S. Congress, House, House Armed Services Committee, HASC TASKS 110-12 (Washington, D.C., May 1982): p. 2.

APPENDIX A

Least Preferred Co-Worker (LPC) Scale

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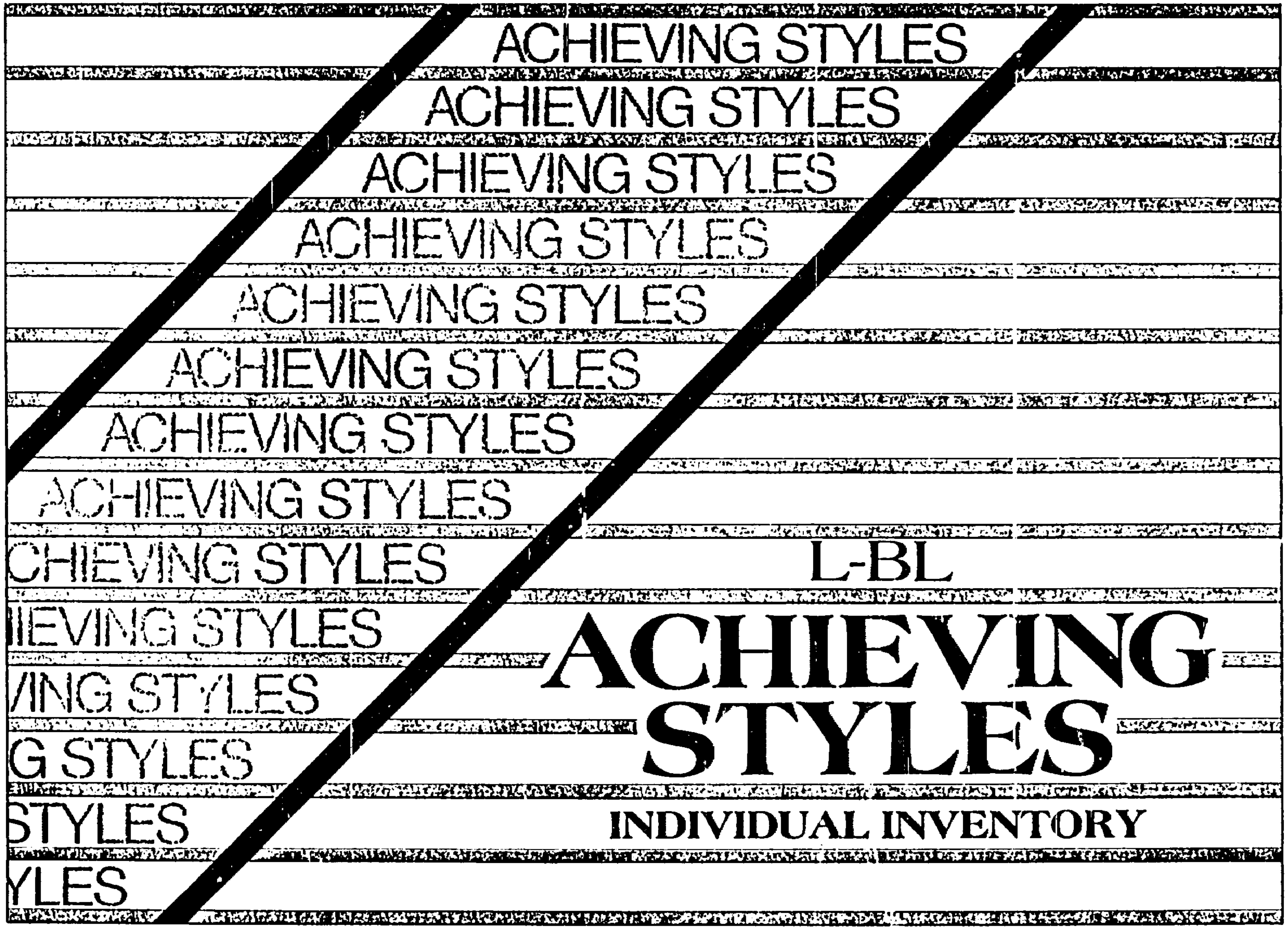
APPENDIX B

Achieving Styles Inventory


ACHIEVING STYLES
L-BL
ACHIEVING STYLES
INDIVIDUAL INVENTORY

[illegible]

Circle the number that best describes your behavior. Please respond to every statement.

	Statement	Never						Always	
1.	For me, the most gratifying thing is to have solved a tough problem.	1	2	3	4	5	6	7	(9)
2.	I get to know important people in order to succeed.	1	2	3	4	5	6	7	(10)
3.	I achieve my goals through contributing to the success of others.	1	2	3	4	5	6	7	(11)
4.	For me, winning is the most important thing.	1	2	3	4	5	6	7	(12)
5.	When I want to achieve something, I look for assistance.	1	2	3	4	5	6	7	(13)
6.	I work hard to achieve so people will think well of me.	1	2	3	4	5	6	7	(14)
7.	I want to be the leader.	1	2	3	4	5	6	7	(15)
8.	More than anything else, I like to take on a challenging task.	1	2	3	4	5	6	7	(16)
9.	Faced with a task, I prefer a team approach to an individual one.	1	2	3	4	5	6	7	(17)
10.	I seek out leadership positions.	1	2	3	4	5	6	7	(18)
11.	Winning in competition is the most thrilling thing I can imagine.	1	2	3	4	5	6	7	(19)
12.	I feel the successes or failures of those close to me as if they were my own.	1	2	3	4	5	6	7	(20)
13.	I strive to achieve so that I will be well liked.	1	2	3	4	5	6	7	(21)
14.	The more competitive the situation, the better I like it.	1	2	3	4	5	6	7	(22)
15.	Real team effort is the best way for me to get a job done.	1	2	3	4	5	6	7	(23)
16.	I achieve by guiding others toward their goals.	1	2	3	4	5	6	7	(24)
17.	For me, the most exciting thing is working on a tough problem.	1	2	3	4	5	6	7	(25)
18.	I seek guidance when I have a task to accomplish.	1	2	3	4	5	6	7	(26)
19.	I have a sense of failure when those I care about do poorly.	1	2	3	4	5	6	7	(27)
20.	I develop some relationships with others to get what I need to succeed.	1	2	3	4	5	6	7	(28)
21.	I seek positions of authority.	1	2	3	4	5	6	7	(29)
22.	I am not happy if I don't come out on top in a competitive situation.	1	2	3	4	5	6	7	(30)
23.	My way of achieving is by coaching others to their own success.	1	2	3	4	5	6	7	(31)
24.	For me, group effort is the most effective means to accomplishment.	1	2	3	4	5	6	7	(32)
25.	I look for support from others when undertaking a new task.	1	2	3	4	5	6	7	(33)
26.	I establish some relationships for the benefits they bring.	1	2	3	4	5	6	7	(34)
27.	I try to be successful at what I do so that I will be respected.	1	2	3	4	5	6	7	(35)
28.	I want to take charge when working with others.	1	2	3	4	5	6	7	(36)
29.	When a loved one succeeds, I also have a sense of accomplishment although I make no direct contribution.	1	2	3	4	5	6	7	(37)
30.	I strive to achieve in order to gain recognition.	1	2	3	4	5	6	7	(38)
31.	I look for reassurance from others when making decisions.	1	2	3	4	5	6	7	(39)
32.	For me, the greatest accomplishment is when the people I love achieve their goals.	1	2	3	4	5	6	7	(40)
33.	I go out of my way to work on challenging tasks.	1	2	3	4	5	6	7	(41)
34.	I succeed by taking an active part in helping others achieve success.	1	2	3	4	5	6	7	(42)
35.	I use my relationships with others to get things done.	1	2	3	4	5	6	7	(43)
36.	Working with others brings out my best efforts.	1	2	3	4	5	6	7	(44)
37.	I select competitive situations because I do better when I compete.	1	2	3	4	5	6	7	(45)
38.	Being the person in charge is exciting to me.	1	2	3	4	5	6	7	(46)
39.	I work to accomplish my goals to gain the admiration of others.	1	2	3	4	5	6	7	(47)
40.	I establish a relationship with one person in order to get to know others.	1	2	3	4	5	6	7	(48)
41.	My way of achieving is by helping others to learn how to get what they want.	1	2	3	4	5	6	7	(49)
42.	The accomplishments of others give me a feeling of accomplishment as well.	1	2	3	4	5	6	7	(50)
43.	For me, the greatest satisfaction comes from breaking through to the solution of a new problem.	1	2	3	4	5	6	7	(51)
44.	When I encounter a difficult problem, I go for help.	1	2	3	4	5	6	7	(52)
45.	My best achievements come from working with others.	1	2	3	4	5	6	7	(53)

Card 2 (80)

	1	2	3	4	5	6	7	8	9
Column Total									
Divide by 5 *(See Divider List)*									

3.86 FOR OFFICE USE

Form 13R	(1-3)
Group Code ___ ___ ___ ___	(4-7)
ID Number ___ ___ ___ ___	(8-11)

DEMOGRAPHICS

1. SEX (Circle one): [1] MALE [2] FEMALE (12)

2. AGE: __________ (13-14)

3. CITIZENSHIP (COUNTRY): ___ [592] USA ___ Other (Please specify.): __________ (15-17)

4. CURRENT MARITAL STATUS: ___ [1] Never married ___ [4] Separated (18)
___ [2] Married ___ [5] Divorced
___ [3] Remarried ___ [6] Widowed

5. NUMBER OF CHILDREN YOU HAVE (Circle correct number.): 0 1 2 3 4 5 or more (21)

6. COMPLETED YEARS OF EDUCATION (e.g., 12 = high school graduate, etc.): (24-25)
(Circle correct number): 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 or more

7. HIGHEST DEGREE EARNED: __________ (26)

8. FIELD IN WHICH HIGHEST DEGREE WAS EARNED
(If currently a student, indicate college major.): __________ (27-29)

9. CURRENT STUDENT STATUS: ___ [1] Full-time student (29)
___ [2] Part-time student
___ [3] Not a student at this time

10. WORK HISTORY: Ever employed outside the home? ___ [1] No ___ [2] Yes (30)
If Yes,
Total years worked part-time: __________ (31-32)
Total years worked full-time: __________ (33-34)

11. CURRENT OCCUPATIONAL STATUS (Check all that apply.):
___ Employed full-time (35) ___ Retired (38)
___ Employed part-time (36) ___ Homemaker part-time (53)
___ Unemployed (37) ___ Homemaker full-time (39)
___ Volunteer (40)

12. LEVEL WITHIN WORK ORGANIZATION (If you are currently employed, answer in terms of your present job. If you are NOT currently employed, then please check for period of longest paid employment.): (41)
___ [1] Upper management ___ [4] Professional nonsupervisory
___ [2] Middle management ___ [7] Secretarial/clerical
___ [3] First-line supervisory ___ [8] Other (Please specify.): __________

13. IF EMPLOYED, YEARS AT PRESENT ORGANIZATIONAL LEVEL: __________ (42-43)

14. CURRENT (OR MOST RECENT) OCCUPATION: __________ (44-46)

15. CURRENT (OR MOST RECENT) JOB TITLE: __________ (47-49)

16. IF EMPLOYED, TYPE OF EMPLOYER: (50)
___ [1] Government ___ [6] Non-profit organization other than school or university
___ [2] Large corporation ___ [4] Self-employed
___ [3] Medium/small business ___ [7] Other (Please specify.): __________
___ [5] Educational institution

17. EMPLOYER'S FIELD OR BUSINESS (e.g., aerospace, health, etc.): __________ (51-52)

(For office use only) INTERNAL GROUP DESIGNATION __________ (54-55)

Card 1 (60)

TABLE B.1

RAW DATA SCORES

Variable	Brief Description	GROUP 1		GROUP 2	
		M	SD	M	SD
INTDIR1	INTRINSIC DIRECT	5.73	.65	6.19	.67
COMPDIR2	COMPETITIVE DIRECT	4.71	.94	4.99	.94
POWDIR3	POWER DIRECT	5.31	1.07	5.81	.61
PERINST4	PERSONAL INSTRUMENTAL	4.86	1.06	4.40	.84
SOCINST5	SOCIAL INSTRUMENTAL	4.06	.84	4.01	1.19
RELINST6	RELIANT INSTRUMENTAL	4.64	.96	4.78	1.01
COLLREL7	COLLABORATIVE RELATIONAL	5.28	.95	5.65	.80
CONTREL8	CONTRIBUTIVE RELATIONAL	5.08	.79	5.73	.78
VICREL9	VICARIOUS RELATIONAL	5.02	.66	5.96	.72
DIRDOMN	DIRECT DOMAIN	5.25	.71	5.66	.77
INSTDOMN	INSTRUMENTAL DOMAIN	4.52	.68	4.40	.69
RELDOMN	RELATIONAL DOMAIN	5.13	.60	5.78	.45

APPENDIX C

Managerial Dimensions Survey

PLEASE NOTE:

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These consist of pages: 233-275

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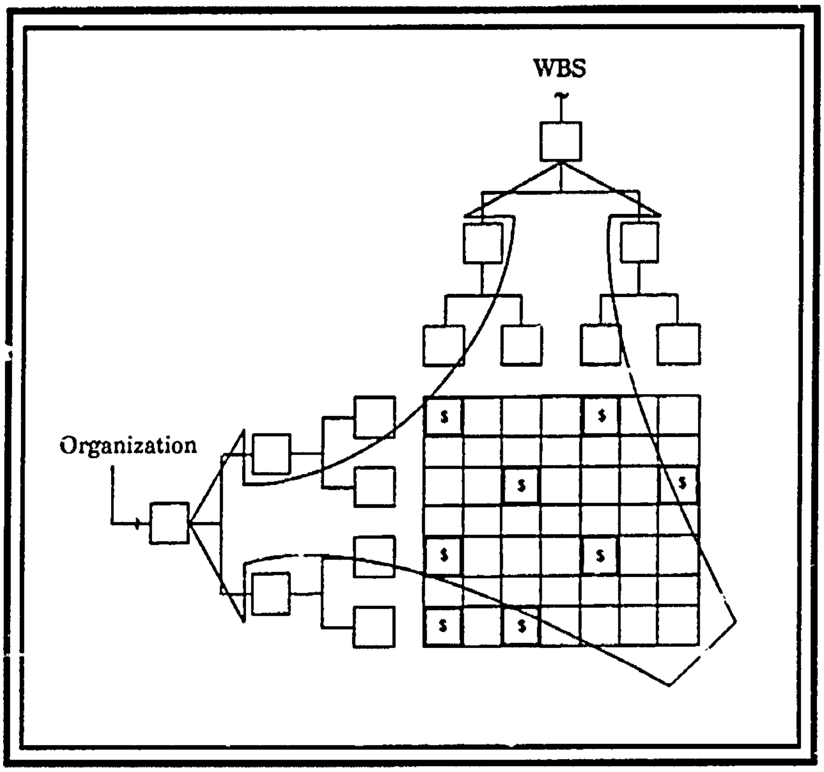
APPENDIX F

Program/Project Management Questionnaire

PROGRAM/PROJECT MANAGEMENT QUESTIONNAIRE



INTRODUCTION

This questionnaire has been designed for use by different levels of personnel within the hierarchy of Program Management, Project Management, and Project Engineering. A generic description of these functional entities is provided as an aid in determining your position. The questionnaire is comprised of two sections. The first section relates to the jobs for which you are responsible. The second section relates to your background; experience, education, and other personal information. Please complete both sections of the questionnaire to provide a meaningful data base. The confidentiality of your firm and your responses will be protected in the final report wherein this data will be used.

DEFINITIONS

PROGRAM MANAGEMENT

A management function designated to have program responsibility and authority, responsible for the successful accomplishment of the program and for meeting contractual requirements. Program management has the authority for task definition, program budgets, cost control, and schedule performance. Program management serves as the prime point of contact with the customer and for status information on the program.

PROJECT MANAGEMENT

A management function designated to have project responsibility for the cost, schedule, and technical performance within a functional department. Project management shall implement the requirements of the program plan and act as the principal liaison between program management, the functional department in which established, and other departments. Project management communicates how the program requirements will be accomplished within the department, and how the operational resources and facilities will be utilized on the program.

PROJECT ENGINEERING

A supervisory or individual assignment having project responsibility for the cost, schedule, and technical performance within an engineering discipline. Project engineering shall implement the requirements of the project plan and act as the principal liaison between project management and the functional department in the engineering discipline represented. Project engineering will determine how the program requirements will be accomplished within its functional discipline, allocate resources, and define facilities necessary to achieve the program objectives.

SECTION 1

SOMETHING ABOUT YOUR JOB

1. Do you consider yourself to be in:

   Program Management ____________
   Project Management ____________
   Project Engineering ____________

2. How many different RDT&E jobs are you presently responsible for? ____________

3. Are these jobs principally

   A. Military ____ Commercial ____
   B. Domestic ____ Foreign ____

4. Are you principally responsible for
   Hardware _____ Software _____ Both _____ or Other (Explain) ______________________

NOTE

In the subsequent questions space is provided for answers to three jobs. Please list those recently completed, or if in progress, most nearly complete.

5. For what portions of the jobs are you responsible?

JOB	RESEARCH	DESIGN	TEST	EVALUATION	ALL	NONE
A	_____	_____	_____	_____	_____	_____
B	_____	_____	_____	_____	_____	_____
C	_____	_____	_____	_____	_____	_____

6. Please provide the title, customer, percent of job complete, and percent of your time devoted to these jobs.

JOB	TITLE	CUSTOMER (GOV'T.,COMMERCIAL,ETC.)	PERCENT COMPLETE	PERCENT YOUR TIME REQ'D.
A	______________	______________	_______	_______
B	______________	______________	_______	_______
C	______________	______________	_______	_______

7. Were these jobs obtained by competitive bid, sole sourced, follow–on to prior contracts, or obtained by other means, i.e., company funded?

JOB	SOLE–SOURCED	COMPETITIVE	FOLLOW–ON	OTHER (SPECIFY)
A	____________	____________	________	________
B	____________	____________	________	________
C	____________	____________	________	________

8. Are these jobs fixed price (FP), cost plus fixed fee (CPFF), cost plus incentive fee (CPIF), fixed price plus incentive fee (FPIF), or other?

JOB	FP	CPFF	CPIF	FPIF	OTHER (SPECIFY)
A	____	____	____	____	____
B	____	____	____	____	____
C	____	____	____	____	____

9. Is your firm the prime contractor, subcontractor to a prime, teaming as a prime, or in a joint venture?

JOB	PRIME	SUB	TEAM	JOINT	OTHER (SPECIFY)
A	____	____	____	____	____
B	____	____	____	____	____
C	____	____	____	____	____

10. How long after commencement of this job was the first article scheduled for delivery? Express in months.

JOB\	A	B	C
DELIVERY	____	____	____

11. Is there a production follow-on to the RDT&E portion of the job?

JOB\	A	B	C
FOLLOW-ON	Y___ N___	Y___ N___	Y___ N___

12. What is the estimated RDT&E budget for these jobs and the estimated budget allocated to the engineering content? Please indicate whether the budget is expressed in direct (D) or burdened through overhead (B) dollars.

JOB\	A	B	C
Total Budget	____	____	____
Eng'g Budget	____	____	____

13. What is the estimated budget within the engineering budget allocated to "hardware" and "software"? Express as a percent.

JOB\	A	B	C
Hardware	____	____	____
Software	____	____	____

14. How would you evaluate the hardware complexity of these jobs?

JOB	STANDARD (OFF-THE-SHELF)				LEADING EDGE TECHNOLOGY
A	____	____	____	____	____
B	____	____	____	____	____
C	____	____	____	____	____

15. How would you evaluate the software complexity of these jobs?

JOB	STANDARD				HIGHLY COMPLEX
A					
B					
C					

16. What is the principal software language used on these programs? If more than one language is used check all boxes which apply, indicating by a P that which is used predominantly.

JOB	ASSEMBLY	FORTRAN	PASCAL	C	ADA	OTHER (SPECIFY)
A						
B						
C						

17. In what principal environment is the software used?

JOB	REAL TIME	BATCH	OTHER (SPECIFY)
A			
B			
C			

18. Are any formal control systems used on these jobs to monitor and control budget, schedule, and technical content?

JOB\	A	B	C
Budget	Y___ N___	Y___ N___	Y___ N___
Schedule	Y___ N___	Y___ N___	Y___ N___
Technical	Y___ N___	Y___ N___	Y___ N___

19. Were these control systems imposed by

JOB	CONTRACT	CORP. POLICY	DEPT. POLICY	OTHER (SPECIFY)
A				
B				
C				

20. What control systems are used?

JOB	C/SCS	CSSR	PERT	PERT/CPM	OTHER
A					
B					
C					

21. How effective do you believe the control systems are to contain budget, maintain schedule, and control technical content and quality? Using a scale ranging from 1 = Very ineffective to 5 = Very effective enter the applicable index in the table below.

JOB\	A	B	C
Budget			
Schedule			
Technical			

22. How much control do you feel you must have over budget, schedule, and technical content of these jobs to meet contracted requirements?

	VERY LITTLE				GREAT DEAL
Budget	____	____	____	____	____
Schedule	____	____	____	____	____
Technical	____	____	____	____	____

23. Do you feel you have sufficient job visibility, access to published or informal information, and authority to actively control what happens to cost, schedule, and technical performance?

	NEVER				ALWAYS
Visibility	____	____	____	____	____
Information	____	____	____	____	____
Authority	____	____	____	____	____

24. Is there any aspect of the control systems you feel should be changed? Yes ___ No ___

If yes, please explain ____

____

____

25. How would you evaluate the job performance relative to the budget expressed as a percent? If over or under budget identify the single most driving factor contributing to the budget variance, e.g., software, hardware, etc.

JOB\	A	B	C
Over Budget	____	____	____
Within Budget	____	____	____
Under Budget	____	____	____
Driving Factor	____	____	____

26. How would you evaluate the job performance relative to the schedule? If early or late express in terms of days, weeks, or months. Identify the single most driving factor contributing to the schedule variance, e.g., software, hardware, etc.

JOB\	A	B	C
Early	____	____	____
On Time	____	____	____
Late	____	____	____
Driving Factor	____	____	____

27. How would you evaluate the job performance relative to meeting technical specifications? Identify the single most driving factor that contributed to a technical variance or deviation, e.g., software or hardware design, parts shortage, etc.

JOB\	A	B	C
Did not meet all specs	____	____	____
Met all specs.	____	____	____
Exceeded specifications	____	____	____
Driving Factor	____	____	____

28. What ranking, in order of importance, would you associate with budget, schedule, and technical performance on these jobs? Rate on a scale of 1 to 5 with 1 being the least important and 5 being the most important.

JOB\	A	B	C
Budget	______	______	______
Schedule	______	______	______
Technical	______	______	______

29. Which single category would you most willingly sacrifice in order to meet any other two?

JOB\	A	B	C
Budget	______	______	______
Schedule	______	______	______
Technical	______	______	______

30. How would you rate the program manager (PGM), project manager (PM), or project engineer (PE) responsible for these jobs? Identify which you are rating, if not applicable skip to Question 32.

JOB	LESS THAN SATISFACTORY	MARGINAL	AVERAGE	GOOD	OUTSTANDING	(PGM),(PM),(PE)
A	______	______	______	______	______	( ) ( ) ( )
B	______	______	______	______	______	( ) ( ) ( )
C	______	______	______	______	______	( ) ( ) ( )

31. Do you prepare the performance appraisal of this individual?

JOB\	A	B	C
Yes	______	______	______
No	______	______	______

32. How would you rate the overall job relative to budget and schedule performance and compliance to technical specification?

JOB	LESS THAN SATISFACTORY	MARGINAL	AVERAGE	GOOD	OUTSTANDING
A	______	______	______	______	______
B	______	______	______	______	______
C	______	______	______	______	______

33. How do you believe your customer rates the overall job relative to budget and schedule performance and compliance to technical specification?

JOB	LESS THAN SATISFACTORY	MARGINAL	AVERAGE	GOOD	OUTSTANDING
A	______	______	______	______	______
B	______	______	______	______	______
C	______	______	______	______	______

34. How would you rate your performance in controling costs (C), meeting schedules (S), and meeting technical performance (T)? Rate your performance in each category, on each job, in the table below.

JOB	LESS THAN SATISFACTORY	MARGINAL	AVERAGE	GOOD	OUTSTANDING
A	______	______	______	______	______
B	______	______	______	______	______
C	______	______	______	______	______

PLEASE PROCEED TO THE NEXT SECTION

SECTION 2

SOMETHING ABOUT YOURSELF

1. Indicate your college level education. Check all boxes which apply.

	ENG'G SCIENCE	MATH	COMPUTER SCIENCE	BUS ADM MGMT	LIB ARTS	LAW	OTHER (SPECIFY)
Associate	___	___	___	___	___	___	___________
Bachelor	___	___	___	___	___	___	___________
Some Grad.	___	___	___	___	___	___	___________
Masters.	___	___	___	___	___	___	___________
Doctoral	___	___	___	___	___	___	___________
Other	___	___	___	___	___	___	___________
(Specify) ____________________							
Executive Certificate	___	___	___	___	___	___	___________

2. Year in which bachelors degree awarded? ________

3. Year in which last advanced degree awarded? ________

4. What special training programs or seminars have you participated in (e.g., 1, 2, or 4-day, or 1 or 2-week programs in program management, software management, engineering management, financial management, etc.)?

TITLE OF PROGRAM	DURATION	APPROX. COMP. DATE
________________	________________	________________
________________	________________	________________
________________	________________	________________
________________	________________	________________
________________	________________	________________

5. How many years of professional experience? ________

6. How many years of software experience in design or management ________

7. How many years of hardware experience in design or management? ________

8. How long have you been with your present employer? Yrs ___ Mons ___

9. How many previous employers have you had? 0___ 1 ___ 2 ___ 3 ___ 4 ___ 5 ___ or more ___

10. What is your official job title? ____

11. What is your official classification? ____

12. What was your prior classification? ____

13. Was this classification within your present firm ________ or previous firm ________?

14. How long have you been in your present position? Yrs ___ Mons ___

15. How many years experience have you had in:

Program Management	______
Project Management	______
Project Engineering	______

16. Do you consider yourself to be a member of:

Senior Management	______
Upper Management	______
Middle Management	______
First Level Supervision	______
Non-Supervisory	______

17. When you assumed your present position did you feel your responsibilities

SIGNIFICANTLY DECREASED	DECREASED	STAYED THE SAME	INCREASED	SIGNIFICANTLY INCREASED
______	______	______	______	______

18. What is your age? Yrs ___ Mons ___

19. What is your sex? Male ___ Female ___

THANK YOU FOR YOUR PARTICIPATION

APPENDIX G

Analytical Results – Group 2

APPENDIX G

ANALYTICAL RESULTS – GROUP 2

Introduction

The analytical results presented in this appendix relate to the findings associated with the respondents in Group 2. Sixteen respondents and 44 projects comprise this group. The demographics of the respondents and the characteristics of the projects for which they are responsible are shown in Tables 4.3 and 4.4 respectively.

This group was identified as singularly different in the initial one–way analysis of variance performed prior to combining data sets for further analysis. We saw in Chapter 4 that the difference appears to be related to the upper levels of corporate management.

A further analysis of variance was performed using the initial data set on the 32 variables in the Profile of Organizational Characteristics (POC). This analysis was performed to ascertain if the differences could be attributed to cultural peculiarities between the organizations. This subsequent analysis revealed two statistically significant variances, both of which were related to the current state of communications.

Recall that initially there were three distinct groups which were identified as groups 1, 2, and 3. Groups 1 and 3 were subsequently combined into Group 1 for further analysis. The differences noted, from the results of the one–way analysis of variance on the POC were between the original groups 1 and 3, not between groups 1 and 2. The indication, from this analysis of the POC, is that there isn't any significant organizational difference between Group 1 and Group 2. The supposition is that the differences are either related to corporate cultural differences or value differences among the respondents.

All regressions used in the analysis of Group 2 were performed using the SPSS/X REGRESSION procedure with stepwise entry. The variables used in the analysis are the same as those used in the analysis of Group 1 and are outlined in Table 3.1. To guard against multicollinearity, TOLERANCE is set at 0.25.[1] To ensure significance of results, PIN is set at 0.05 and POUT is set at 0.10.[2] Missing data is handled by pairwise deletion.

The limited data set in Group 2 precludes the extensive analyses which were performed on Group 1. Nevertheless, where possible, comparisons will be made from the results obtained in the analysis of Group 2 to those obtained in the analysis of Group 1.

Hypothesis 1

The Effect of Management Controls on Project Success

This hypothesis evaluates the effectiveness of management controls on project success when controlling for project size. The respondents in Group 2 only provided budgetary data on 35 of the 44 projects on which they reported. The largest project was discarded from this analysis as it alone was five times larger than the next largest project and significantly affected the mean value of the projects evaluated. This left 34 projects having a M = \$3,774 million, with a SD = \$9,150 million, when valued by the projects' engineering value.

The respondents provided information about the projects' contract value on 37 projects. Again, the largest project was discarded from evaluation. This left 36 projects having a M = \$5,234 million, with a SD = \$11,161 million, when valued by the projects' total contract value. In either case, the project size, when compared to Group 1, is in the medium size classification.

Weighted Score of Project Success: AATOTAL

The results obtained from the regressions performed on the weighted score of project success (AATOTAL) are shown in Table G.1. When size is defined by the projects' engineering value R is 0.65, indicating that 42% (R2) of the variance in AATOTAL is explained by the independent variables. When size is determined by the projects' total contract value R is 0.73, indicating that 53% (R2) of the variance in AATOTAL is explained by the independent variables.

TABLE G.1

HYPOTHESIS 1

REGRESSIONS PERFORMED AGAINST AATOTAL

PROJECT SIZE BASED ON ENGINEERING VALUE

DEPENDENT VARIABLE

AATOTAL Weighted score of project success

$R = .65$ $R^2 = .42$ Adj $R^2 = .36$ $F(3,30) = 6.92$ SIG $F = .0013$

INDEPENDENT VARIABLES

		BETA	SIG
VISIB	Managers' visibility of the project	0.43	.01
DEPT	Project control imposed by the department	–0.37	.02
TCON	Technical control is exercised on the projects	–0.34	.03

PROJECT SIZE BASED ON CONTRACT VALUE

DEPENDENT VARIABLE

AATOTAL Weighted score of project success

$R = .73$ $R^2 = .53$ Adj $R^2 = .46$ $F(4,31) = 8.1$ SIG $F = .0002$

INDEPENDENT VARIABLES

		BETA	SIG
VISIB	Managers' visibility of the project	0.53	.00
DEPT	Project control imposed by the department	–0.41	.00
BCON	Budget control is exercised on the project	–0.39	.01
FPIF	Project performed on a FPIF contract	0.29	.01

There are several similarities regardless of how project size is defined. The independent variable pertaining to the managers' visibility of the projects (VISIB) is positively related to project success. The variables pertaining to the technical and budget controls placed on the project (TCON and BCON) by the project department (DEPT) are negatively related to project success.

Similar results were obtained for Group 1. For Group 1, department controls are negatively related to project success. The management controls which are negatively related to project success are budget control (BCON) and technical control (TCON).

Managers' Rating of Project Success: JOBR

The results obtained from the regressions performed on JOBR are shown in Table G.2. Regardless of how project size is determined R=0.37, indicating 13% (R^2) of the variance in JOBR is explained by the independent variable which indicates that the project is being performed on a cost plus incentive fee contract (CPIF). This variable is positively related to project success.

For the regressions performed on JOBR in Group 1, we saw that the type of contract on which the small project was performed did influence the positive or negative relationship to project success. The relationship was negative for those projects performed on fixed price contracts (FP) and positive for those projects performed on cost plus contracts (CP).

Summary

The results of the analysis performed on Group 2, when compared to Group 1, are not that much different from the results obtained for Group 1. The use of department control is negatively related to project success in both instances. Cost plus incentive contracts are positively related to project success. Fixed price plus incentive contracts were positively related to project success for Group 2 on medium size projects, but negatively related to project success for Group 1 on small size projects. For Group 2, technical and budget control exercised on the projects is negatively related to project success. For Group 1, schedule control is positively related to project success on small projects, whereas budget control is negatively related to project success on large projects.

TABLE G.2

HYPOTHESIS 1

REGRESSIONS PERFORMED AGAINST JOBR

PROJECT SIZE BASED ON ENGINEERING VALUE

DEPENDENT VARIABLE

JOBR Managers' rating of project success

$R = .37$ $R^2 = .13$ Adj $R^2 = .11$ $F(1,31) = 4.7$ SIG $F = .0386$

INDEPENDENT VARIABLES

		BETA	SIG
CPIF	Project performed on CPIF contract	0.37	.04

PROJECT SIZE BASED ON CONTRACT VALUE

DEPENDENT VARIABLE

JOBR Managers' rating of project success

$R = .37$ $R^2 = .13$ Adj $R^2 = .11$ $F(1,34) = 5.0$ SIG $F = .0326$

INDEPENDENT VARIABLE

		BETA	SIG
CPIF	Project performed on CPIF contract	0.37	.03

There is some indication, based on the managers' visibility on the projects for Group 2, that there is either less need for the management controls placed on the projects or the use of a different type of management control. This indication is deduced from the negative relation that department controls have to project success.

Hypothesis 2

The Effect of Leadership Characteristics on Project Success

The size of the data base for Group 2 precludes any division into management subsets by either corporate management or project management level. As Table 4.1

indicates, Group 2 is comprised of senior, upper, and middle level managers who are in program and project management. This grouping is the same as the corporate and project management groupings in Tables 5.7 through 5.10 for Group 1. The results of the regressions performed on GAATOTAL and GJOBR for Group 2 are shown in Table G.3.

TABLE G.3

HYPOTHESIS 2

CONTRIBUTION TO PROJECT SUCCESS BY THE UPPER TIER OF MANAGEMENT LEVEL

DEPENDENT VARIABLE			
GAATOTAL	Weighted score of project success		
$R=.71$ $R^2=.51$ Adj $R^2=.48$ $F(1,14)=14.6$ SIG $F=.0019$			
INDEPENDENT VARIABLES		BETA	SIG
VARM10	Managers' desire to obtain high degrees of quality and perfectionism in work	0.71	.00
DEPENDENT VARIABLE			
GJOBR	Managers' rating of project success		
$R=.56$ $R^2=.32$ Adj $R^2=.27$ $F(1,14)=6.6$ SIG $F=.0226$			
INDEPENDENT VARIABLES		BETA	SIG
INTDIR1	Intrinsic–direct achieving style	0.56	.02

The regression on the weighted objective score of project success (GAATOTAL) results in $R=0.71$, indicating that 51% (R^2) of the variance is explained by the project managers' desire to obtain a high degree of quality and perfectionism in work (VARM10). The regression on the managers' rating of project success (GJOBR) results in $R=0.56$, indicating that 32% (R^2) of the variance is accounted for by the project managers' intrinsic direct achieving style (INTDIR1).

Summary

The results of the regressions for Group 2 cannot be compared directly to those obtained in testing Hypothesis 2 for Group 1. Testing of Hypothesis 2 for Group 1 was performed controlling for corporate and project management subsets. We can, however, compare the results obtained for Group 2 in this hypothesis against the results obtained for Group 1 in Hypothesis 3. By doing this, we are able to compare all the managers in Group 1 (n = 55) against all the managers in Group 2 (n = 16).

The regressions for Group 1 against the weighted objective score of project success (GAATOTAL) result in two independent variables which account for the variance in GAATOTAL. The first, and most significant, is the managers' competitive direct achieving style (COMPDIR2), which is negatively related to project success. The second is the managers' vicarious relational achieving style (VICREL9) which is positively related to project success.

The indication is that the Group 1 managers compete with, rather than support, help, or collaborate with, the people they manage. Further, these managers contribute more to project success through their encouragement and praise of the project and its members, then they do in direct project participation.

The regressions for the Group 1 managers against their subjective rating of project success (GJOBR) are different. There, we see their reliant instrumental achieving style (RELINST6) and their ability to engage in gamesmanship (VARM30) are positively related to project success. This latter variable (VARM30) is related to the personal instrumental achieving style (PERINST4). This achieving style is associated with those achievers who use aspects of the self to accomplish their tasks.

These results suggest the Group 1 manag... .re reliant on others to aid them in their tasks and are adept in the use of their personal skills to enlist others aid to assist them. Conversely, their direct competitive achieving style (COMPDIR2) and their ability to organize and present information clearly and convincingly are both negatively related to project success.

The results for the Group 2 managers indicate their desire to obtain a high degree of quality and perfectionism in their work (VARM10) is related to their direct intrinsic direct achieving style (INTDIR1). Individually, these variables are positively related to the measures of project success, GAATOTAL and GJOBR, respectively.

The intrinsic direct achievers confront their tasks directly and personally, relying primarily on themselves. They strive for perfection. Their basic reward is derived from meeting the challenge of the task and performing well according to their own standard of excellence. This achieving style is considered a task–oriented achieving style.

There is a marked distinction between the Group 1 and Group 2 managers that is attributed to either a work ethic or work culture. The Group 1 managers are more relational or politically–oriented than the Group 2 managers. The Group 2 managers are more task–oriented. We also found that the Group 1 managers' task–oriented management style detracted from project success. The opposite is true for the Group 2 managers. Their task–oriented management style contributes to project success.

Hypothesis 3

The Effect on Project Success of the Combination of Leadership Characteristics and Management Controls

This hypothesis examines the effect leadership characteristics and management controls have on project success. These two factors were evaluated separately and in combination on the measures of project success (GAATOTAL and GJOBR). The results of the regressions are shown in Tables G.4 and G.5.

Weighted Scores of Project Success: GAATOTAL

Leadership Characteristics

The R for this regression, Table G.4, is 0.71, indicating the independent variable accounts for 51% (R^2) of the variance in GAATOTAL. The single independent variable in the regression equation is the managers' desire to obtain a high degree of quality and perfectionism in their work (VARM10) and is positively related to project success. This result is considerably different than that obtained for Group 1.

The results for Group 1 reveal the managers' competitive–direct achieving style (COMPDIR2) is negatively related to project success. The competitive direct achievers are characterized by their concern for winning. They wish to be in situations that permit clear comparisons of their performance to relevant others. This achieving style is not amenable to the group effort required for project success. The project managers exhibiting this achieving style would always be in competition with the projects' members.

On the other hand, the Group 1 project managers' vicarious relational achieving style (VICREL9) is positively related to project success. The vicarious relational achievers take pride in the achievements of others, including the corporation, as if the accomplishments are their own. They will frequently offer praise, encouragement, and even advise to the group with whom they are associated.

The Group 2 managers' desire to obtain a high degree of quality and perfectionism in their work (VARM10) is similar to those managers who exhibit an intrinsic direct achieving style (INTDIR1). They are perfectionists. They confront their tasks directly and derive pleasure from being able to perform their tasks in accord with their own intrinsic standard of excellence.

Management Controls

The R for this regression, Table G.4, is 0.89, indicating that the independent variables account for 80% (R^2) of the variance in GAATOTAL. Two independent variables resulted from this regression: one positively related to project success, the other negatively related to project success. The positive variable relates to the managers' information about the project (GINF). The negatively related variable to project success indicates the management control system is imposed by the department (GDEPT).

The positive relation which GINF has to project success forcefully reflects the importance managers' information about the project has to project success. A similar result for Group 1 was seen only as an indirect effect to project success in the path analyses reported in chapter 7. The negative relation which department imposed management control has to project success was also seen in several regressions for Group 1. The negative relation of department controls to project success may reflect use of department controls that are not consistent with corporate controls.

By contrast, the regressions for Group 1 indicated the managers viewed schedule control imposed on the project (GSEFF) and the performance of the project on fixed price contracts (GFP) as positively related to project success. Costs on fixed price contracts are a principal concern to project managers. The results indicate the managers feel schedule control is effective on fixed price contracts. This being the case, the managers may feel they can deliver the projects on time and, simultaneously, control project costs.

Leadership Characteristics and Management Controls

The R for this regression is 0.89, indicating that the independent variables account for 80% (R^2) of the variance in GAATOTAL. The combination of leadership characteristics and management controls does not explain any more of the variance in project success (GAATOTAL) than management controls alone. The same independent variables account for the variance in this regression as are seen in the regressions for management controls alone: the managers' information about the project (GINF) and the imposition of department management controls on the project (GDEPT).

By contrast, the Group 1 results for the combination accounted for almost twice the variance in project success (44%) as opposed to management controls alone (23%). For Group 1, the variables accounting for the variance were: 1) the managers' effectiveness in supporting the organizations' overall mission and goals (VARM31); 2) performing the project on a fixed price contract (GFP); 3) the managers' assessment of schedule control (GSEFF); their ability to resolve conflicts (VARM23); and 5) the imposition of project control by the corporation (GCORP). The leadership characteristics (VARM31 and VARM23) were negatively related to project success, whereas the management controls were positively related to project success.

The negative relationship of the Group 1 leadership characteristics to project success may be related to their inability to relate to the corporations goals. They may not be

TABLE G.4

HYPOTHESIS 3

PROJECT SUCCESS ASSESSED BY LEADERSHIP CHARACTERISTICS AND MANAGEMENT CONTROLS

DEPENDENT VARIABLE

GAATOTAL   Weighted score of project success

LEADERSHIP CHARACTERISTICS ALONE

$R = .71$ $R^2 = .51$ Adj $R^2 = .48$ $F(1,14) = 14.6$ SIG $F = .0019$

INDEPENDENT VARIABLE

		BETA	SIG
VARM10	Managers' desire to obtain high degree of quality and perfectionism in work	0.71	.00

MANAGEMENT CONTROLS ALONE

$R = .89$ $R^2 = .80$ Adj $R^2 = .77$ $F(2,13) = 26.0$ SIG $F < .0001$

INDEPENDENT VARIABLES

		BETA	SIG
GINF	Managers' information about the project	0.97	.00
GDEPT	Project control imposed by the department	-0.52	.00

LEADERSHIP CHARACTERISTICS AND MANAGEMENT CONTROLS

$R = .89$ $R^2 = .80$ Adj $R^2 = .77$ $F(2,13) = 26.0$ SIG $F < .0001$

INDEPENDENT VARIABLES

		BETA	SIG
GINF	Managers' information about the project	0.97	.00
GDEPT	Project control imposed by the department	-0.52	.00

able to relate their personal goals with the corporate goals. Another explanation is that these managers may be more interested in the recognition they receive from their peers and colleagues. They may strive to satisfy their own direct achieving style needs, rather than the projects' objectives. For both Group 1 and Group 2, management controls alone accounted for a greater percent of the variance in project success than leadership characteristics alone.

Managers' Rating of Project Success: GJOBR

Leadership Characteristics

The R for this regression, Table G.5, is 0.56, indicating the independent variables account for 32% (R^2) of the variance in GJOBR. The single independent variable in the regression equation represents the managers' intrinsic direct achieving style (INTDIR1), which is positively related to project success.

This is in marked contrast to the results obtained for Group 1. The results for Group 1 reflect a positive relationship to project success of the managers' reliant instrumental achieving style (RELINST6) and their ability to engage in gamesmanship (VARM30). Conversely, their competitive direct achieving style (COMPDIR2) and ability to organize and present information clearly and convincingly (VARM13) are negatively related to project success.

The intrinsic direct achievers confront tasks directly and rely primarily on themselves. The reliant instrumental achievers, on the other hand, expect whoever is there will help them carry out their task. The two groups are markedly different in their achieving styles as their achieving styles relate to project success. The Group 2 project managers' appear to have an affinity to do it themselves, whereas the Group 1 project managers rely on others to help them. We also see that the competitive direct achieving style of the Group 1 project managers is negatively related to project success. For Group 1, this achieving style reflects the project managers' competition with the project group: ranking their own contribution in relation to those made by others.

Management Controls

The R for this regression, Table G.5, is 0.94, indicating the independent variables account for 87% (R^2) of the variance in GJOBR. The independent variables accounting for the variance are both positively related to project success. They are the variables defining who imposed the management control system (GCOTH) and that the project is being performed on a cost plus incentive fee contract (GCPIF).

For Group 1, the results indicated three variables were positively related to project success: 1) the management control system used (GPERTC); 2) the use of budget control on the project (GBCON); and 3) the effectiveness of schedule control on the project (GSEFF).

No direct comparison can be made between the two groups from this analysis. We might note that there were no management control variables negatively related to the managers' subjective rating of project success (GJOBR).

Leadership Characteristics and Management Control

The R for this regression is 0.95, indicating that the independent variables accounted for 89% (R^2) of the variance in GJOBR. Similar to the results for Group 1, the combination of leadership characteristics and management controls did not increase the explanation of variance in project success over the variance explained by management controls alone.

There are two independent variables which account for the variance in GJOBR and both are positively related to project success. These variables are: who imposed the management controls (GCOTH) and the managers' ability to identify important points in verbal communication (VARM07).

The results of the regression for Group 2 were entirely different than those obtained for Group 1. For Group 1, the regression of leadership characteristics and management controls on the managers' rating of project success (GJOBR) resulted in three management control variables which were positively related to project success: 1) the use of PERT/CPM as a management control tool (GPERTC); 2) exercise of budget control on the project (GBCON); and 3) the effectiveness of the projects' schedule control (GSEFF).

TABLE G.5

HYPOTHESIS 3

PROJECT SUCCESS ASSESSED BY LEADERSHIP CHARACTERISTICS AND MANAGEMENT CONTROLS

DEPENDENT VARIABLE

GJOBR Managers' rating of project success

LEADERSHIP CHARACTERISTICS ALONE

$R = .56$ $R^2 = .32$ Adj $R^2 = .27$ $F(1,14) = 6.6$ SIG $F = .0026$

INDEPENDENT VARIABLE

		BETA	SIG
INTDIR1	Intrinsic–direct achieving style	0.56	.02

MANAGEMENT CONTROLS ALONE: f (2,13)

$R = .94$ $R^2 = .89$ Adj $R^2 = .87$ $F(2,13) = 50.5$ SIG $F < .0001$

INDEPENDENT VARIABLES

		BETA	SIG
GCOTH	Management controls imposed by other than contract, corporation, or department	0.88	.00
GCPIF	Project performed on CPIF contract	0.21	.04

LEADERSHIP CHARACTERISTICS AND MANAGEMENT CONTROLS

$R = .95$ $R^2 = .89$ Adj $R^2 = .88$ $F(2,13) = 54.7$ SIG $F < .0001$

INDEPENDENT VARIABLES

		BETA	SIG
GCOTH	Management controls imposed by other than contract. corporation, or department	0.93	.00
VARM07	Managers' ability to identify important points in verbal communication	0.23	.02

Summary

The results of the regressions performed do not support the hypothesis that the combination of leadership characteristics and management controls contribute more to project success than either by itself. The results are similar to those obtained when evaluating Group 1. Management controls account for a greater percent of the variance in project success (GAATOTAL and GJOBR) than leadership characteristics.

The leadership characteristics exhibited in these regressions reflect some of the differences between Group 1 and Group 2. Group 1 appears to be more relational oriented as shown by the positive relation their vicarious relational achieving styles (VICREL9) have to project success. Group 2, on the other hand, appears to be more task–oriented as seen by the positive relation their intrinsic direct achieving styles (INTDIR1) have to project success.

There is some similarity between the management control methods used by the two groups. Both groups, not just from the results seen in this hypothesis, indicate that department controls are negatively related to project success. Group 1 results show the use of PERT or PERT/CPM management tools to be positively related to project success. A management control method did not appear in the regressions for Group 2.

When the leadership characteristics are combined with the management controls, the results for both groups are similar. The most significant variables that are positively related to project success are those which define management control functions. Those variables that are negatively related to project success are the variables which define leadership characteristics.

Hypothesis 4

The Effect of Project Size, Technical Composition, and Technological Complexity on Project Success

The results of the evaluation of the effects of project size to project success (GAATOTAL and GJOBR) are shown in Table G.6. The regressions against the weighted score of project success (GAATOTAL) resulted in R=0.39, indicating 15% (R^2) of the variance in GAATOTAL is accounted for by the independent variable defining project size (ASIZE) and is negatively related to project success. The results are similar to the results obtained for Group 1. That is, as the project size increases, project success declines. There was no regression of the independent variables against the managers' rating of project success (GJOBR).

The results of the regressions performed to evaluate the effect technical composition and technological complexity have on project success are shown in Table G.7. The independent variables used in these regression are those defining hardware and software complexity, the percent of hardware and software comprising the project, the software languages used, and the software environment for which the software is being designed. There were no regressions against the weighted score of project success (AATOTAL).

The regressions against the managers' rating of project success (JOBR) resulted in R=0.57, indicating the independent variables account for 33% (R^2) of the variance in the dependent variable. The two independent variables in the regression equation relate to the complexity of the hardware used on the projects (HWCOMP), with a positive relation to project success, and the software language used on the projects (FORT), with a negative relation to project success.

When the variables defining hardware and software complexity are converted to a single variable defining project complexity (JOBCMP) as defined in Chapter 6, the results are similar to those just described. There was no regression of the independent variables against the weighted objective score of project success (AATOTAL).

The regression against the managers' rating of project success (JOBR) resulted in R=0.40. This indicates that 16% (R^2) of the variance in JOBR is accounted for by the independent variable indicating that the software language FORTRAN is used on the projects (FORT). It is negatively related to project success.

The results are not surprising based on the composition of the projects reported on by the respondents in Group 2. The projects on which they work are comprised chiefly of software. There was no hardware on 16 of the projects reported. Moreover, the mean of the

TABLE G.6

HYPOTHESIS 4

THE EFFECT OF PROJECT SIZE
ON PROJECT SUCCESS

PROJECT SIZE DEFINED BY PROJECTS ENGINEERING VALUE

DEPENDENT VARIABLE

AATOTAL Weighted score of project success

$R = .39$ $R^2 = .15$ Adj $R^2 = .12$ $F(1,26) = 4.6$ SIG $F = .0412$

INDEPENDENT VARIABLE

		BETA	SIG
ASIZE	Project size defined by the projects' engineering value	–0.39	.04

DEPENDENT VARIABLE

JOBR Managers' rating of project success

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

PROJECT SIZE DEFINED BY PROJECTS TOTAL CONTRACT VALUE

DEPENDENT VARIABLE

AATOTAL Weighted score of project success

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

DEPENDENT VARIABLE

JOBR Managers' rating of project success

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

TABLE G.7

HYPOTHESIS 4

THE EFFECT OF TECHNICAL COMPOSITION AND TECHNICAL COMPLEXITY ON PROJECT SUCCESS

TECHNICAL COMPOSITION

DEPENDENT VARIABLE

AATOTAL Weighted score of project success

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

DEPENDENT VARIABLE

JOBR Managers' rating of project success

$R = .57$ $R^2 = .33$ Adj $R^2 = .28$ $F(2,29) = 7.2$ SIG $F = .0030$

INDEPENDENT VARIABLES

		BETA	SIG
HWCOMP	Complexity of hardware used on the project	0.41	.01
FORT	Software used on the project is FORTRAN	–0.37	.02

TECHNICAL COMPLEXITY

DEPENDENT VARIABLE

AATOTAL Weighted score of project success

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

DEPENDENT VARIABLE

JOBR Managers' rating of project success

$R = .40$ $R^2 = .16$ Adj $R^2 = .14$ $F(1,30) = 5.8$ SIG $F = .0219$

INDEPENDENT VARIABLE

		BETA	SIG
FORT	Software used on the project is FORTRAN	–0.40	.02

projects' hardware complexity of the remaining projects is 3.04 (SD = 1.37) on a scale of 1 to 5 with 5 being the most complex. There were only four projects on which there was no software. The mean of the projects' software complexity for these projects is 3.58 (SD = 1.33). The negative relation of FORTRAN to project success is not unexpected as it is the principal software language used on 39 of the 42 projects in the regressions.

There is no direct comparison which can be made to the results obtained from Group 1. There we found that for projects having less than 30% software content, software complexity (SWCOMP) and the software language used (OTH) were negatively related to project success, but hardware complexity (HWCOMP) was positively related to project success. If software comprised more than 30% of the project, the hardware complexity (HWCOMP) and the software language used (ADA) were both negatively related to project success. We also found that on the most technologically complex projects that the software complexity (SWCOMP) and the software language used (ADA) were both negatively related to project success. For the least technologically complex projects, project size, determined by the projects' engineering budget (VALUEEK), accounted for the variance in project success. This single variable was negatively related to project success.

Summary

The results of the analysis support the hypothesis that as project size increases, project success will decline. Nothing can be definitively stated regarding the effect that technical composition and technological complexity have on project success for Group 2. We can only state that, for the projects evaluated, the lack of hardware complexity is positively related to project success. Further, we found the use of FORTRAN is negatively related to project success in projects which contain a large percent of software. FORTRAN is the principal language used in the Group 2 projects which may explain this result.

Hypothesis 5

The Effect of Training, Education, Experience, and Corporate Tenure on Project Success

This hypotheses addresses the effect training, education, experience, and corporate tenure have on project success. These factors were evaluated without regard to the software content in the project as was done with Group 1. The data base was too small to break into subsets based on the projects' software content. The results are shown in Table G.8.

TABLE G.8

HYPOTHESIS 5

THE EFFECT OF EDUCATION, EXPERIENCE, AND CORPORATE TENURE ON PROJECT SUCCESS

DEPENDENT VARIABLE			
AATOTAL	Weighted score of project success		
$R=.48$ $R^2=.23$ Adj $R^2=.18$ $F(2,23)=4.8$ SIG $F=.0139$			
INDEPENDENT VARIABLES			
		BETA	SIG
EXPPE	Years experience as a project engineer	–0.37	.02
YRWPEM	Years with present employer	–0.33	.04
DEPENDENT VARIABLE			
JOBR	Managers' rating of project success		
$R=.32$ $R^2=.11$ Adj $R^2=.08$ $F(1,38)=4.6$ SIG $F=.0388$			
INDEPENDENT VARIABLES			
		BETA	SIG
TIMERD	Time spent on project business	0.33	.04

The regression against the weighted score of project success (AATOTAL) resulted in $R=0.48$, indicating the independent variables accounted for 25% (R^2) of the variance in project success. The independent variables which explain the variance are negatively related to project success. They are the project managers' experience as a project engineer (EXPPE) and the number of years they have been with their present employer (YRWPEM). The data suggests that the lack of project engineering experience, i.e., the day–to–day operational experience, is detrimental to project success. The managers are lacking the experience pertaining to how the project comes together. The project managers' lack of tenure with the firm also suggests the managers may not be sufficiently knowledgeable about the firms' processes in pushing a project through the firm. The project managers may not have been with the firm long enough, or in their positions long enough, to form alliances and the informal networks necessary to aid them in completing their project tasks.

The regression performed against the managers' rating of project success (JOBR) resulted in R = 0.32. This indicates 11% (R^2) of the variance is explained by the managers' amount of time spent on the project (TIMERD). The relationship to project success is positive indicating that the more time the project managers devote to the project the more successful the project.

The results obtained from the analysis of Group 1 are considerably different than the results obtained for Group 2. The Group 1 results indicated that the time spent by the project managers on the projects (TIMERD) was negatively related to project success. For Group 1, we found that the least successful projects required more of the project managers' time. The Group 2 results, however, suggest that the more time spent on the project contributes to project success.

The mean size of the projects in Group 2 is one–third the size of the projects in Group 1. The managers in Group 1 work on fewer projects than the managers in Group 2 and spend more time on each of them. The data suggests the Group 2 project managers may spend more time on their projects as a consequence of their intrinsic direct achieving style. Their desire to confront a task directly, combined with their lack of experience as project engineers and their inexperience with their current position, may result in their spending more time on the projects to the projects benefit.

For Group 1, we also saw that years of experience (YRSPEX) was positively related to project success. This did not appear in the regressions for Group 2. For Group 1, holding an advanced degree (ADVDEG) was negatively related to project success. This was attributed to either the project managers over specialization in a given field or their assignment as project managers to projects to which their educational background was incompatible. There was no attempt to evaluate the Group 2 project managers background to either project size or to subsets of the projects when controlling for project software content. The data set was too small to divide into subsets and still obtain significant independent variables which would explain the variance in the dependent variables defining project success.

Summary

The results suggest that the project managers in Group 2 spend more time on their projects as a consequence of several factors: 1) their lack of experience as project engineers; 2) their short period of employment with their present employer or in their present position; and 3) their task oriented intrinsic direct achieving style.

This contrasted with the results found for Group 1. The results for Group 1 suggest that the project managers' professional experience is an important factor contributing to project success. Further, we found that the Group 1 project managers were either over specialized for their assignments or their assignments are not amenable to their educational backgrounds.

We did not evaluate the Group 2 project managers' professional and educational background when controlling for project size or project software content. The Group 2 data set was too small to divide into subsets. This was done for the Group 1 project managers. When controlling for project size, the results for Group 1 indicated years of professional experience and years of hardware experience were positively related to project success. The project managers' years of education was negatively related to project success. The findings for Group 1, when controlling for the projects' software content, indicated that the project managers' software and hardware experience were contributing factors to project success.

Hypothesis 6

The Effect of Leadership Characteristics on Project Manager Success

This hypothesis examines the effect leadership characteristics have on project manager success. The leadership characteristics examined relate to the project managers' needs for power and achievement, their achieving styles, and their leadership style. We also evaluated the project managers' needs to control the schedule, budget, and technical criteria related to the project.

There were two analytical methods used to evaluate this hypothesis. The first was a multiple regression to evaluate the project managers' need for achievement (n Ach) and power (n Pow). The second was another multiple regression of the independent variables against the rating of the project managers' success GATOTAL.

Needs for Achievement (n Ach) and Power (n Pow)

Based on studies performed by Stahl (1983), successful managers have a high need for both achievement and power. A manager with high needs for both power and achievement is classified by Stahl as having high managerial motivation. Those managers with high needs for neither achievement nor power are classified as having low managerial motivation. Those managers having either a high need for achievement or a high need for power, but not both, are classified as having medium managerial motivation. The variable related to managerial motivation is MMOT. Scaling for this variable is 1, 0, or –1 depending on whether the managerial motivation is high, medium, or low.

The managers in Group 2 were grouped into four classifications of success, ranging from unsatisfactory to outstanding, based on their weighted score of manager success (GATOTAL). Recall from Chapter 4 that GATOTAL was constructed from the managers' rating of their own performance. These groups were in turn compared to Stahl's ranking of managerial motivation.[3] The results are shown in Table G.9.

Among the 13 managers rated as successful, i.e., average to outstanding, all 13 were rated as having medium to high managerial motivation. Of these 13, five scored themselves as having high managerial motivation. Proportionately, the results for Group 2 did not have as many managers with high managerial motivation, who rated themselves as successful, as there were in Group 1: 59% for Group 1, 38% for Group 2. The Group 2 results for n Pow ($\underline{M}=0.44$, $\underline{SD}=0.21$) and n Ach ($\underline{M}=0.62$, $\underline{SD}=0.24$) compare closely to the Group 1 managers classified as "project managers": n Pow ($\underline{M}=0.42$, $\underline{SD}=0.25$), n Ach ($\underline{M}=0.61$, $\underline{SD}=0.25$).

Regression of Independent Variables on GATOTAL

The results of the regression of the independent variables against GATOTAL are shown in Table G.10. The regression resulted in $R=0.89$, indicating that 79% (R^2) of the variance in GATOTAL was accounted for by the independent variables. There are two variables which account for the variance in GATOTAL.

These two independent variables are positively related to the project managers' success and are the managers' need for budget control on the project (GBNEC), and their

TABLE G.9

HYPOTHESIS 6

MANAGEMENT MOTIVATION VERSUS MANAGERS' SUCCESS

GMGRSUC	MMOT			
	–1	0	1	TOTAL
1	–	6	5	11
2	–	2	–	2
3	–	–	–	–
4	–	1	3	3
TOTAL	–	9	7	16

TABLE G.10

HYPOTHESIS 6

THE EFFECT OF LEADERSHIP CHARACTERISTICS
ON PROJECT MANAGERS' SUCCESS

DEPENDENT VARIABLE

GATOTAL — Weighted score of project managers' success

$R = .89$ $R^2 = .79$ Adj $R^2 = .76$ $F(2,13) = 24.8$ SIG $F < .0001$

INDEPENDENT VARIABLES

		BETA	SIG
GBNEC	Project managers need for budget control	0.72	.00
PERINST4	Personal–instrumental achieving style	0.63	.00

personal instrumental achieving style (PERINST4). The positive relationship of these two variables to the project managers' success is not unexpected. The personal instrumental achievers are usually skillful negotiators and generally excel in bargaining. They also tend to be charismatic leaders. As project managers, the personal instrumental achievers are frequently required to bargain and negotiate terms related to the project as they relate to budget, schedule, and technical parameters. These project managers will frequently exert political influence within legitimate constraints to achieve their objectives. Their need for budget control on their projects would be related to their personal instrumental style. Those managers who control the budget are in a powerful bargaining position vis-á-vis those who wish to use this resource.

Leadership Style

The variable defining leadership style, LPCD1, did not appear as an independent variable in the regression on GATOTAL nor in any other statistical procedure used in testing this hypothesis. The results obtained from the LPC instrument reveal the 16 respondents had a mean score of 68.9 with a standard deviation of 10.7. This is comparable to the results for Group 2: $\underline{M} = 70.8$, $\underline{SD} = 8.5$. The LPC score for both groups is within the range of 55 to 93 that is normally associated with those individuals characterized as both relational and task oriented. Further, the managers' leadership style in both groups is closer to a task oriented, rather than a relational-oriented, leadership style. Both groups also had one project manager who exhibited a task-oriented leadership style with a LPC test score of less than 55.

Summary

The results of the analyses performed on Group 2 are not unlike those obtained from the analyses performed on Group 1. The needs for power (n Pow) and achievement (n Ach) for Group 2 correspond to the classification of managers' success GMGRSUC, i.e., 13 of the managers having either medium or high managerial motivation were rated as average to outstanding. Although the project managers in Group 2 were principally comprised of upper and senior level corporate managers, their scores on the JCE were very similar to the project management level of project managers in Group 1 which were comprised chiefly of upper and middle level corporate managers.

The five principal achieving styles used by Group 2 (see Table G.11) are more intense than the same achieving styles used by the aforementioned project managers in Group 1. We note that, for both Group 1 and Group 2, the least used achieving styles are those in the instrumental domain. The two instrumental achieving styles least used by both groups are the social and reliant instrumental achieving styles. The social instrumental achievers see other people as a means to accomplish their goals. The reliant instrumental achievers feel the need for others to help them achieve their goals. The connotation of these achieving styles may not be acceptable to the image which the project managers have of themselves. Consequently, the project managers may not acknowledge the extent to which they use these achieving styles.

TABLE G.11

HYPOTHESIS 6

RANKING OF ACHIEVING STYLES BY INTENSITY LEVEL

ACHIEVING STYLE	M	SD
Intrinsic–Direct	6.19	0.67
Vicarious–Relational	5.96	0.72
Power–Direct	5.81	0.61
Contributory–Relational	5.73	0.78
Collaborative–Relational	5.65	0.80
Competitive–Direct	4.99	0.94
Reliant–Instrumental	4.78	1.01
Personal–Instrumental	4.40	0.84
Social–Instrumental	4.01	1.19

The leadership style predominantly used by Group 2 is the task/relational style. Only one of the project managers in Group 2 did not have a task/relational leadership style, but, instead, exhibited a task oriented leadership style. Similar results were obtained for Group 1.

The results of the regressions for Group 1 and Group 2 were somewhat different. The results for both groups indicate the collaborative relational achieving style is positively related to project managers' success. Group 1 had one achieving style negatively related to project managers success. This was their competitive direct achieving style. The Group 1 project managers used their personal instrumental achieving style to aid in their success. The Group 2 managers exhibited a need for budget control to achieve their success.

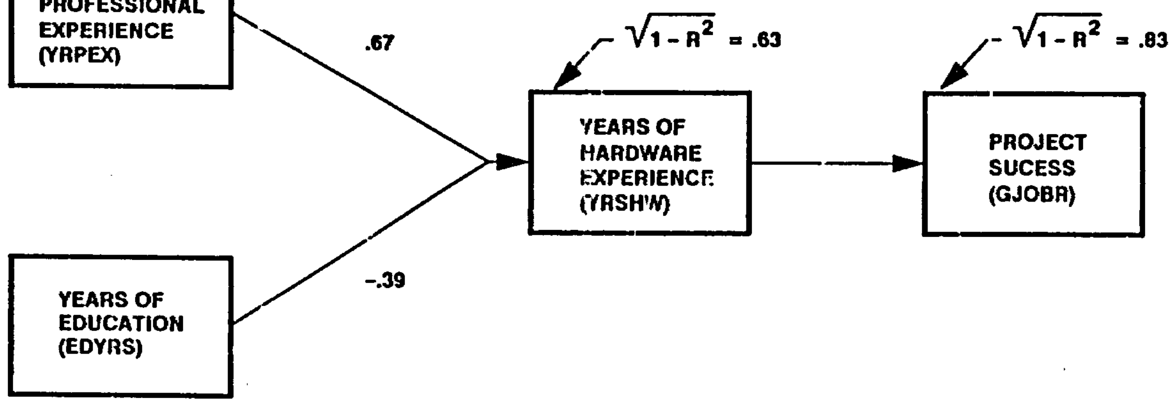
Hypothesis 7

Path Analysis Results

The analysis performed for Group 2 was the same as that for Group 1. There were three path analyses performed to evaluate the individual effect leadership characteristics, management controls, and project characteristics have on project and project manager success. The path models used for each of these dimensions are the models shown in Chapter 3, Figures 3.2 – 3.3. The dimensions of leadership characteristics, management controls, and project characteristics were then combined in a fourth path analysis to evaluate the effect the combined dimensions have on the measures of success used in this research. The variables shown in the path models were predicted to have a causal relationship to the weighted score of project success (GAATOTAL), the managers' weighted score of success (GATOTAL), and the managers' rating of project success (GJOBR). The results of the individual analyses are presented in Figures G.1 through G.3 and Tables G.12 through G.14. The results of the combined path analysis are shown in Figure G.4 and Table G.15.

Leadership Characteristics

The results of this analysis are shown in Figure G.1. Only one regression resulted from the regression of the leadership characteristics against the measures of success. This



Path Analyses Leadership Characteristics
Figure G.1

was the regression of the leadership characteristics against the managers' rating of project success (GJOBR). The lack of regressions against the weighted score of project success (GAATOTAL) and the weighted score of managers' success is attributed to the omission of variables from the path model.

Leadership characteristics accounted for 32% ($R^2 = .32, F(1,14) = 6.5$) of the variance in GJOBR. The predictor is the years of hardware experience (YRSHW). The variable is negatively related to project success, but we note, that in the prediction equation for project success, the variable has only a small effect on project success. The negative relation to project success is not unexpected as the projects reported on by Group 2 are predominantly comprised of software. Hardware experience would not necessarily be a contributing factor to project success. The significance of the independent variables on the dependent variable is shown in Table G.12.

Management Control

The results of the path analysis are shown in Figure G.2. Management control functions account for 45% ($R^2 = .45, F(1,14) = 11.6$) of the variance in the path model for the weighted score of project success GAATOTAL. This variance is accounted for by the direct effect of the managers' authority on the project (GAUTH). From the results obtained on the analyses performed on Group 1, we found that the managers' authority could be exercised on and have a positive relationship to small and medium size projects. Thus, the same finding here is not surprising.

Management control functions account for 82% ($R^2 = .82$, $F(1,14) = 73.9$) of the variance in the path model for the managers' rating of project success (GJOBR). This variance is accounted for by the direct effect of the use of PERT as a management tool (GPERT).

There are also indirect effects which have a bearing on project success. These include the managers' information about the project (GINF), the managers' need for budget control (GBNEC), and the imposition of management control on the project by other than the contract, corporation, or department (GCOTH). The indirect effects are all positively

TABLE G.12

HYPOTHESIS 7

PATH ANALYTICAL MODEL
LEADERSHIP CHARACTERISTICS

DEPENDENT VARIABLE

GAATOTAL Weighted score of project success

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

DEPENDENT VARIABLE

GJOBR Managers' rating of project success

$R = .56$ $R^2 = .32$ Adj $R^2 = .27$ $F(1,14) = 6.5$ SIG $F = .0236$

INDEPENDENT VARIABLE

		B	BETA	SIG
YRSHW	Years of hardware experience	-0.06	-0.56	.02
	Constant	4.78		

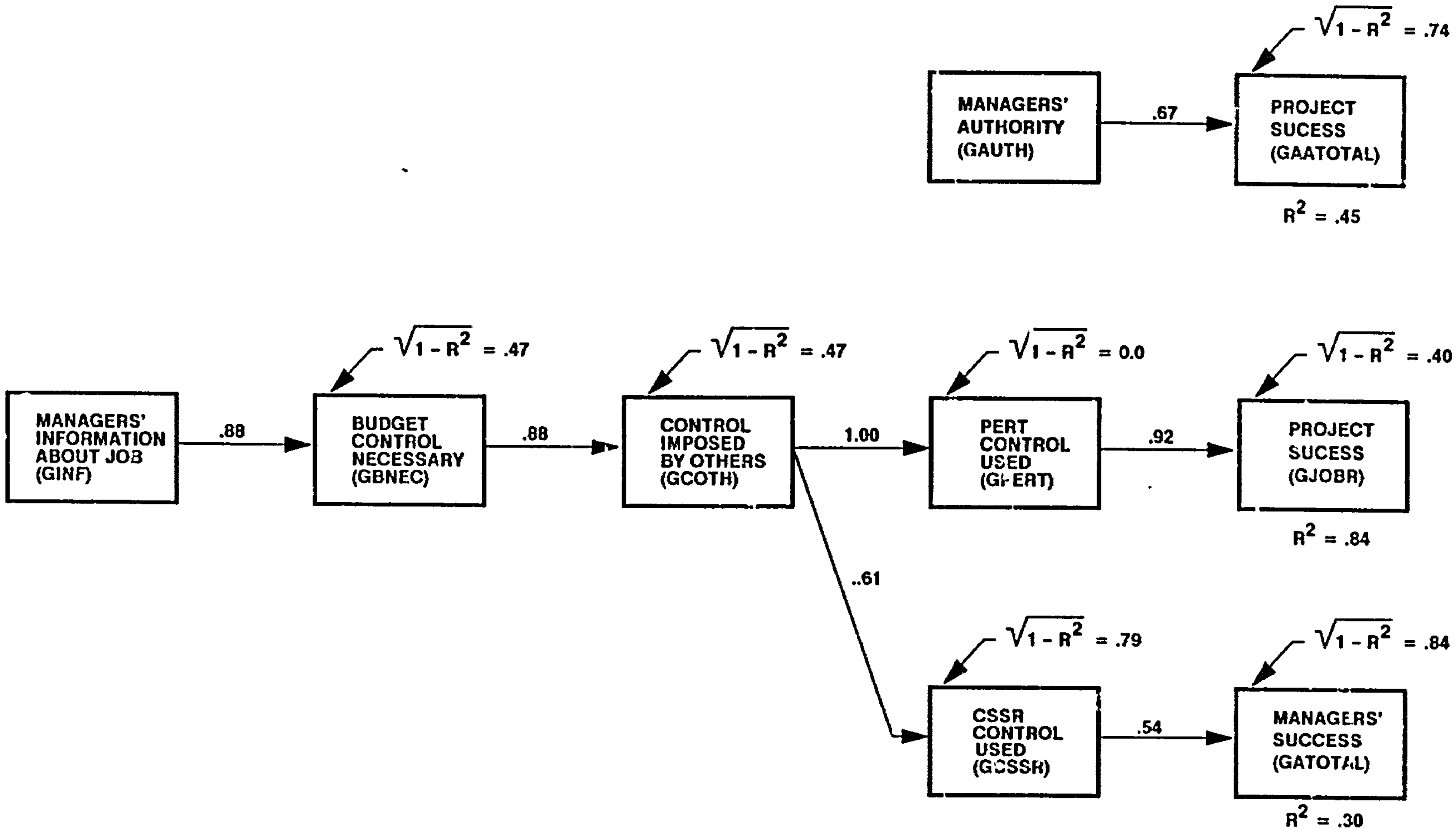
DEPENDENT VARIABLE

GATOTAL Weighted score of project success

PIN = 0.05 LIMITS REACHED. There was no significant regression against the dependent variable.

related to project success. This suggests that the projects are small enough so that the managers can combine their information about the project (GINF) with their authority (GAUTH) to impose a method of control on the project (GSOTH).

Management controls account for 30% ($R^2 = .30$, $F(1,14) = 5.9$) of the variance in the path model for the weighted score of project management success (GATOTAL). This variance is accounted for by the direct effect of the CSSR management control system used on the project (GCSSR). The indirect direct effects on the managers' success (GATOTAL) are the same as those for the managers' rating of project success (GJOBR). The significance of the independent variables on the dependent variables is shown in Table G.13.



Path Analysis Control Functions
Figure G.2

TABLE G.13

HYPOTHESIS 7

PATH ANALYTICAL MODEL
MANAGEMENT CONTROL

DEPENDENT VARIABLE

GAATOTAL Weighted score of project success

$R = .62$ $R^2 = .45$ Adj $R^2 = .41$ $F(1,14) = 11.6$ SIG $F = .0042$

INDEPENDENT VARIABLES

		B	BETA	SIG
GAUTH	Managers' authority	0.77	0.67	.00
	Constant	0.43		

DEPENDENT VARIABLE

GJOBR Managers' rating of project success

$R = .92$ $R^2 = .84$ Adj $R^2 = .83$ $F(1,14) = 73.9$ SIG $F < .0001$

INDEPENDENT VARIABLES

		B	BETA	SIG
GPERT	PERT used as management tool	4.33	0.92	.00
	Constant	0.00		

DEPENDENT VARIABLE

GATOTAL Weighted score of project success

$R = .54$ $R^2 = .30$ Adj $R^2 = .24$ $F(1,14) = 5.9$ SIG $F = .0296$

INDEPENDENT VARIABLES

		B	BETA	SIG
GCSSR	CSSR used as management tool	1.80	0.54	.03
	Constant	1.24		

Project Characteristics

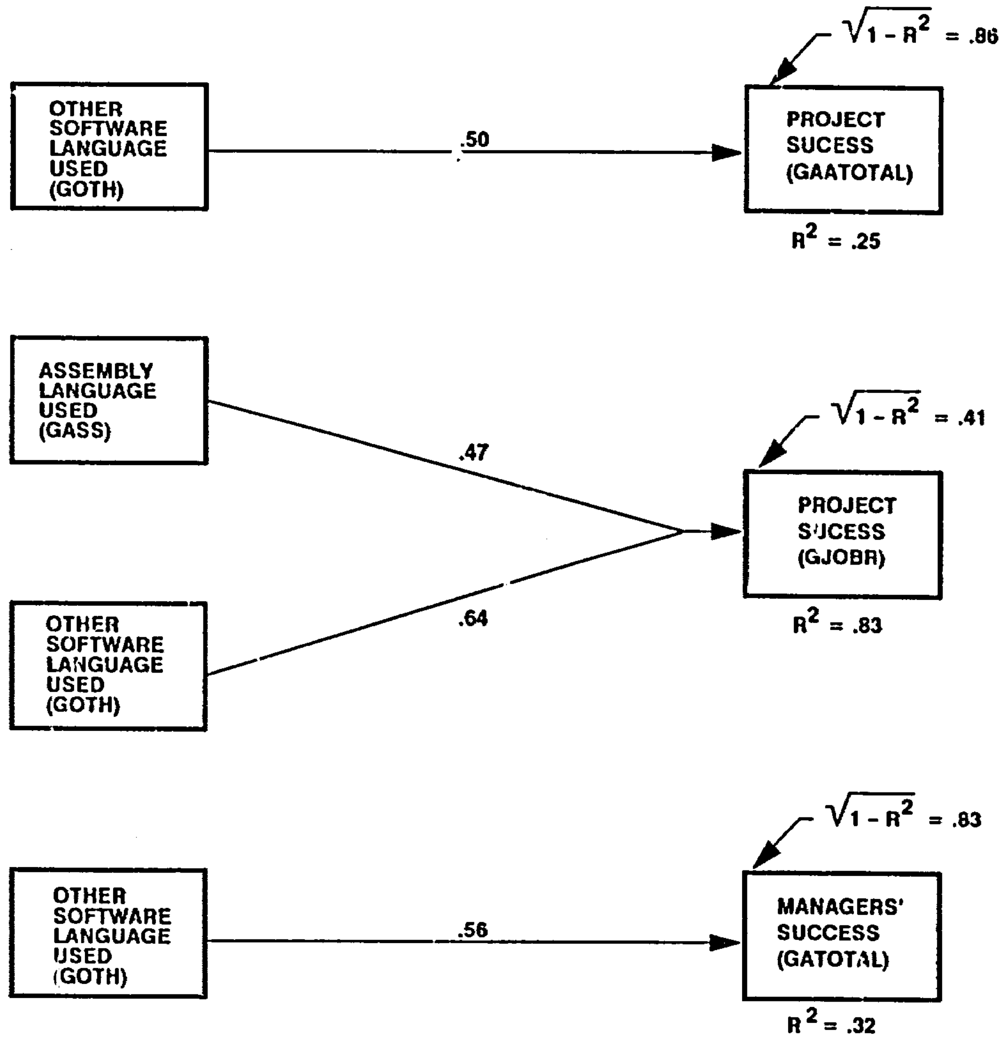
The results of the path analysis are shown in Figure G.3. Project characteristics account for 25% ($R^2 = .25$, $F(1,14) = 4.8$) of the variance in the path model for the weighted score of project success (GAATOTAL). This variance is accounted for by the use of software other than FORTRAN, C, ADA, PASCAL, and ASSEMBLY (GOTH). This same relationship exists for the weighted score of managers' success (GATOTAL). The independent variable GOTH accounts for 32% (R^2, $F(1,14) = 6.5$) of the variance in the path model for GATOTAL.

The project characteristics account for 83% ($R^2 = .83$, $F(2,13) = 32.8$) of the variance in the path model for the managers' rating of project success (GJOBR). This variance is accounted for by the direct effect of two types of software used on the projects. The most significant is (GOTH), and the other is the use of ASSEMBLY (GASS). Both are positively related to project success (GJOBR). There were no indirect project characteristics which contributed to the measures of success. The significance of the independent variables on the dependent variables are shown in Table G.14.

Leadership Characteristics, Management Control and Project Characteristics

The results of the path analysis are shown in Figure G.4. The combined characteristics account for 65% ($R^2 = .65$, $F(2,13) = 11.9$) in the weighted score of project success (GAATOTAL) in the path model. There are two variables accounting for this variance and both are positively related to GAATOTAL. These are the managers' authority (GAUTH) and their need for affiliation (BAFF).

The combined characteristics account for 90% ($R^2 = .90$, $F(2,13) = 58.3$) of the variance in the managers' rating of project success (GJOBR) in the path model. The direct effects accounting for this variance are the control method employed (GPERT) and the complexity of the hardware used on the projects (HWCOMP). Both are positively related to project success. The indirect effects are the use of ASSEMBLY language software (GASS), the managers' information about the project (GINF), the managers' need for budget control (GBNEC), and who imposed the management control on the project (GCOTH).



Path Analyses Project Characteristics
Figure G.3

TABLE G.14

HYPOTHESIS 7

PATH ANALYTICAL MODEL
PROJECT CHARACTERISTICS

DEPENDENT VARIABLE

GAATOTAL Weighted score of project success

$R = .50$ $R^2 = .25$ Adj $R^2 = .20$ $F(1,14) = 4.8$ SIG $F = .0467$

INDEPENDENT VARIABLES

		B	BETA	SIG
GOTH	Other software language used	1.95	0.50	.05
	Constant	1.28		

DEPENDENT VARIABLE

GJOBR Managers' rating of project success

$R = .91$ $R^2 = .83$ Adj $R^2 = .81$ $F(2,13) = 32.8$ SIG $F < .0001$

INDEPENDENT VARIABLES

		B	BETA	SIG
GOTH	Other software language used	1.96	0.64	.00
GASS	Assembly language used	1.18	0.47	.00
	Constant	0.66		

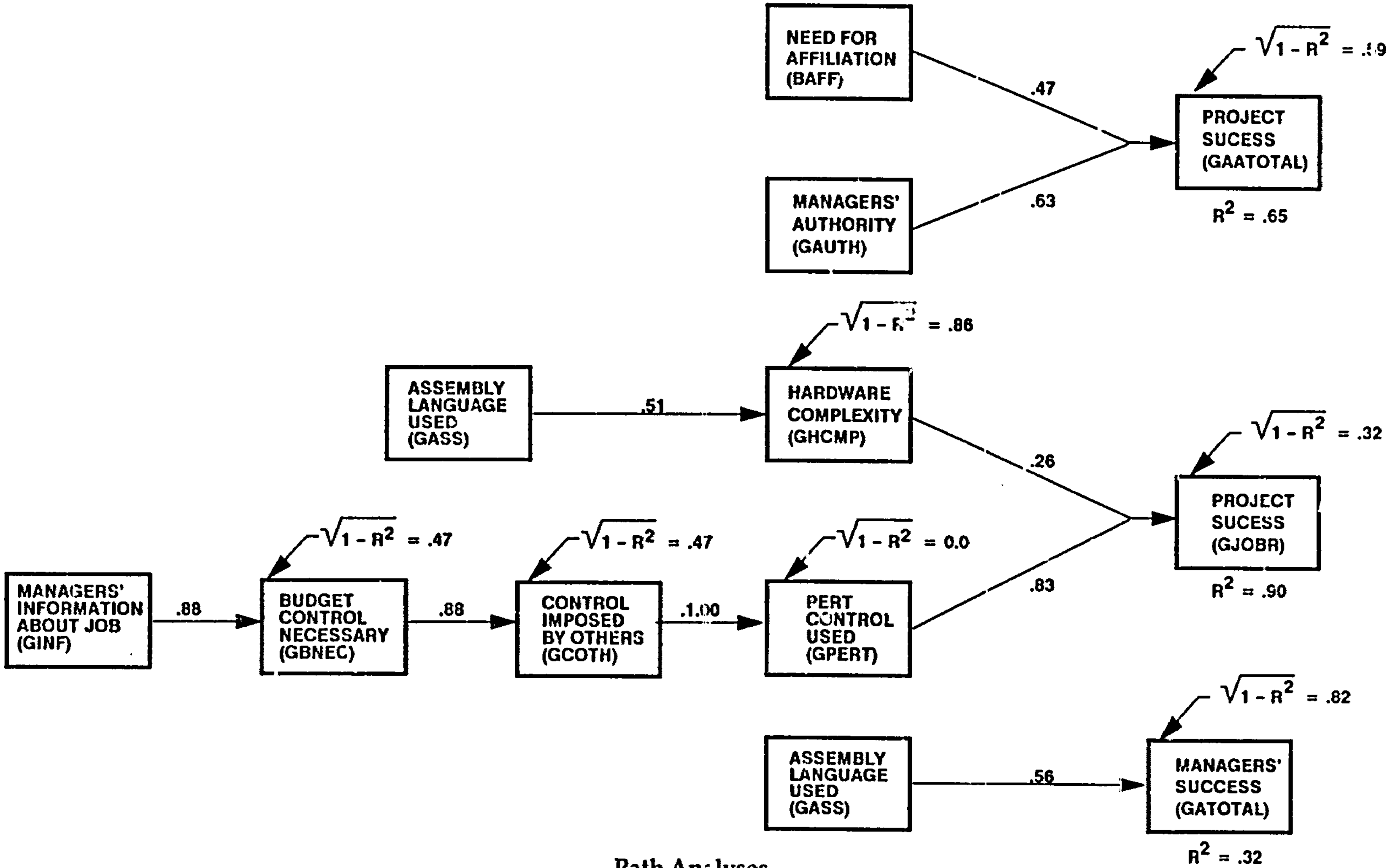
DEPENDENT VARIABLE

GATOTAL Weighted score of project success

$R = .56$ $R^2 = .32$ $F(1,14) = 6.5$ SIG $F = .0230$

INDEPENDENT VARIABLES

		B	BETA	SIG
GOTH	Other software language used	2.49	0.56	.02
	Constant	0.80		



Path Analyses
Leadership, Management Control and Project Characteristics
On Project and Manager Success
Figure G.4

The combined characteristics account for 32% ($R^2 = .32$, $F(1,14) = 6.5$) of the variance in the weighted score of the managers' success (GATOTAL) in the path model. The direct effect accounting for this variance is the variable which indicates the use of a software language other than FORTRAN, C, ADA, PASCAL, or ASSEMBLY on the project (GCOTH). There are no indirect effects contributing to the weighted objective score of managers' success (GATOTAL). The significance of the independent variables on the dependent variables is shown in Table G.15.

Summary

The results obtained from the path analysis for Group 2 are considerably different than the results obtained from the path analyses for Group 1. The results do support the hypothesis that leadership characteristics have more effect on project success than management controls have on project manager success. This is illustrated by the results of the regressions performed on GAATOTAL and GATOTAL.

A comparison between Group 1 and Group 2 is made using the results obtained from the combined path analysis. For Group 1, the variance in GAATOTAL is accounted for by the management controls used, the effectiveness of schedule control, and the direct domain of achieving styles. The first two were positively related to GAATOTAL, whereas the last was negatively related to GAATOTAL. For Group 2, we see that the managers' authority and need for affiliation are positively related to GAATOTAL.

The projects in Group 2 are smaller than those in Group 1 which can account for the managers' authority contributing to project success. The need for affiliation may partly explain the difference between Groups 1 and 2. The positive relation of this variable to project success suggests there is a closer knit relationship among the managers of Group 2. They may work closer together among themselves than the managers in Group 1. The managers in Group 1 work on larger projects and may have less time for individual relationships due to the multiplicity of interfaces they must maintain.

The managers' subjective rating of project success (GJOBR) indicates that management controls are a requisite to project success. Group 1 results showed that the

TABLE G.15

HYPOTHESIS 7

PATH ANALYTICAL MODEL
LEADERSHIP CHARACTERISTICS, MANAGEMENT CONTROL FUNCTIONS, AND PROJECT CHARACTERISTICS

DEPENDENT VARIABLE

GAATOTAL Weighted score of project success

$R = .80$ $R^2 = .65$ Adj $R^2 = .59$ $F(2,13) = 11.9$ SIG $F = .0012$

INDEPENDENT VARIABLES

		B	BETA	SIG
GAUTH	Managers' authority	0.89	0.83	.00
BAFF	Need for affiliation	3.32	0.46	.02
	Constant	–1.29		

DEPENDENT VARIABLE

GJOBR Managers' rating of project success

$R = .95$ $R^2 = .90$ Adj $R^2 = .88$ $F(2,13) = 58.3$ SIG $F < .0001$

INDEPENDENT VARIABLES

		B	BETA	SIG
GPERT	PERT used as management tool	3.92	0.83	.00
GHCMP	Complexity of hardware used on project	0.18	0.26	.02
	Constant	0.00		

DEPENDENT VARIABLE

GATOTAL Weighted score of managers' success

$R = .56$ $R^2 = .32$ Adj $R^2 = .27$ $F(1,14) = 6.5$ SIG $F = .0230$

INDEPENDENT VARIABLES

		B	BETA	SIG
GOTH	Other software language used	2.49	0.56	.02
	Constant	0.80		

control method used (GPERTC), and the effectiveness of technical controls (GTEFF) related positively to project success. The Group 2 results show that the control method used (GPERT) and the complexity of the hardware used on the project (HWCOMP) contributed to project success.

The managers in both groups, however, were indirectly related to project success. In Group 1, this relationship is exhibited through the managers' authority. In Group 2, this relationship is illustrated through the managers' information about the project. This distinction is attributed to the projects' size. On larger projects, the managers' will rely on their authority to achieve objectives, while on smaller projects, the managers are apt to have greater knowledge about the details of the project.

The distinction between the two groups is also reflected in the results of the path analysis on the weighted score of project manager success (GATOTAL). The variables directly contributing to the project managers' success in Group 1 are principally those associated with management controls. One variable associated with the project characteristics also contributed to the project managers' success. This variable reflects the use of the software language PASCAL on the project (GPAS). For Group 2, the only variable in the combined path analysis that is related to project success is the use of a non-specified software language (GOTH).

General Summary

The results of the analysis performed on Group 2 cannot be directly related to the results obtained from the analyses performed on Group 1. The small sample size in Group 2 precluded examination of subsets within a particular variable of interest, for example, project size or project management level. Nor, because of the sample size, can the results be said to support or invalidate the hypotheses set forth in this research. Nevertheless, some observations can be made.

Hypothesis 1, which evaluates the effect of management controls on different size projects, cannot be supported from the analysis of Group 2. For the medium size projects in Group 1, however, the project managers reported having considerable visibility of the project. This suggests the projects were still small enough that the project managers could keep abreast of the day–to–day progress and/or problems on the projects. The results for hypothesis 7 indicate the projects are so large that the project managers must use their authority to accomplish their objectives. This is also seen in the results of hypothesis 6, where we see that the project managers in Group 2 have relatively intense task oriented achieving styles (i.e., intrinsic direct and power direct). This suggests that the managers in Group 2 do exercise considerable control over the projects under their purview. These findings do not support hypothesis 1.

The results of the analysis performed for hypothesis 2 reflect high standards of achievement expected by the Group 2 project managers. There were insufficient data to evaluate the multiple project management levels. The results, however, did not indicate, that for Group 2, the higher management levels have less effect on project success.

The results obtained in the analysis of hypothesis 3 do not support the hypothesis. The combination of management controls and leadership characteristics did not account for a greater percent of the variance in project success than either characteristic alone.

The results obtained in the analysis of hypothesis 4 supported the hypothesis that project size is a determinant of project success, i.e., the larger the project the less likelihood of project success. The insufficient data sample precluded any examination of the projects' technical composition and technological complexity and the effect these factors have on project success. For Group 2, however, the projects' hardware complexity is positively related to project success, but the use of FORTRAN software is negatively related to project success. The complexity of the software language appears to outweigh the advantages gained from either the simplicity of or the lack of the hardware used on the project.

The results of the analysis of hypothesis 5 generally support the hypothesis. The results suggest the Group 2 project managers' lack of experience as project engineers and the short time they have been in their current position detract from project success. These two factors appear to account for the amount of time the Group 2 managers devote to their projects. In contrast, the Group 1 project managers' years of experience (actually years since BS) were positively related to project success. For the Group 1 project managers, we also found that an advanced degree was negatively related to project success. This finding suggests the project managers in Group 1 are either over specialized for their assignments or their education is not commensurate with their assignments as project managers.

Hypothesis 6 was supported by the analysis of Group 2. Leadership characteristics appeared to contribute to project success. The project managers in Group 2 have a predominant middle LPC leadership style, a wide range and high intensity of achieving styles, and medium to high managerial motivation. This latter result indicates that the Group 2 managers have both high needs for power (n Pow) and achievement (n Ach).

The results obtained in the analysis of hypothesis 7 for Group 2 generally support the hypothesis. The data base, however, is simply too small to claim the hypothesis is proved. The path analysis performed did possibly identify the distinction between Group 1 and Group 2. There is some indication there is a cultural difference between the two groups in their work habits.

The Group 2 project managers use their authority and their intrinsic direct achieving styles to achieve project success. They expect high standards of quality and perfectionism in their work (i.e., hypothesis 3). Conversely, the use of the direct domain of achieving styles is negatively related to project success for the Group 1 project managers. On the other hand, the Group 1 managers' instrumental achieving styles are positively related to project success. The indication is that the Group 1 managers are politically–oriented, whereas the Group 2 mangers are task–oriented.

Concluding Remarks

The results of the analyses performed on Group 2 support the initial findings in this research presented in chapter 4. There are distinct differences between Group 1 and Group 2 that go beyond the differences noted in the managers' demographics and the project characteristics.

The Group 1 project managers are more relational oriented than their counterparts in Group 2. This is underscored by the relation the Group 1 project managers' instrumental achieving styles have to project management success. They are dependent on their alliances with others to achieve project management success.

In contrast, the Group 2 project managers are more task–oriented. This is evidenced by the relation their direct domain of achieving styles have to project management success. The Group 2 project managers use their authority and task orientation to achieve project management success.

Further support for this distinction is noted in how each group perceives the use of management control tools. Both groups indicate that the use of department controls are negatively related to project success. The Group 1 project managers view corporate imposed use of either PERT or PERT/CPM management tools as related to project success. The data also suggests the Group 1 project managers view contract imposed management control tools as negatively related to project success. The Group 2 project managers indicate the use of the contract imposed CSSR management tool is related to project success.

The distinction between the two groups may be a difference in perspective. The Group 2 project managers were principally from senior and upper levels of corporate management: the decision makers. The Group 1 project managers were chiefly from the middle and supervisory levels of corporate management: the implementors. The decision makers believe control is necessary. Those who must implement the controls may view them as onerous without a sufficient return for the additional burden imposed.

FOOTNOTE

[1] Variables which are almost linear combinations of other independent variables are often called multicollinear. A regression equation in which the independent variables are multicollinear will exhibit a significant R^2 although few of the coefficients are significantly different than zero. If a variable has a large R^2, or equivalently a small tolerance (0.01), the potential exists that the variables are multicollinear. To protect against this occurrence in the small data set, TOLERANCE was set at 0.25.

[2] The parameters PIN and POUT are used in the stepwise entry process to ensure the independent variables which are finally selected (from the full range of candidate variables) for inclusion in the regression equation fall within a specified range of significance. Setting PIN at 0.05 precludes a variable from entering the regression unless its "probability of F–to–enter" is less than or equal to 0.05. Similarly, setting POUT to 0.10 will cause a variable to be removed from the regression if its significance has degraded during the stepwise process. The statistics for the regression (R, R^2, F, etc.) are those based on the independent variables which remain at the conclusion of the stepwise process.

One final item should be noted. To account for variability in sampling, the number of samples (N) should be large relative to the number of variables used (K) in the statistical process. A general rule of thumb suggests $N > 10K$ to help ensure the resulting solution is stable. See for example, Leonora A. Marasciulo and Joel R. Levin, Multivariate Statistics in the Social Sciences: A Researcher's Guide (Monterey, CA.: Brooks/Cole Publishing Co., 1983): p. 202. The regression results have generally followed this rule of thumb. The statistics for the regression (R, R, F, etc.) are those based on the independent variables which remain at the conclusion of the stepwise process.

[3] M. J. Stahl, "Achievement, Power and Managerial Motivation: Selecting Managerial Talent with the Job Choice Exercise," Personnel Psychology 36 (1983): 779. In his work Stahl has labeled those subjects, whose average beta scores on the 24 regressions on job–choice were higher than 0.314 on n Pow and 0.464 on n Ach as high in managerial motivation. A subject who scored lower than or equal to 0.314 on n Pow and less than or equal to 0.464 on n Ach was labeled low in managerial motivation. All others were labeled as medium in managerial motivation.

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