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CHAPTER 1
INTRODUCTION

In the Construction Industry there is significant momentum for change in the way building projects are completed. The traditional, systematic process of planning, design, construction and occupancy, all performed by separate entities, is giving way to alternative approaches to project delivery. These approaches, consolidating groups of people traditionally responsible for separate functions in the project's delivery, are resulting in new forms of organizational structure and hierarchy for the design and construction of these works. Whether these new project design teams are called Design-Build, Concurrent Engineering, Partnering, Construction Management or any one of a number of titles, the impact is the same. In order for such projects to be successful, it is essential that the participating organizations are comprised of staff that can work effectively with one another (Kichuk and Wiesner, 1997).

One of the first steps in any Building Construction project is the selection of optimal members of the Design Professional's workforce, the A/E (Architect-Engineer) Team. The effective or optimal selection of a firm's professional composition should take place before a project is begun, and this will enhance the probability of the team's success (Kichuk and Wiesner, 1997). An organization, selected, ignoring all of the factors which play a role in optimizing performance, invites chaos and ultimate project failure (Kezsbom, 1992).

The characteristics or preferences of one's personality have been demonstrated in numerous research studies to be factors impacting job performance (Kichuk and Wiesner, 1997; Tett et. al. 1991, Tizner, 1985; Maidique and Zirger, 1984; Barrick and Mount, 1991; Day and Silverman, 1989). Striving to comply with the need for optimization of

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individual efforts and a design's achievement, an organization can no longer look at only cognitive abilities, education and experience as indicators of predicted performance. The dimensions of an individual's personality must therefore be recognized as a significant factor impacting job performance.

Furthermore, these personality factors are acknowledged to hold potential in the organization of optimal performance (Kichuk and Wiesner, 1997 and Franklin, 1995). Effective organizations require appropriate talent, efficient procedures, clear roles and responsibilities. In addition, these teams require an atmosphere for constructive interpersonal relations, managerial reinforcement and strong diplomatic ties with other parts of the organization. It is this later group of criteria that relies considerably upon the presence and interaction of certain personality attributes to yield effective and positive team performance.

This research holds that the contribution of personality traits of the individual members of cross-functional, multi-discipline, public sector building design firms will be significant variables impacting the outcome of various project activities and ultimately, overall team performance.

Psychometric instruments have been designed to provide trait profiles of people's personalities. The major grouping of personality traits have been referred to as the Big-Five Personality Factors (McCrae and Costa, 1987). These factors, as defined by Costa and McCrae, are Conscientiousness, Extraversion, Agreeableness, Emotional Stability and Openness to Experience. These factors can be measured and used to provide an indication of how an individual will react in certain situations, faced with a particular challenge or task. McCrae and Costa evaluated the five-factor model of personality with

the MBTI (McCrae and Costa, 1989). It was found that the MBTI consistently measured

four of the five factors of the five-factor model's accepted taxonomy. The one factor

neither correlated with, nor measured by the MBTI was Emotional Stability, or

neuroticism, which the present research has chosen to avoid. The avoidance of this

personality trait is because the work of this dissertation is that of an occupational study

and not a clinical effort.

If a reliable indication of expected behavior is a function of personality, and can

be predicted, then logic follows that optimal job assignments and team development may

be expressed as a function of individual personality (Kichuk and Wiesner, 1997).

The way an individual interacts with others is a function of both the perception

and decision making components within the makeup of his or her personality. Since it is

possible to use psychometric instruments to define these personality traits, then it may be

possible to predict what the impact of certain combinations of personalities will be on

enhancing, or diminishing, project performance (Kichuk and Wiesner, 1997).

The research undertaken in this study is to use personality testing, through the

administration of Form M of the MBTI®. These results are then analyzed against the

Critical Project Success Factors (CPSFs) Questionnaire, developed and tested in this

work. This examination provides a source to evaluate the impact of individual personality

traits on design team member's performance in the General Building sector of the

Construction Industry.

1.1 Personality Traits, Critical Success Factors and the Construction Industry

The noted Swiss psychologist, Dr. Carl G. Jung, held an unproved theory that

people could be identified by their attitudes and for their preferences in the decision

making process (Spoto, 1989). This theory held that people gather information, arrive at decisions and interact with others in different, yet appropriate, ways. Recognizing the theory of Jungian psychology, the behavior of participants in any organization, including all segments of the construction industry, is a function of both personality traits and contingency variables (Lester and Bombaci, 1984). The circumstances of a construction project, whether in the planning, design or construction phase, create the situational factors that will drive the behavior of individuals and organizations in the performance of critical duties. To these situations, each member of the design team brings with him, or her, a combination of individual technical knowledge, skill and experience, along with those personal attributes known as personality traits. It is those traits that are founded in Jungian psychological theory.

There has been an extensive body of research, and subsequent knowledge developed, relative to performance and personality characteristics of individuals and teams (Kichuk and Wiesner, 1997; Tett et al. 1991, Tizner, 1985; Maidique and Zirger, 1984; Barrick and Mount, 1991; Day and Silverman, 1989). As we move into a more technically mechanized and fast paced arena in the construction industry, the role of the individual's behavior, driven by the attitude and functions of the personality, will become a critical concern. With the movement toward greater consolidation of services, hence greater consolidation of functional roles in the delivery of building construction projects, the distinct personalities of the individual participants will become a major element in determining the success or failure of the effort.

Much of the current literature on personality traits, relative to group performance, emphasizes psychopathology and the avoidance of such characteristics (Driskell, Hogan

and Salas, 1987). In light of the recognized need for improved performance of individuals and groups, the relationship of positive personality traits and performance outcomes warrants exploration. It is this domain where the MBTI has focused; where its use is specifically for "normal healthy" persons, capturing relevant characteristics of personality to differentiate the preferred behavior patterns of individuals. Military service is a prime arena where negative traits have been the essential metric for whether or not a team assignment will be made. It has long been recognized that identified personality traits can be employed in the selection process, and that these traits may be categorized to either enhance performance or prove detrimental to performance. There is a significantly greater body of knowledge about "undesirable people than… about (people's) talent, competence, and effectiveness" (Driskell, Hogan and Salas, 1987, p. 93).

The design outcome of the concepts, innovations, judgments and detailed plans of the consulting engineer or architect is, simply put the product. To define and determine that product's quality can be somewhat obscure (Saarinen and Hobel, 1990). According to Saarinen and Hobel, quality is the "conformance to requirements." It is also held that if a firm were to provide "requirements without the system or conditions conducive to success" (Saarinen and Hobel, 1990, p. 179) that there can be no expectation of quality. It is the position of this research that one of the base ingredients for conditions conducive to success is the combination of individual talents in conjunction with the proper personality traits matched with the assignment.

Technical capabilities are relatively easy to identify, judge and monitor on both an individual and team basis. Recognition and identification of individual personality traits, along with the interaction of those traits in work groups and teams is another matter.

Saarinen and Hobel state "that every transaction engaged in by a company's people in the chain from project initiation to delivery to the ultimate customer has a quality dimension to it. Each of those interfaces must be performed as well as possible…" (Saarinen and Hobel, 1990, p. 179) lest the chain be broken and exposure to the conditions of failure will follow. This is a profound and important observation in that there is a clear identification of the "*chain*" of the design process. Each module of activity is a new creation in the design process. There is a fundamental need for each of those elements to arrive at the subsequent phase in a state of high quality. If the product does not arrive at the subsequent project phase in high quality, therein may very well lie the genesis of what has been referred to as the "Sinister Momentum" (Vorster, 1998) for project failure.

Numerous studies have demonstrated that personality variables are valid and important predictors of performance outcomes, particularly when matched with the appropriate occupation (Kichuk and Wiesner, 1997; Tett et al. 1991, Tizner, 1985; Maidique and Zirger, 1984; Barrick and Mount, 1991; Day and Silverman, 1989). This critical element should then be recognized as having a potentially significant impact on project quality. In order to achieve a project's best results it is important to maintain congruency between personalities and project situations through the appropriate assignment of personnel to specific job functions, work teams, and even project phase. A representative of the design firm with a personality incongruent with the hectic, accelerated pace of a fast-track construction program could lead to immeasurable problems. Such a situation would likely need an intuitive engineer or architect who is

open to new ways of getting things accomplished, and is comfortable dealing outside of himself, with other people.

In contrast, disaster may follow when the firm is working on getting the job designed, put on paper and out the door, if the job is not managed by task oriented, reality based individuals. A design project is likely destined for trouble if left to the direction of a personality such as that described in the previous paragraph, open to new ideas and always looking for another way of arranging the job.

In each of these cases, it is a different set of personality traits driving the action. The impact of those personalities can result in an integral component of success or failure that can be summed up in two words, "good judgment." It is this judgment, which is primarily situational, which can set in motion the conditions of project success, or project failure.

It is condensed into the concept of "judgment," when decisions made in complex and constraining work environments, under conditions of both uncertainty and stress, where the natural preference of an individual's personality will dictate behavior with greatest clarity (Myers, 1980 and Jensen, 1982). One of the purposes of this research is to identify the personality patterns which, when viewed in conjunction with that complex of an organization's task, will serve as a predictor of success or failure on an individual basis. The goal of this research is to evaluate the relationship between personality traits and the factors of success or failure.

Throughout industry, there has been a significant effort to focus on and evaluate personality traits as measures and predictors of performance on the job (Tett, Jackson and Rothstein, 1991). A number of psychometric instruments have been utilized in an effort

to capture the characteristics of the behavior of individuals into distinct categories of personalities. Two of the most widely accepted, and broadly employed instruments are the Myers-Briggs Type Indicator (MBTI®) (Myers, McCaully, Quenk and Hammer, 1998) and an instrument using the Five-Factor Model of Personality Inventory (McCrae and Costa, 1987, Goldberg, 1990, and Ghiselli, 1973). There are a number of instruments that focus on the Five-Factor Model; however, one of the most popularly reported is the NEO Personality Inventory (NEO-PI®) (McCrae and Costa, 1989).

There is a high correlation of the personality factors of the Five-Factor Model, when evaluated with those of the Myers-Briggs Type Indicator (MBTI) (McCrae and Costa, 1989 and, Johnson, 1995). The major difference between the MBTI and the other instruments, whether they be the NEO-PI, the Minnesota Multiphasic Personality Inventory (MMPI), or any of the others, is that the MBTI is designed for use only in a "normal population" (Myers, et al., 1998, and Barrick and Mount, 1991). Although there are a number of supporting reasons, on the strength of the instrument's focus on a normal population, the MBTI® is chosen as the appropriate psychometric instrument for this research.

The approach using personality traits for the prediction of job performance has gained wide acceptance in recent years. The validity of personality types, or traits, has gained recognition through meta-analyses performed by various researchers, with significant and recent work completed by Barrick and Mount (1991); and Tett, Jackson and Rothstein (1991). It has been discovered that a major problem with the early work of personality theory application and job performance prediction, was that studies had

utilized such a broad array of personality traits and attributes that they appeared to have little or no importance for the job in question (Ghiselli, 1973).

Several important and encouraging findings have been reported in recent literature (Tett, et al., 1991). These efforts have found that performance prediction using personality profiling for professional staff was significantly higher than it was for non-professional staff. These predictions were also true for managerial versus non-managerial personnel (Barrick and Mount, 1991). Recent work has also found that increases in tenure, age and incumbency in the job were all conditions that increase the validity of using personality factors as predictors of performance. This is a significant finding in light of the mandatory intern period for design professionals, prior to being awarded a license to practice either engineering or architecture.

These reported results are particularly applicable in this dissertation, since it has provided valuable guidance on establishing a correlation between Critical Success Factors (CSF's) and personality traits. These studies by others suggest that the investigation of older, higher tenured professional and managerial staff, having held their particular positions for some time, (incumbency), will provide the highest probability for the collection of stable and predictive personality traits for comparison to job and project performance measures.

Based on the above summary of information, consolidating the validity of personality traits as an influencing factor for the prediction of job performance, it seems reasonable to expect that these personality factors should play an equally important and valid role in the determinant of group performance. There are a number of considerations and questions that arise as we consider the implications of personality traits on the

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performance of organizations. It is reported that group performance "often differ(s) from the simple additivity model" (Tziner, 1985). Tziner reported a number of apparently competing phenomena in team performance. The question of homogeneity of teams on complex projects leading to enhanced performance (Tziner, 1985) is at odds with the work of Pearce and Ravlin, (1987) that suggests the greatest performance will be achieved through a team of heterogeneous composition. This inconsistency in research findings highlights then that a clear design and definition of the team and its objectives is needed prior to prediction of performance outcomes. What will work in one situation or project phase, vis-à-vis team composition, may prove a dismal failure under different circumstances. This enhances the proposition of the criticality of an individual's preferred behavior pattern and subsequent performance.

A specific situation may impact performance relative to an organization or group. Respect and trust between members may provide the understanding that could lead a heterogeneous team toward a homogeneous functioning. An effective and homogeneous team, intuitively appropriate for a particular job assignment because of the need for good communication, cooperative relations and a pleasant interpersonal atmosphere, could provide for the best team. In a situation such as in the final design phase of a project, where different staff members are all working cooperatively on separate aspects of the same project, the aggregation of individual capabilities that are homogeneous may in fact provide the most effective team.

The theory of Pearce and Ravlin (1987) is that the highest performing teams are those that are composed of individuals with diverse personality traits (attitudes and abilities). This heterogeneity can be useful in the planning, or the design development

phase of a construction project, where innovation and problem solving are called for. This research holds that the keys are communication, understanding, respect and trust to enhance effective performance. Personality characteristics with a preference towards coping with uncertainty, as well as dealing with innovation may be called for here. During the detailed design phase of a project, where work just needs to be "cranked out" to stay within budget and schedule, a "new and innovative" approach to the design of standard details could prove devastating to the project.

An integral component of this study is the consideration of personality interactions of different members of the multi-task design team, and the impacts on success or failure of project phase activities.

CHAPTER 2
PERSONALITY AND CRITICAL SUCCESS PERFORMANCE RESEARCH: A LITERATURE REVIEW

2.1 Changing Role of the Design Professional

For decades, the construction industry has functioned in a relatively stable approach in the delivery of design and construction services to clients and owners. The owner identified a need, and the Architect/ Engineer (A/E) team conducted studies, developed a planned program to satisfy that need, prepared detailed design documents and oversaw construction. These created plans and professional services provided the directions to guide the construction forces in the building of the facility. The inter-relationships of the planning and design task, although well defined, have always presented the participants with a "complex situation" (Douglas, p. 1).

The construction industry, and the public bid general building sector in particular, is changing. The businesses in this industry are in a period of consolidation, through acquisitions and mergers, according to FMI Management Consultants, a leading consultant to the construction industry with headquarters in Raleigh (Engineering Times, p. 14). These acquisitions include mergers of traditional design firms with construction companies. The industry is facing owners and clients who are demanding one point of project responsibility. This demand is placing more risks on the deliverers of design and construction services, with less being retained by the project owner. A/E firms are moving into project services where greater risk exists, along with broader responsibilities (Engineering Times, p. 14).

As these new consortiums are formed, we find dissimilar members are participating in various branches of the design and/or construction process. The old,

traditional and stable team of design professionals working together, as they had for years, if not decades, find themselves in a complicated mix. This new and challenging environment seems to become more complex with every project.

The idea that we can predict and control the work through our traditional time tested methods of management is simply not enough. Daily, the world becomes more complex. Prudent management would dictate that if a factor can be predicted, reducing risk, an effort should be made toward such predictions. These results may then be factored into the organizational equation. While the factors of education, experience and cognitive ability have served us well over time, James Gleick, in his 1987 bestseller Chaos, summarizes this concept efficiently. "Tiny differences in input could quickly become overwhelming differences in output – a phenomenon given the name 'sensitive dependence on initial condition'" (Gleick, 1987, p. 8). Clearly, personality traits account for one factor in the "initial conditions" which can direct an outcome in one direction (success) or onto the opposite path. Much of the initial work in this field, predicting performance based on personalities, was initiated to avoid negative behaviors and undesirable traits (Driskell, Hogan and Silas, 1987).

In the past, it was not unusual for a design team to be together for literally decades. Today, the most critical issues facing consulting engineering firms is to "retain and motivate quality employees" (Hecker, 1996). As in many other industries, the Architectural and Engineering Design professions are not immune to labor shortages. This has led to a new way of forming teams through aggressive recruitment of professional staff, often using signing bonuses as an enticement to lure staff to a particular firm (Stussman, p. 27). This mobile and transient workforce places a new

challenge on the managers of these professionals, to put together an effective design group of professionals. With little or no time to create a culture, let alone really get to know one another and put together design teams based upon the temperaments of the individuals, the positive potency of the professional group will likely be a lucky coincidence. In fact, according to Mike Robbins, temporary employees assigned from agencies are commonplace in technical fields such as engineering (Robbins 1998). It is reported that "(t)emporary professionals are increasing twice as fast as the temporary workforce as a whole" (Robbins, 1998, p. 42).

It is an accepted premise that there are fundamental standards for the development of successful teams and the creation of effective teamwork. Gibson (1996) promotes the idea that there are three fundamental criteria that define a successful team. These criteria are training/education, communication and ownership. However, in order to put together an effective team for a particular job, there is much more to the task than simply selecting a group of technically competent engineers who can talk to one another. It takes the right team; or in other words, the right mix of people to make it all work.

It is reported in the work of Ghiselli (1975) that investigations using tests as a prediction of job performance can be traced back to Munsterberg, who in 1910 conducted research on the selection of motormen. This work coincided with the advancement of what is now commonly referred to as scientific management, the work of efficiency expert Frederick Taylor. Continuing through the 1920's, the validity of personnel selection based upon aptitude, intellectual ability, spatial ability, perceptual accuracy, motor abilities and personality traits was tested (Ghiselli, 1975). These tests, including

personality traits, began to yield encouraging information relative to the usefulness of this data as a predictive tool in the effective assignment of persons to jobs.

This is supported in the work of a number of researchers who have investigated the relationship between personality and performance. Personality variables have been shown to be "significant predictors of job performance when carefully matched with the appropriate occupation and organization" (Day and Silverman, 1989, p. 24). The variable of personality in an individual is an effective predictor, supporting cognitive ability, in assessing which prospect is apt to work well within a firm. Wherever a job's function requires the employee to work within a team setting, there is not only a cognitive element to the work, but an interpersonal aspect. The task requirement is recognized as an important factor in performance, however, particularly in a setting with a need for active team performance, this task completion is strongly linked to a people requirement. This people factor effectiveness has been shown to be a predictable function when considering occupation, organization and personality traits (Day and Silverman, 1989).

While a number of early research studies were less than successful in establishing any clear relationship between personality traits and job performance, (Locke and Hulin, 1962, Hedlund, 1965, Guion and Gottier, 1965) recent work in this area has demonstrated significant improvement (Kichuk and Wiesner, 1997; Tett et al. 1991, Tizner, 1985; Maidique and Zirger, 1984; Barrick and Mount, 1991; Day and Silverman, 1989). The 1965 work of Guion and Gottier is one of the most commonly referenced works in advocating the difficulty of using personality factors in performance prediction. The Meta-Analysis of Tett, Jackson and Rothstein, (Tett, et al. 1991) using the "Big Five"

personality factors, found significant "grounds for optimism concerning the use of personality measures in employee selection" (Tett, et. al 1991, p. 703).

Guion and Gottier (1965) concluded that personality traits would require validation, with adequate regard of the specific task framework. Unlike aptitude tests of general cognitive ability that have been proven as important performance predictors across employment settings, personality traits do not offer the same level of inter-correlation (Tett, et al. 1991). Job analysis directed at specific personality requirements is an area of research supported as valid by Tett et al. (1991).

As mergers and acquisitions take place, new teams will be formed and mobilized, based upon the availability of professional staff. The research of Keller (1986) suggests that the highest performing teams are those with the longest tenure. This finding supports that of Barrick and Mount (1991) where tenure was found to mediate personality factors as performance predictors. Unfortunately, the variable of rapid team formation will not allow for the essential factor of "tenure" to take its course. The impact of rapid formation on how these units will function clearly does not support a prediction of high performance. If the team's personality factors will be considered during formation, research has shown the results on performance can be positive, (Day and Silverman, 1989), and an advantage to success can be seized.

The need to ensure the creation of high performing design teams will be critical to successful projects. It is the design effort that has the greatest impact on the success of a project (Badawy 1995, Post 1998). Badawy emphasizes that the leading cause of project failure is "poor conception of the project" (Badawy 1995, p. 262). He further suggests

that the first phase to ensure project success is to "appoint a capable project manager with the proper mix of technical, *interpersonal* (emphasis added), and administrative skills."

It is essential that these groups have the technical skills to perform the task ahead of them, but it is equally important that they have the capacity to function well as a unit. It is commonly held that the character of the individual is an important factor in determining whether the effort of the group will result in success, or will follow on a path to disaster.

Since in the construction industry, teams of people necessarily undertake most tasks, the effects of group performance and team personality interactions are important. Within such work groups cooperation, cohesiveness and coordination are imperative for the attainment of effective results (Tziner, 1985).

Therefore, the goal of this research is to investigate the factors of personality that will enhance the effective selection, formation, maintenance and intervening adjustments to Architectural and Engineering design professionals for the Building Sector of the Construction Industry. This is accomplished through the correlation of individual personality traits and critical success factors (performance measurements).

2.2 Personality and Behavioral Data

"Happy is the manager who understands his own philosophy, who report to like minded supervisors, who hires employees who share the same outlook or at least can live with it, and who is able to implement his *preferred* (emphasis added) management style with personal ease and organizational efficiency. Unhappy (as well as ineffective or a cause of chaos) is the manager who is caught in an organization that does not share his *natural inclinations* (emphasis added)" (Kline and Coleman, 1992, pg. 17).

The investigation of personality traits, attributes and/or characteristics alone will only begin to hint at a prediction relative to expected performance. It is the behavior of the individual, which is the outcome of the combination of personality traits and situations, which becomes of value to the manager. The example offered by Day and Silverman, (1989) compares the job of an accountant versus the duties of a fireman. While cognitive ability plays a role in determining the successful performance in either job, so do "relevant personality traits" (Day and Silverman, 1989, p. 26). It is not probable that individuals performing within these two diverse occupations, when judged to be functioning at a high level of success will hold the same traits. Different sets of personality traits will likely be congruous with the achievement levels of different occupations (Day and Silverman, 1989).

Most managerial decisions, necessary throughout the design and construction of a building project, require a contingency or situational approach, which requires the design professional to assess any given set of circumstances to make a decision. The objectively oriented engineer or architect, when dealing with technical matters is generally thought to be within his element. He is often less than comfortable in dealing with the subjective world of interpersonal, informational and decisional roles (Nelson, 1988).

Much of the success or failure in the design and construction industry will be a function of client satisfaction, or client perceived value (Ahmed and Kangari, 1995). Recognizing that the client is a member of the project team, this consideration increases the complexity of achieving a successful project. This is the entrance of yet another uncertain, and in some sense, random variable into the complex of the formation of effective project performance. Ahmed (1995) promotes that primary service providers

who have direct contact with clients and others on the overall project team, outside of their own firm, should possess good interpersonal skills. These interpersonal skills, or other attributes of personality for any particular job function should come natural to those assigned to particular duties. Within the basic premise of personality theory, it is accepted that people, when under stress, are most comfortable and at ease when working in their preferred functions and attitudes.

As stated previously, in earlier studies (Locke and Hulin, 1962, Hedlund, 1965, Guion and Gottier, 1965) there was a problem in correlating, in a valid and reproducible manner, personality traits and job performance. It has been reported that this was due in part, to not having a well-understood and valid taxonomy for the classification of personality traits (Barrick and Mount, 1991). As early as 1932, W. McDougall reported in the first issue of *Character Personality* that, "Personality may to advantage be broadly analyzed into five distinguishable but separate factors, namely intellect, character, temperament, disposition and temper…" (Barrick and Mount, 1991, p.2). Throughout the years, different researchers have promoted various theories ranging from those that are impracticably complex, to those which are uselessly simple. The impressive body of literature, that this study has found, continues to return again and again to two primary, and, in fact, complementary taxonomies; the Big-Five factor of personality and the Myers-Briggs typology, based on the psychological theory of Carl Jung. While a number of researchers have adopted the Big Five factor of personality (Extraversion, Emotional Stability, Agreeableness, Conscientiousness, and Openness to Experience) each seems to have their own interpretation of the meaning of each factor (Norman, 1963, Barrick and Mount 1991, Goldberg, 1990, and McCrae and Costa, 1985).

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The alternate taxonomy, in common and widespread use, is the Myers-Briggs Type Indicator (MBTI®). The advantages of this measure of personality are numerous, including the fact that its wide acceptance may be found in that it is for use in "normal" populations and offers little guidance in clinical cases. The factor of "emotional stability" is noticeably absent in the MBTI®. The MBTI® is based on Jung's classic statement of personality theory, and is designed to measure types (dichotomous values), rather than traits (continuous values).

The Myers-Briggs Type Indicator (MBTI) defines four personality measures, or Types. As stated previously, these Type measures are viewed, not as scales, but rather as dichotomies, where an individual's preferred state is defined. This powerful instrument, which has been extensively tested for validity and reliability, measures and reports personality factors as Types rather than traits. The scoring, though, does record responses on a continuous scale, which allows further analysis of data. The basic measure of the MBTI is the preferred direction in four dimensions of personality, and can be used to identify an individual's preferences. In this way it can be used as a predictor of behavior and performance in various circumstances (Myers, et al., 1998). It may also be used to evaluate the strength of the particular personality preference that will aid in the evaluation efforts of this research. For these additional reasons it is the MBTI® that has been chosen as the psychometric instrument for use in this study. The detailed discussion of the MBTI personality dichotomies is presented in the later sub-section entitled "Individual Personality Traits".

2.3 Industry Application

There are many reasons why the construction industry is particularly influenced by the composition of teams. One reason is the varying characteristic of the individual personalities of the participants in each phase of a building project. The Construction Industry Institute's publication 12-2 (CII, 1991) provides a Comparison of Construction Culture in their Table 3 (page 26). These comparative cultures shed light on the uniqueness and the differences between the construction industry and other industries. These differences relate to objectives, rewards, players, systems, procedures, time and space. For example, considering "objectives", the CII reports that the manufacturing industry "tends to be centralized, homogeneous, top down driven… reconciled by (a) single authority… (c)lear, non-conflicting and controlled." On the other hand, a project in the construction industry is apt to involve "(m)any companies" with varied objectives. The objectives may " be schedule, profit, cost, safety, professional credo, liability…" and the objectives may be those of "conflicting-adversaries." Recognizing that when any procedure is grounded in such diverse objectives it will certainly experience at some level "conflict", and the control of this conflict is essential to avoid chaos and failure. The Five Stages of Conflict (Nadler, 1998) move rapidly from the impersonal, "fixing the problem", to subsequent stages, all with significant dimensions of "personal". One of the key elements to be recognized and dealt with by those charged with controlling and resolving disagreements as they arise, is the containment of "personal" antagonism, prior to the conflict taking on an existence of its own quite apart from the actual technical issue which is the origin of the trouble.

These diverse goals can also lead to situations of great stress, with a high potential for hostility and "failure", on a job by job basis. Since each project is generally composed of a new set of "teams" (owner, designers and contractors) in the public building sector of the construction industry, there is little opportunity to develop long-term understandings and relationships to enhance and improve the interactions of the players. It is critical to have the right people, in the right assignments, from the beginning of the project, to minimize the initiation of conflict, and have the people in place with the temperament to mitigate those situations when they do arise.

In the design phase of the project, it is critical to minimize errors and deficiencies which, if undetected, can lead to potential negative impacts on the construction process. During construction there are more participants actively involved in the building process. As the number of participants increases in any phase of the project, the opportunity for conflict increases geometrically. Disciplined and scheduled planning and design reviews can provide significant protection for a project through the detection and correction of design conflicts and errors (Lutz, et al. 1990), but it takes the right managerial and technical personality to provide that quality control function.

Research has shown that job-relevant personality scales are significantly related to job performance. These performance outcomes are predicted through personality traits with greater accuracy and validity, than if predicted based on cognitive ability only (Day and Silverman, 1989). Therefore, it can be surmised that in order to enhance the probability for a successful outcome, the project needs persons with the right abilities, in the right situations, who possess the proper personality characteristics to deal with the people and situations of the moment. The evaluation of work related personality traits,

and understanding the implications of those traits will help improve employee task assignment and problem intervention, which will subsequently improve the probability for a successful project outcome.

On any project, an individual, group or team must meet certain criteria in order to be successful (Hensey 1991). What is needed for any project is a mix of people; these Hensey refers to as bottom-line people, visionaries, and technically wise people. What is being said is that there is a need for people with different views, temperaments and personalities to perform a variety of functions effectively. High performance teams value diversity of personalities when placed in the proper functional roles (Hensey, 1991). The basic managerial roles are identified as; producer, administrator, entrepreneur, interrogator and leader. Hensey recognizes that there is no one manager who holds these capabilities. That is because each of these roles parallels a unique set of personality traits that are held by unique individuals. This research work investigates the particular personality traits that maximize performance outcomes, such as those described by Hensey.

2.3.1 Current Examples of Industry Application

In the conduct of this work several firms have been investigated where personality factors and their measurements are used. This sub-section of this study moves beyond a strict literature review and reports on several examples of the current use of these psychometric tools, their methods and their perceived effectiveness.

In each of the organizations investigated there existed the common theme for "the importance of the selected psychological test to answer the question management held" (Nitsch, 1999). It was recognized by each organization that there are valid limitations in

the tester's training, experience and professional objectives, as well as the competency in the proper interpretation of the test results. Often the testing is done by outside professionals. For example, one firm pays a professional management consultant an annual fee to perform the administrative and interpretation tasks associated with their psychometric application. On the other hand, one case study organization was "seminar trained" in an alternative psychological "type" instrument called the Enneagram, used as a method of psychological evaluation. The firms investigated varied in size, offering substantial variations in instruments used. This investigation demonstrated the breadth of psychometric testing currently in use within the industry.

Each organization reported value in the psychometric testing. In addition, the participants in such training/testing sessions gained the added benefits of self-awareness and empathy. It is here that we begin to see the value of personality preferences beyond managerial awareness. Much of the psychological testing and application is to enhance "self-awareness." Once a self-awareness is achieved we begin to move into a zone where there is hope of ideal communications. George Kelly, the noted cognitive psychologist, stated the "ideal communication takes place when one person understands how another person sees the world" (Burger, 1997 p. 503).

This portion of the research has served to clarify the essential role that *communication* plays in the development of *cooperation and trust* on a project. Without effective *communication* there can be no expectation of *understanding* between the participants within the construction process. If one is unable to cross the hurdle of *understanding*, gaining the associated quality of empathy, there can be no expectation for the development of *respect* between the parties. Likewise, without *respect*, there can be

little hope for the development of *trust*. In summary, who would possess a desire to be on a project team with others they believe that they cannot trust or respect? It is unlikely one would succeed where there was no appreciation for the other team members' goals and aspirations. Without these critical elements there is no opportunity to effectively achieve the project goals that the ultimate user of the constructed facility expects. The suffering will be evidenced in the project's quality, efficiency, costs and even safety. The entire process will suffer.

A psychometric instrument may be selected for the sole purpose of behavioral prediction and diagnosis. The prediction of individual behavior was not, in itself, the sole purpose of the tests conducted by the group investigated in this research, but rather the promotion of a better understanding of the motivating factors which impact behaviors. With the use of these tests in organizational settings, rather than clinical settings, the goal is the understanding of personality driven behavioral patterns, contrasted with the clinical psychologist's objective of intervention; an attempt to change behavior. The application in the A/E/C (Architecture, Engineering and Construction) Industry is for use with "normal-healthy" individuals and not intended to offer insight in dealing with neurosis within any of the firms participating in the investigation.

The three firms interviewed provide a wide range of service offerings, firm size and management orientation. In addition, each of the three firms used a different psychometric instrument, for a different purpose, and at different intervals. These three cases offer a broad cross-sectional view of the industry and will offer a better understanding of the basis for this proposed research.

2.3.2 Firm Interviews and Profiles:

Firm A (JNE) is a full service civil engineering and surveying firm specializing in the design of educational facilities, senior housing and commercial facilities sectors of the construction industry. The firm's staff is made up of 55 full-time employees, of which 43 are professional and technical staff members. It is estimated that the gross annual billings for the firm range between $3 and $4 million dollars in fees for service. JNE uses the Myers-Briggs Type Indicator (MBTI) for leadership and team building, while using the Predictive Index (PI) for all employees and new hires.

Firm B (MAE), like JNE, is also a full service Civil/MEP engineering firm, however, this firm also holds prime consultant status on a number of major Architectural projects. The firm is made up of approximately 110 employees and associates. There are 10 partners, comprising the professions of Architecture, Engineering and Surveying. It was reported that the gross annual billings for the firm are estimated to exceed $10 million dollars per year. MAE uses the Myers-Briggs Type Indicator (MBTI) for leadership development and managerial assignments.

Firm C (RGC) was selected due to the principal's keen interest in the use of the Enneagram, an increasingly popular, yet "non-mainstream" psychometric instrument. The unique application of personality profiling using the Enneagram adds breadth to the research, and RGC's principal was willing to openly share his views and uses of the instrument.

RGC is a small, specialty engineering and construction firm specializing in the niche market of tunneling work. The firm's principal also provides expert witness and

negotiation services across the country. The size of the firm's staff varies by project, however, it was primarily the principal who uses the Enneagram.

2.3.3 The Alternate Psychometric Instruments:

The three psychometric tools, tests or instruments used by the firms are the Predictive Index, the Myers-Briggs Type Indicator Form G, and the Enneagram. The basics of each of these tools are described, along with their use, in the following paragraphs.

The Predictive Index and Firm A.:

The Predictive Index is a tool developed in 1955 by the principal of a firm in Wellesley, Massachusetts called Praendex. The basic instrument is a classic psychometric method of a self-report Adjective Checklist. The goal of the checklist approach is to provide a "snapshot" of an individual's personality. The PI is an 86 item adjective list. The respondent is to make a choice of preferred adjectives describing how they believe others would view them. This is followed with the test subject using the same adjective checklist, then selecting *those words that "truly describe" themselves*. Typical adjectives include "patient, passive, restless, dutiful, obstinate, innovative and talkative" (Atanasov, pg. 10). The process takes about 15 minutes.

The question then becomes does it work? Can a quick tool such as the PI provide meaningful information? The Handbook of Psychological Assessment, (1997) reports that when dealing with external social reinforcements, or in other words, when you are in a "real world" situation, predicting "real world" behavior, self-report questionnaires provide impressive results of correlation scores ($\Delta= 0.35$). The adjective checklist is one of the self-report methods discussed and reported on in this reference handbook.

The PI measures four traits of personality reported as A, B, C and D. The four measurements are for A - Dominance, B - Extraversion, C – Patience, and D - Caution and Duty. The theory of this simplified measurement tool is to combine the high and low measurement traits with job characteristics that fit a particular assignment. For example, if the firm's principal was to look for a staff member to "sell" her firm as a marketing specialist, she might look for a high A, even higher B with low scores on both C and D (Nitsch, 1999). If it were a draftsperson she was attempting to place, the opposite traits might be sought. Low A's and B's would be desired in order that the person will not become impatient working in one location all day. It would be expected that someone who is methodical and cautious with a sense of duty, a high C and D, would be useful here.

It was reported that the firm has been using the Predictive Index System with management consultant for several years. Prior to that, the experience with psychological testing was at the managerial level, with the firm using the Form F, MBTI to develop team understanding. The firm's view is that the details of the MBTI are beyond that needed for hiring and initial work assignments.

The Predictive Index is used by the management consultant to objectively measure traits that will impact work behavior, but this information is then blended with the standard practice of candidate interviews, background investigations, educational preparation and experience evaluation to make a hiring decision. In addition, Firm A uses the PI as a tool viewed as "easy to understand", and not as prone to misinterpretation.

Myers-Briggs Type Indicator (Form F), and Firm B:

The Myers-Briggs Type Indicator is a personality measurement tool that has been used in many studies on engineers and technical professionals (Myers, et. al, 1998). The use of the MBTI is secure, in that it is an extensively researched instrument recognized and accepted for personality measurement. The Handbook of Psychological Assessment (1997) lists the Sixteen-Personality Factors Test, the NEO-PI-R, the Myers-Briggs Type Indicator and the Adjective Checklist as the four primary instruments for general personality measurement. Other tests are listed for areas of psychology such as "interpersonal patterns", "schizophrenia prognosis", "depression", and "intellectual functioning" to name a few. This list develops a comparison between the "General Personality Measures" and the other more clinical domains.

The Myers-Briggs Type Indicator is reported to be the tool preferred by managers of many of the country's leading companies (Gibson, et. al, 1996). Exxon, General Electric and Apple are named as users of the instrument.

The concept of the MBTI is based on the work of the Swiss psychoanalyst Carl Jung who saw sensing and intuition as influencing a person's perception, while thinking and feeling impact an individual's judgment (Myers, et. al, 1998). Myers and Briggs went on to develop a test which follows the basic principles of an adjective checklist, where a subject chooses from a word pair the item that appeals to them more. The example of *planned/open* might be a typical choice. From this an indication of a person's preference for structure or openness to experiences can be drawn, which is a measure of the *Judging-Perceiving* preference. This is one of the four scales of personality defined and measured in the Myers-Briggs Type Indicator.

While the MBTI is not viewed as a test, and there are no "right or wrong" answers, the tool does sort personalities by four preference scales (Myers, et. al, 1998). These are not referred to as "traits" in MBTI, they are "type" measurements indicating a non-scalar measurement, or a dichotomous sorting of personalities. The evaluations of the scalar testing scores are commonly used in research. The scales, or dichotomies are *Introversion (I) / Extraversion (E), Sensing (S) / Intuition (N), Thinking (T) / Feeling (F), and Judging (J) / Perceiving (P)* (Myers, et. al, 1998). For additional information on the MBTI Dichotomies, refer to the sub-section 2.6, entitled "Individual Personality Traits".

The E/I scale measures the focus of a person's preferred source of energy and stimulation, from the outside world (extraversion), or from an internal source (introversion). The J/P scale identifies a person's preference for closure on an issue (judging) or the preference to keep options open (perceiving). These two traits outline a person's "attitude" in dealing with the outside world, theoretically sorting people into Type.

The following two scales determine a person's preference for how they collect data and subsequently make their decisions (Myers, et. al, 1998). The sensing/intuition, (S/N) dimension measures how people gather information and data, with their senses; what you can touch, see and feel, or with their intuition; what they can imagine or connect from the hard, sensed data collected. Likewise the thinking/feeling, (T/F) dimension then offers an indication of how a person makes his/her decision; with one's head (logical and analytical) or with one's heart (subject and value based) (Myers, et. al, 1998).

The use of the MBTI is a rather complex psychometric exercise, particularly when using it for *management training* and *team-building* work as the Firm B is doing with their executive group.

Current roles of the firm's senior management are reviewed and assessments made as to points of strength and weakness in each assignment and group. Points of potential conflict of types, styles and even values are assessed as the firm undergoes its annual review of its officers', directors' and management duties.

Certain appraisals of the firm's personality profile are conducted when new stockholders are being considered. It is reported in the literature (Myers, et al., 1998) that firms sometimes find themselves in the "likes like likes" syndrome, and that when new people are considered for stock acquisition the mix of personalities needs to be taken into account. This accounting is both to ensure a broad mix of personality types in order to prevent corporate myopia, and to take into account the potential for major conflicts in the corporate decision process. In order to understand the "groupthink" syndrome, it is important to understand the distribution of Type across a national sample. The MBTI Training Manual (Myers, et. al, 1998) is the data source for the percentage of people in a national sample that fall within each MBTI Type. This information is helpful in allowing an organization to discover if there exists a balance within their ranks of all Types, or if they suffer from an unbalanced distribution of personality Types, self-selected to "fit in"; likes like likes. This information is presented in Figure 2-1, Type Distribution – National representative Sample (Base Population).

	ISTJ %	SFFJ %	INFJ %	INTJ %
Total Population	11.6	13.8	1.5	2.1
Male	16.4	8.1	1.2	3.3
Female	6.9	19.4	1.6	0.9
	ISTP %	ISFP %	INFP %	INTP %
Total Population	5.4	8.8	4.4	3.3
Male	8.5	7.6	4.1	4.8
Female	2.3	9.9	4.6	1.7
	ESTP %	ESFP %	ENFP %	ENTP %
Total Population	4.3	8.5	8.1	3.2
Male	5.6	6.9	6.4	4
Female	3.0	10.1	9.7	2.4
	ESTJ %	ESFJ %	ENFJ %	ENTJ %
Total Population	8.7	12.3	2.5	1.8
Male	11.2	7.5	1.6	2.7
Female	6.3	16.9	3.3	0.9

Figure 2 - 1. Type Distribution - National Representative Sample (Base Population)

The Enneagram and Firm C:

The Enneagram is a psychometric instrument that classifies people into one of nine different types. Each of these types falls into one of three major subdivisions of personality according to the theory. While tools such as the MBTI, the Predictive Index, Keirsey's Temperament Sorter and others have become popular in the corporate world for hiring and management, the Enneagram has found increasing recognition in the mainstream of society, although not the mainstream of corporate America. While the Enneagram is being promoted as a method of self-understanding, the true value of understanding oneself is clearly captured in Jung's quote, "Everything that irritates us about others can lead us to an understanding of ourselves" (Hall and Nordby, 1973).

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The concept of the Enneagram is that each of the nine personality types holds certain traits that allow for the prediction of emotional makeup. These various personalities are coupled with a strategy for facing life and all its challenges (Riso, 1996). From this, the practitioner using the Enneagram may understand his/her own personality, and is then also able to identify the personalities of others, and thus predict their motivations and behaviors. The concept further holds that the personalities are actually groups of human emotions and behaviors that are both positive and negative.

The nine personality types that form the Enneagram are grouped into three categories or triads. The three triads are: *the <u>feeling</u>, the <u>doing</u> and the <u>relating</u>* categories. Within the triads, there are three types in each, which lead to nine personalities in total. Different literature refers to these by different names. A common listing is *1. The perfectionist, 2. The giver, 3. The performer, 4. The romantic, 5. The observer, 6. The questioner, 7. The epicure, 8. The boss, 9. The mediator* (Clough, 1999). While it is beyond the scope of this research to go into detail on the individual characteristics of each of these Enneagram personalities, each one consists of its own descriptive definition of type. One example would be that the *giver* would be empathetic and demonstrative, but can be intrusive and manipulative.

The common use of the Enneagram is for self-knowledge and understanding of human motivations and behaviors. The firm's principal, who has been trained in the use of the Enneagram, employs it daily in his work, within what he describes as a sector of the design and construction industry where individual performance (as opposed to equipment performance) has the highest impact on the project's overall productivity (Clough, 1999). It is the principal's contention that in the tunneling industry egos run

high and personality sensitivity by management is critical to maintaining a safe and efficient workplace. It was reported that the application of the principles of the Enneagram to understanding personalities in his dispute resolution, mediation and arbitration work is most important to the principal's success.

With this instrument, the main purpose is self-understanding. The use is not in the application of a "test" to an individual, to better diagnose individual personalities for job assignments, but rather to thoroughly understand a range of personalities and the associated motivational forces. To accomplish this, the starting point is to understand one's own type. Once that is fully developed, then one may move on to effective "type watching" (Keirsey and Bates, 1974, Kroeger and Thuesen, 1988, Kroeger and Thuesen, 1992 and Keirsey, 1998). Keirsey, Bates, Kroeger, and Thuesen are practitioners and promoters of the effective use of self-understanding, followed by efficient identification of others' types. According to these authors, such an effort can result in the accurate predictions of motivations and behavioral patterns. That being possible, the contention of the Enneagram users is that the application of these principles will promote understanding and tolerance, which will provide a venue to resolve conflicts.

2.4 Problem Statement

One of the major trends in the practice of engineering and architectural design as a profession, according to FMI Management Consultants is the continued "convergence of design and construction" (Engineering Times, 1998, p. 14). This view reflects the philosophy of Professor J. M. de la Garza of Virginia Tech, where he states that "Construction is the last phase of the Design process…" and "Design is not what's

represented on paper drawings or CAD models, but rather, Design is what actually gets built."

A project's design, and its subsequent construction, has been commonly performed for decades, as separate industry functions. This has been particularly true in the public works market of the building sector of the construction industry. Today, there exists a strong movement in the construction industry for a consolidation of these services. This convergence of design and construction can be found in the increasing acceptance of project delivery systems, such as partnering and design-build, and with the use of such methods as concurrent engineering, construction management and fast-tracking. Such changes in the industry will create great challenges in the evolution of effective professional design teams, which will be of primary importance for the assurance of successful project performance.

According to a recent study of the Personalities of Civil Engineers (Johnson and Singh, 1998), it is reported as commonplace to find "conflict and infighting" between the various participants of the design and construction process. While this particular thesis may create debate, there is a commonly held belief that as a result of the differing goals, objectives and motivating forces between the various groups within the design and construction process, conflicts frequently arise. One challenge facing industry professionals today is how to mitigate these conflicts, and deliver for facility owners, and the public at large, a more efficient, effective and problem free construction process.

The construction industry is a large sector of our national economy. These industry sectors are divided into the general categories of Building (Residential, Commercial and Institutional), Heavy and Highway (or Engineering) and Industrial.

While common elements remain between them, each of these sectors of the industry has their own unique characteristics and methods.

Badawy (1995) points out that as any project progresses through its phases, the competencies required to perform, and/or manage these phases will vary. This is particularly true in the design element in construction industry. The skills, attitude and administrative capacity needed for the initial studies, and the planning of a project, are quite different from those needed for the detailed design. Likewise, the interpersonal expertise and temperament required for the construction oversight phase, is not that which is needed for either of the first two phases. The attributes needed most in the planning phase, differ from either design or construction administration. The recognition of these differences, and the limitations they impose are "crucial, and yet (the) most neglected, requirement for project success" (Badawy, 1995, p. 263).

Tziner (1985) looks at the impact of Similarity Theory and Equity Theory relative to how team composition impacts task performance. Any question of team performance which involves the coordinated effort of activity must address the issues of interpersonal relations (Tziner, 1985). This view is particularly connected to the detailed design sub-phase of the A/E's work. Where there is a high level of inter-dependence of complex tasks, the benefits of attraction, good communication and a pleasant working atmosphere through "likes like likes" (Tziner, 1985, p. 1113), there will be improvement of group cohesiveness (Tziner, 1985). In this activity of the A/E's work, there is a great need for many people to work cooperatively, yet independently, on several of the design elements. In contrast, the notion that the creative forces of diversity enhance the efforts of the *planning sub-phase* of the A/E's work is well grounded.

The *construction administration sub-phase* of the A/E's scope of work involves the interrelationship with more outside business entities. Until this point in a project, (construction) the A/E has been dealing primarily with the owner, interpreting his needs and reflecting those needs within the details of the design documents. Now the process takes on a new, and potentially hostile dimension, with the involvement of outside construction companies chosen for their low competitive price bids, who will transform those designs, from plans to structure. It is here that the A/E, performing the construction administration duties, must balance the goals of the contractor with the needs of the owner, all the while ensuring that the details and concepts of the design remain undiminished. This requires a whole new set of skills, attributes and, as theorized in this research, personality traits, in order to provide success.

There is little doubt that the tension of creative conflict can enhance the outcome of a product. However, the fine line between *creative conflict* and *confrontational conflict* can offer a very dangerous zone for managing a project. It is here that an understanding of equity theory can play an important role (Gibson et al., 1997). The perception of over-reward and under-reward has a strong potential for enhancing or restricting project performance. The sense of inequity arises when it is perceived by one or more of the participants that their effort in achieving the outcome is disproportionate to the efforts of others. This is particularly problematic when rewards do not correspond to the efforts demanded. These balances, as well as the detection, control and resolution of conflict, are the primary challenges of the construction phase of a project. Of course, this is all required in an environment where "differing individuals of differing talents come together"(Tziner, 1985, p. 1117), where one hopes for an outcome of performance greater

than the sum of the parts. Unfortunately, if one is unable to maintain the balance of the equity theory, the exposure to negative non-additivity of talents is real, and will likely manifest itself in project failure.

The current research work in the area of personality traits as predictors of performance, employing valid and reliable taxonomies along with job specific performance criteria, demonstrate that there exist true and measurable correlations (Barrick and Mount, 1991). Moreover intuition dictates, and research has confirmed, that supervisors and management personnel rely upon impressions of personality traits in hiring and team formation decisions (Kichuk and Wiesner, 1997).

These personality traits of an individual explain in part the tendency of persons to conduct themselves in certain manners and to interact with others, cooperatively or unsatisfactorily (Kichuk and Wiesner, 1997).

Therefore, it is the premise and scope of this research to evaluate whether or not we can enhance the opportunity for project success through determining which combinations of personality traits will contribute to individual, team and project performance. As such, this research effort investigates and identifies the characteristics of professional staff members who participate in various phases of the design process in the building sector of the construction industry.

2.5 Research Considerations

Considerable research has been conducted directing attention to personality traits, attributes and characteristics relative to predictors of job performance. Studies have focused on cognitive abilities and personality. The two primary elements of an A/E (Architectural/Engineering) firm's work are "*products* (such as the plans and

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specifications for a project) and *service* (the process used to develop the design, build the project and maintain budget and schedule)" (Principal's Report 1999, p. 14). While the product and services of a firm are unquestionably intertwined, the product is primarily a function of cognitive ability. The service component has a significant interpersonal element that is at all times ready for the convergence of friction and conflict.

As the construction project is planned and designed, within the A/E's office setting, various personality traits can have an impact on performance (Barrick and Mount 1991, Tett et al., 1991). In fact, personality traits can impact performance based upon the leadership perception and achievement (Lord, De Vader and Alliger, 1986).

Once the project moves into the construction phase there can be an exponential increase in the opportunity for conflict, with the introduction of the construction contingent; prime contractors, subcontractors and suppliers. It is here that the personality characteristics of the participants continue as critical elements to successful outcomes.

It is the objective of this research to explore relevant personality dimensions pertinent to the professional performance of duties in the planning, design and construction administration in the general building sector of the construction industry.

2.6 Individual Personality Traits

A literature review has been conducted to investigate the published criterion based studies of personality for the prediction of job performance. The journal articles have been drawn from publications including: *Journal of Construction Engineering and Management, Journal of Management in Engineering, Personnel Psychology, Journal of Applied Psychology*, *Journal of Research in Personality, Journal of Personality and Social Psychology, Human Factors, Academy of Management Journal, Journal of*

Engineering and Technology Management, Industrial Engineering, Journal of Research in Personality. Journal of Abnormal and Social Psychology, Human Relations, and Psychological Reports.

Of the various evaluations offered, it has been found that those known as the Big-Five Personality Factor taxonomy are the most commonly encountered in recent literature. This Big-Five taxonomy of traits has been a primary tool to compare an individual's personality attributes with predicted job performance, in a broad array of research reports. The Myers-Briggs Type Indicator (MBTI), however, is a psychometric instrument developed to measure individual personality preferences on four dichotomous scales that has also found wide application in education, career counseling and organizations (Myers, McCaully, Quenk, and Hammer, 1998). The MBTI differs fundamentally from the Big-Five, in that neuroticism, or emotional stability, is not a personality dimension explored in the MBTI. The other four factors of the Big Five are significantly correlated to the MBTI dimensions of personality (McCrae and Costa, 1989). The MBTI is classified for use in normal, healthy populations and does not enter the arena of clinical or abnormal psychology. Therefore, the MBTI is considered as the instrument for use in this research.

In addition, this literature review has illustrated that within the various research papers and journal articles, the most powerful test of the Jungian functions and attitudes, is the Myers-Briggs Type Indicator (MBTI). This instrument, a well-validated and reliable measurement tool applied across a wide landscape of occupations, has been proven to be particularly effective in the engineering and architectural professions (McCaully, MacDaid and Walsh, 1986, and Hall and MacKinnon, 1969).

It is the basic premise within Jung's theory of psychological type that what might appear to be random behavior patterns in an individual's actions, and their inter-personal relations with others, can actually be explained through personality types (Spoto, 1989). These types are based on preferences measured in four dichotomous categories that reflect preferred attitudes and decision-making functions (Myers, McCaully, Quenk, and Hammer, 1998 and Quenk, 1993).

These traits, or types, actually allow for the prediction of behavior in an "orderly and consistent" manner (McCaully, MacDaid and Walsh, 1986, p. 99). Additionally, it is held that if one is capable of predicting behaviors, then there is a better opportunity to contend with the differences in personalities in a productive manner (Myers, 1980).

One important consideration in the evaluation of performance as a function of personality characteristics, is that personality traits offer an enduring measure of an individual that is quite resistant to change (Helmreich, 1984). There is considerable evidence in psychotherapy that personality traits are stable. This is demonstrated in the low level of effectiveness in the efforts to modify personality through intensive therapeutic interventions. This is supported and reported in the work of the Myers, et al. (1998)

The basis of the MBTI, and its application of the theory of Jung, are that people perceive and make judgments in different ways. Myers (1980, p.1) supports this in the statement that the "basic differences (in people) concern(s) the way people *prefer* to use their minds, specifically, the way they perceive and the way they make judgments." The theory is, however, that although there is a wide and continuous intensity of traits through a breadth of personalities, these dimensions can be captured through the analysis of four

distinct dichotomies (Myers, McCaully, Quenk, and Hammer, 1998). These factors of personality are captured and identified through the MBTI personality inventory. The four dichotomies of personality include two that distinguish attitude, and two that identify perception and judgment, or functions.

The four dichotomies measured through application of the MBTI are presented in the MBTI Manual (Myers, McCaully, Quenk, and Hammer, 1998) and paraphrased below (McCaully, MacDaid and Walsh, 1986, p, 101).

Extraversion/Introversion (E and I)

"Some people are oriented to a breadth-of-knowledge approach to quick action; others are oriented to a depth-of-knowledge approach, reflecting on concepts and ideas. Jung calls these orientations, extraversion and introversion (E or I in MBTI terminology)."

Sensing and Intuition (S and N)

"Some people are attuned to the practical, hands-on, common-sense view of events, while others are more attuned to the complex interactions, theoretical implications, or new possibilities of events. These two styles of information gathering, or perception, are known as sensing and intuition (S and N), respectively."

Thinking and Feeling (T and F)

"Some people typically draw conclusions or make judgments objectively, dispassionately and analytically; others weigh the human factors or societal import, and make judgments with the personal conviction as to their value. These two styles of decision making, or judgment, are called thinking and feeling (T and F), respectively."

Judgment and Perception (J and P)

"Finally, some people prefer to collect only enough data to make decisions before setting on a direct path to a goal, and typically stay on that path. Others are finely attuned to changing situations, alert to developments that may require a change in strategy, or even a change of goals. These two styles are called the preferences for judgment or perception (J and P), respectively."

Since it is the consensus of current research that personality traits "consistently predict performance", (Lord, De Vader and Alliger, 1986, p. 407) the purpose of this research is to identify an accurate set of performance criteria that reflect the achievement of participants in the design group of the construction process. The next step would be to correlate through statistical measures, these performance criteria with the personality traits inventoried in the MBTI, hypothesized as being associated with effective individual performance on any one of the achievement categories.

The next sub-section identifies current areas of research, and the resulting factors that define and measure project success or failure. These are known as Critical Project Success Factors (CPSFs), or Critical Success Factors (CSFs).

2.7 Properties for the Measurement of Project Success – Critical Success Factors

Critical Project Success Factors (CPSFs or CSFs) are varied, and are neither singularly project team related, nor related to individual factors. The primary CPSFs can be summarized as falling within the following categories (Lutz, et al., 1990):

a. Owner Satisfaction

b. Schedule and completion

c. Construction and operational costs

d. User safety and health

e. User morale

f. Litigation and liability

The major areas where a project's success is put at risk, is a carryover from the design activities. This risk to a project includes errors in the design work, which if allowed to go undetected, will result in problems from conflicts or omissions in the specifications or on the drawings. These can be categorized, according to Lutz (1990) as:

a. Contract Document conflicts

b. Interdisciplinary coordination errors

c. Technical compliance discrepancies

Jain's work studies the effectiveness of organizations in the construction industry (1997). An essential consideration that is presented in this literature, is that for an organization to be effective it is important that members are not out doing "their own thing" (Jain, 1997, p. 41). Only when there is a congruence of goals and objectives of the organization and the individual, will there be an expectation of high performance. Of course, it can be extrapolated that if there is to be a consistency in the delivery of quality services, in conformance with the goals of the organization, that the individuals must clearly understand what those objectives are, and be given the opportunity to be successful in their delivery (Saarinen and Hobel, 1990).

Management processes that will lead to these CPSF's being accomplished include the following basic principles (Saarinen and Hobel, 1990):

a. Total involvement at every level of the firm

b. Customer orientation: and understanding at all levels of the firm as to what the client requires and expects

c. Systematic support by way of policies and procedures to allow quality

d. Continuous improvement-even when the client is satisfied

CPSF's can be measured in the quality of the delivered project. The cost of quality is in "not doing things right the first time" (Saarinen and Hobel, 1990). In order to deliver a successful project it must be recognized that different points of view will see success or failure differently (Sanvido, Grobler, Parfitt and Coyle, 1992). The owner's criteria of "on budget, on time, and user satisfaction" differ from the view of the contractor, who sees success as meeting requirements for "schedule, profit and claims avoidance" (Parfitt and Sanvido 1993). The designer, on the other hand, ranks success by the level of owner satisfaction, architectural quality, adequacy of fee and professional staff fulfillment (Parfitt and Sanvido, 1993).

As demonstrated above, there seems to be no single, comprehensive list of CPSF's. In fact, there is a good deal of literature on general factors believed to be correlated with project successes that are less than manifest. Maidique (1991) suggests an understanding of customer needs, efficiency of service, and seniority and authority of responsible managers, are discriminators of project success and failure. The additional factors that Maidique highlights as having significant impact on project success include:

a. Marketing Proficiency

b. Technological Capacity

c. Program Management

d. Product Uniqueness

e. Benefit to Cost Ratios

f. Synergy with other Projects

In preparation for moving into the construction phase of a project the design team can evaluate their preparation for achieving a successful outcome through the review of (Stukhart, 1987):

a. Design constructibility recommendations

b. Construction document coordination

c. Cost estimating, budget and control

d. Planning and scheduling of work, including design

e. On-site management and processing of documentation

f. Procurement management

g. Contract compliance and field procedure review

h. Value engineering and safety review

The critical sub-phases of the design firm's duties relative to the contract performance are broken down into five categories by Stukhart (1987), where his research evaluates effectiveness.   Those design-related activities are:

1. Planning

2. Conceptual design

3. Preliminary Design

4. Detailed Design

5. Construction

For the purposes of this research these activities have been collapsed, with the first two forming the *planning sub-phase*, while the third and fourth are likewise combined to form the detailed *design sub-phase*. The last *sub-phase, construction administration* remains.

The most important "personal traits" reported by Abdel-Razek (1997) constituting success measures, listed in order of importance are: the ability to innovate, the presence of personal integrity, ability to communicate, and a discipline and adherence to regulations and procedures.

Most of the research work, investigated in this literature review, offer their own positive measures of performance, vis-à-vis, those criterion that when met will ensure a higher probability of a successful project outcome. Lester (1984) suggests several characteristics, or thought patterns, that create hazards to success. Those patterns are labeled *"anti-authority, impulsivity, invulnerability, macho, and external control or resignation"*(Lester, 1984, p. 567)*.* It can be hypothesized that if there is a consistent disposition within an approach to a project that is defined within these patterns of thought, then there may be a personality trait correlated with this style which may predict the potential for problems.

Each of the above references offers varied measures of project success, and it requires consideration of each dimension to develop an effective measurement instrument in the form of an investigative questionnaire. Songer and Molenaar (1997) focus succinctly on the most widely held definition of success criteria. The following traditional criteria for project success are offered:

1. On Time

2. On Budget

3. Meets Specifications

4. Conforms to User Expectations

5. High Quality of Workmanship

6. Minimizes Construction Aggravation

There can be little argument that it is the measurement of these factors that determines whether the combined efforts of individuals on a project have been successful or not. The "traditional" measurement of these hard criteria need to be supplemented with the additional tracking, forecasting and control of "additional soft measurements, such as customer satisfaction, leadership, employee involvement, teamwork, training, flexibility, responsiveness, and so forth" (Stevens, 1996. p. 36).

Keying off these criteria, it is the task of this research to develop a questionnaire to define and measure project success based on individual performance. These criteria are then analyzed in the statistical evaluation against the personality traits of those participants functioning within the various design sub-phases of the building sector of the construction industry.

2.8 Fitness of the Psychometric Tool – Myers-Briggs Type Indicator®

Extensive research has been conducted throughout the last century investigating the relationship of personality traits, types, temperaments and preferences with job performance characteristics. In fact, it is reported that Sir Francis Galton, in 1884, was one of the first investigators to observe that through the use of language one could begin to "tap the more conspicuous aspects of character" (Goldberg, 1990, p. 1216). Thomas Jefferson, in an 1823 correspondence with John Adams observed that, "No duty the executive had to perform was so trying as to put the right (person) in the right place," (Jefferson, 1823).

The difficulty of finding the right person for the right job is one that has plagued management through the ages. In fact, the temperaments postulated by Hippocratic;

Sanguine, Choleric, Phlegmatic and Melancholic, have been of significant value to noted psychiatrists and psychologists, including Jung, Freud and Maslow, in the development of their theories of personality (Keirsey and Bates, 1978, Keirsey 1998, Hall and Nordby, 1973 and Groth-Marnat, 1997). These early attempts to understand the nature of man's temperament and personality continue today.

The research of the Construction Industry Institute (CII, 1994) has concluded in "Lessons Learned" (CII p.14) that disputes and problems in construction are not necessarily caused by people, but people will either help or hinder the process of dispute resolution. It reports that in "essence, disagreements on *Project* issues will be settled by *People."* This work highlights the importance of people, and by inference the unique and individual personalities of those people.

The value of individual and team personality traits, as dimensions of achievement, rest in the incremental contribution of understanding beyond the traditional measures of predictive performance (Kichuk, 1997). The most commonly employed variable to predict performance is the measure of an individual's general cognitive ability (Tett, et al., 1991). Barrick and Mount's research (1991) showed that personality traits generally do not co-vary with cognitive ability, thus personality factors hold promise in offering unique insight into performance measures. It is understood, however, that the validity of peer-evaluated and expert rater validity was consistently lower than self-report measures (Barrick and Mount, 1991, and McCrae and Costa, 1989). Likewise, the validity of objective correlations, such as cognitive ability also have been demonstrated as consistently higher than those performance measures of a more subjective nature (Tziner, 1985).

The recent works published within the traditional publications of the psychological institutions seem to have centered on the Five-Factor Model of Personality. As previously stated, the study conducted by McCrae and Costa, (1989) comparing the MBTI with the NEO-PI measurement of the Big-Five factors, found that the MBTI "did measure four of the five dimensions of normal personality." (McCrae, 1989, p.17). Furthermore, this study went on to conclude, "the five-factor model provides an alternative basis for interpreting MBTI findings within the broader, more commonly shared conceptual framework" (McCrae, page 17). Clearly, the reciprocal view is equally valid, that the results of the MBTI may be extended to interpret the personality dimensions investigated by the five-factor model, and its derivatives. This ties the MBTI psychometric instrument to a wide array of earlier research on individual and team performance.

The Myers-Briggs Type Indicator is an instrument that has been under development for over 50 years. The instrument has been subjected to intensive evolution since 1962. It continues to be improved through its mission to distinguish personality types even today, through the ongoing efforts of the research centers for psychological type of the Consulting Psychologists Press, Inc. (CPP) in Palo Alto, California, and the Center for Applications of Psychological Types (CAPT) in Gainesville, Florida.

One of the principal, and MBTI competing, research teams of personality traits as predictors of performance is Robert McCrae and Paul Costa. Although there is continuing evidence of competition between McCrae and Costa's NEO-PI and the MBTI; their 1989-study (McCrae and Costa, 1989) found considerable validity and correlation between the two instruments when evaluated against the five-factor model of personality.

The quote from their 1987 research, performed for the National Institutes of Health and the National Institute on Aging states, "(u)nless methodological studies are conducted on *well-defined and meaningful traits* (emphasis added) their conclusions are dubious; unless the traits are selected from a comprehensive taxonomy, it is impossible to know how far or in what ways they can be generalized" (McCrae and Costa, 1987, p. 81). McCrae and Costa's testimony for the validity of the Myers-Briggs Type Indicator, as a sufficient tool for the investigation of personality dimensions, supports its confirmation as the psychometric instrument for use in this research.

This is further supported by the findings of Barrick and Mount (1991, p. 1) that these models of personality are most appropriate for "research and practice in personnel psychology, especially in the sub-fields of personnel selection, training and development, and performance appraisal."

In addition, any psychometric instrument must be both reliable and valid. The following appraisal of the MBTI® further substantiates its selection as the instrument of this research.

The *construct validity* of a psychological tool was dubbed the "queen bee" of tests by C. B. Rogers of the Psychological Testing Enterprise. The MBTI® Type Indicator is no different, it must prove its *reliability and validity* to show it is a legitimate and effective psychometric tool.

The common concept in the development of psychometric instruments prior to 1995 was to select items defining theoretical traits, without the benefit of extensive reliance upon external criteria. The efforts of the Consulting Psychologists Press, Inc., the

distributor of the MBTI®, from mid-1970 through the completion of the new Form M is therefore noteworthy.

The Form M of the MBTI® was developed with the goal of maximizing validity, specifically the maximization of *construct validity*. The development of the MBTI® produced internal reliabilities reported to range from 0.86 to 0.95 (Myers, et al., 1998). Recognizing that reliability estimates of higher than 0.70 are expected for instruments to be used for research, the MBTI® provides that reliance. Other tests such as Jackson's Personality Research Form, although widely used falls short, with internal consistencies of less than 0.60 (McCrae and Costa, 1989). The NEO-PI on the other hand shows internal consistencies of 0.86-0.95, precisely the same range as that of the MBTI® (0.86-0.95).

It is the finding of this paper that the MBTI® is a powerful tool for use in Personality Assessments and Research work based on its demonstrated *reliability, consistency and validity.*

The MBTI® is a psychometric instrument that has been under continuous development for decades. The basic concept of the theory of the MBTI® "is that much seemingly random variation in behavior is actually quite orderly and consistent, being due to the basic differences in the way individuals prefer to use their perception and judgment" (Myers, et al., 1998, p.3).

The concept of the preferences was developed independent of the work of Carl Jung, by Katherine Briggs. Briggs discovered the theory of Jungian psychology after her initial investigations and theory development had begun. Once this "discovery" was made, Briggs used the concepts of Jung to continue her refinement of the instrument she

was in the process of creating (Myers, et al., 1998). This instrument was being designed to produce an inventory of personality characteristics to better understand why people behave the way they do; different from one another.

Jung's theory of psychological type consisted of three basic elements; Introversion/Extraversion, Sensing/Intuition and Thinking/Feeling. Briggs, in her interpretation of Jung's work, added a fourth dimension of personality, Judging/Perceiving. This added fourth dimension is the core of the MBTI® in that it is here that each of the four preference categories of the instrument guide the use of perception and judgment in the gathering of information and forming of decisions from that data (Myers, et al., 1998).

The four dichotomies: E/I, S/N, T/F and J/P are classified as either, *orientations* or *attitudes* for the first and last dimensions, while the two middle dimensions are considered *functions* and *processes.*

As presented by Spoto (1989), from the collected works of Dr. Jung (no. 6, par. 986) the concept of typology is clearly recognized. "It is not the purpose of a psychological typology to classify human beings into categories; this in itself would be pretty pointless. Its purpose is to provide a critical psychology which will make a methodical investigation and presentation of the empirical material possible" (Spoto 1989, p.23).

It is held that one of the problems with the application of Jungian theory is that it is the unconscious that stimulates an individual's action. Therefore, problems may be produced if the theory is believed to be too well mastered, or that there are distinct and definite explanations from this work (Spoto, 1989).

The core notion of Jungian psychology rests in the concept of "polar opposites". This notion may begin to be expressed in word pair preferences, such as "rationalistic-empiricist, intellectualistic-sensationalistic, idealistic-materialistic, optimistic-pessimistic, etc." (Spoto, 1990, p. 25). The MBTI® mines the polarity of the four dichotomies of personality, with such word pairs and short preference questions. For example, the *realistic* versus the *imaginative* word pair would offer insight into the Sensing-Intuition dichotomy. The *Intuitive's* tendency is to *imagine* the *reality* <u>within</u> things at the expense of seeing the simple appearances. This is the opposite of the *Sensor's* inclination to see only what is, without the benefit of appreciating what is occurring out of view. This example gives an introduction of the concept of polar opposites as it relates to the dichotomies of the MBTI®.

The specifics of each dichotomy may be found in any number of reference documents; that includes texts, journal articles and user manuals. The primary source of information used in this research work is the MBTI® Manual, 1998 (Myers, et al., 1998). The MBTI® consists of four dimensions of personality. Those dimensions are Extraversion/Introversion, Sensing/Intuition, Thinking/ Feeling and Judging/Perceiving. These in combination are expanded to form 16 Types, which are demonstrated in Figure 2-2 from the Manual (Myers, et. al, 1998).

ISTJ	ISFJ	INFJ	INTJ
I depth of concentration	**I** depth of concentration	**I** depth of concentration	**I** depth of concentration
S reliance on facts	**S** reliance on facts	**N** grasp of possibilities	**N** grasp of possibilities
T logic and analysis	**F** warmth and sympathy	**F** warmth and sympathy	**T** logic and analysis
J organization	**J** organization	**J** organization	**J** organization
ISTP	**ISFP**	**INFP**	**INTP**
I depth of concentration	**I** depth of concentration	**I** depth of concentration	**I** depth of concentration
S reliance on facts	**S** reliance on facts	**N** grasp of possibilities	**N** grasp of possibilities
T logic and analysis	**F** warmth and sympathy	**F** warmth and sympathy	**T** logic and analysis
P adaptability	**P** adaptability	**P** adaptability	**P** adaptability
ESTP	**ESFP**	**ENFP**	**ENTP**
E breadth of interest	**E** breadth of interest	**E** breadth of interest	**E** breadth of interest
S reliance on facts	**S** reliance on facts	**N** grasp of possibilities	**N** grasp of possibilities
T logic and analysis	**F** warmth and sympathy	**F** warmth and sympathy	**T** logic and analysis
P adaptability	**P** adaptability	**P** adaptability	**P** adaptability
ESTJ	**ESFJ**	**ENFJ**	**ENTJ**
E breadth of interest	**E** breadth of interest	**E** breadth of interest	**E** breadth of interest
S reliance on facts	**S** reliance on facts	**N** grasp of possibilities	**N** grasp of possibilities
T logic and analysis	**F** warmth and sympathy	**F** warmth and sympathy	**T** logic and analysis
J organization	**J** organization	**J** organization	**J** organization

Figure 2-2 Contribution Made by Each Preference to Each Type

In general, the dichotomy of Extravert/Introvert is the dimension that will distinguish an individual's preference for the focus of energy. This means the E/I dimension will identify if a person prefers the outer world of "people and objects", or the inner world of "concepts, ideas and internal experiences". The Judging/Perceiving dichotomy is similar, yet uniquely different in that this dimension identifies the person's preference for how they deal with the outer world. This is the dichotomy that indicates the dominant function for the Sensing/Intuition and Thinking/Feeling dimensions for the extraverted part of an individual's life. The Judging person prefers T/F (decision-making) in dealing with the outer world, while the Perceiving person shows a preference for S/N (data gathering) in their interaction with the world of others.

In dealing with each of these dichotomies, there is no single use of a preferred style to the exclusion of the other. MBTI Type theory promotes (in fact adamantly so) that there should be no mistake between type (categorical) and traits (scalar). The issue remains that there is a balance in the use of both elements of each dichotomy. There should be no belief that a "less preferred" is never used, the theory only identifies the individual's preferred process.

The functions of data gathering (perceiving) and decision making (judging) are identified in the middle dichotomies, S/N and T/F. The Sensing individual prefers the clearly observable elements around them. They find comfort in collecting data using their five senses. On the other hand, an Intuitive is quite comfortable making observations with the senses and looking for the meanings, connections and opportunities that this data offers. Once the data is in, the T/F spectrum provides insight into the preferred way of making a decision. The Thinking person will make judgments based on the logical consequences of that action. The Feeling person will allow personal and/or social values and the future impact of an action to enter into the decision making function (Myers, et al., 1998).

Everyone occasionally uses each of the eight preference elements to guide their actions in life. While the theory states that relative to Type, you either are, or you are not, an E vs. an I, and so forth, there is a recognition that different people use the complementary attitudes and functions at least some of the time. There has been little use of the MBTI® to predict severity of Extraversion or Intuition; therefore, there appears a great aversion to the use of this instrument as a scalar measure of personality traits. There are a number of references in the manual to validity studies viewing the

measurement in a scalar fashion, however, in the practice of administering the MBTI® in a non-research forum the instrument is strictly a categorical Type tool.

The use of the scale consideration, or the severity issue is approached in the use of the Preference Clarity Index. This offers, as the name would indicate, the level of clarity a respondent demonstrates for a particular preference in the completion of the instrument. "The preference clarity index is an estimate of relative confidence that a preference has been accurately identified" (Myers, et al., 1998, p.121).

This is, however, in contrast with the research use of the instrument as detailed throughout chapter 9 of the Manual (Myers, et al., 1998). Here the MBTI® reports numerous correlational studies using continuous scores. This use, while discouraged for interpretation of individual results, seems a readily accepted standard for investigative research.

2.8.1 Creation and Construction of the MBTI® Form M:

The Form M Indicator was developed from the extensive research effort of a number of investigators. The creation of the questionnaire followed the procedure of 1) Creation of an *Initial Item Pool*; 2) Develop the selection criteria; 3) Construct the *Form*; 4) Administration to a national sample; and 5) Select the *Final Items for Form M*. The primary method used to select the items for inclusion in the latest revision of the Indicator is referred to as Item Response Theory (IRT). This theory has been designated as the new rules of measurement for psychological instruments. The IRT differs from Classical Test Theory (CTT), in that CTT uses the entire test to determine its reliability, while IRT measures and validates each item individually.

The concept of the IRT is to measure the likelihood that a person with a true personality characteristic of E, or I; or S, or N; (or any of the other dimensions) will provide a particular response to an individual item tested (Myers, et. al, 1998). For example, with the word pair *"structure* and *possibilities"*, what is the likelihood that a true *J* will select *structure* or more accurately a true *P* will select *possibilities?* The *keyed direction* is, for the sake of consistency, and by convention, a positive z scores in the direction of I, N, F and P. The measure of the response relationship is depicted in the Item Characteristic Curve (ICC) as shown in the example figure below.
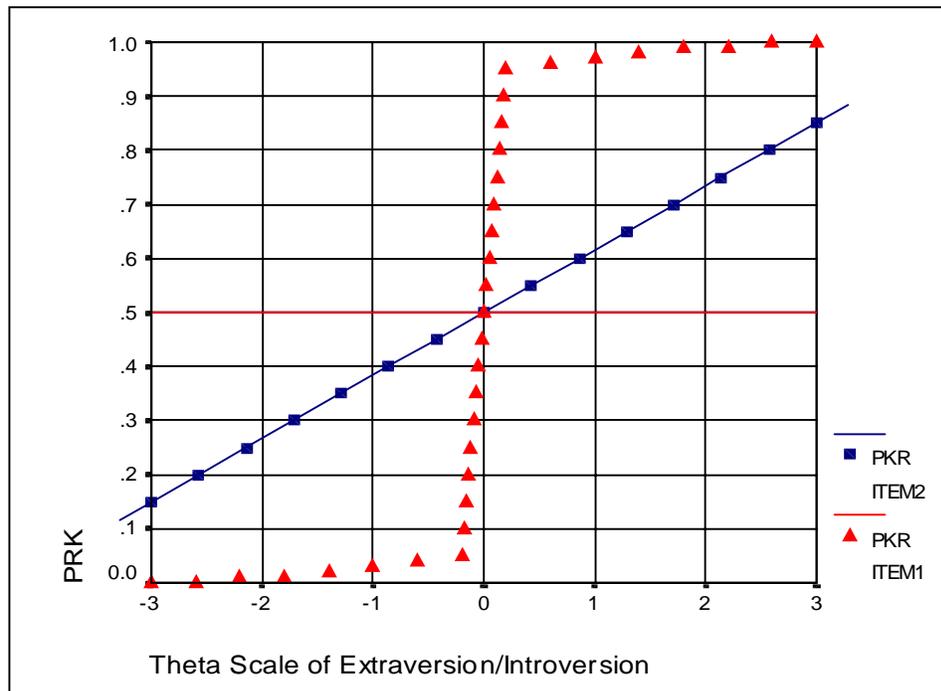
Figure 2-3 Item Characteristic Curve for Two Hypothetical Items

The curve in Figure 2-3 plots on the "Y" axis the probability of a person or subgroup of persons classified as (or intensity of) extravert or introvert will answer in a

particular direction. In other words, a "true" introvert has a low probability of choosing an extravert response (negative theta).

The *Theta* score is an arbitrary scale, usually a *Z-score* with "0" defining the mid-point. This is where the continuous nature of the "personality trait scale" measurement is used for research purposes.

In Figure 2-3 there are three factors that impact the ICC. The first is *discrimination*. This is the shape and slope of the line providing information on the item. The steeper the slope the more information is provided relative to the response, and the more likely the respondent is answering in the keyed direction. In 2-3, an example would be if the line was horizontal, there would be no information of a discriminatory value given, and the item would be of little value.

The second dimension of the ICC is the *difficulty*. This would be shown in a shift of the 0.0-theta intercept point. As the intercept shifted up or down from the 50% probability point (0.50 PKR), the difficulty of discrimination of the item would be increased. Or in other words, the mid-point of the ICC would not be above the theta 0.0 point, but rather would be either to the left or right. If a steep slope were found at other than the mid-point, this would indicate *difficulty*. Those who were not sure would answer incorrectly and thus shift the mid-point.

Continuing with the example in Figure 2-3, the third characteristic of the ICC is the *lower asymptote* at the left of the theta scale. This is typically non-zero for right-wrong tests as well as personality tests. The non-zero *lower asymptote* for right-wrong tests is a function of answer guessing. On a personality test, the non-zero point is

attributed to social desirability of a particular answer, where some true extraverts may provide a pressured introvert answer.

The power of the IRT for individual items on the MBTI is that there are three parameters for discrimination and selection, offering increased validity assessments of the item. The particular value of IRT to the MBTI® is that it is most powerful as a dichotomous selection instrument, while the four dimensions of the MBTI® are bipolar elements.

Once the concept of the IRT is established, the Individual Response Items are tested in theory against the proposed MBTI dimensions. With this baseline, the actual application of the MBTI® Form M development is outlined. The method used was to first collect an array of possible distinguishing items. Each of these items would purport to discriminate between a particular dimension of personality defined in Jungian psychological theory (E/I, S/N, T/F or J/P).

In the case of the Form M there was an initial set of 290 discriminating items proposed. These were from a collection made throughout the years of research done by Myers and Briggs, along with their colleagues. In addition to these 290 items there was added another 200 items proposed by L. Thomas (a Virginia Tech student) in an unpublished Masters Thesis (Thomas, 1996). Two professionals who regularly used the MBTI® wrote the final 90 items (Myers, et al., 1998).

This pool of 580 potential discriminators of personality dimensions was then subjected to the various tests of the IRT. Combining those results with the theoretical criteria, such as forced choice format, and phrase questions and word pairs, the MBTI

Research Advisory Board selected the 264 "best" items to be further investigated for ultimate inclusion in the new MBTI® Form M.

These 264 items were subjected to a factor analysis at which time it was discovered that 26 of the items yielded a poor discrimination for one or more of the dimensions. This was generally found on the S/N and J/P scales (Myers, et al., 1998). As a side note, this is one of the examples of why the pure Jungians are not in favor of the Myers-Briggs addition of the implied J/P scale, because it is thought to interfere with the S/N and T/F dichotomies (Myers, et al., 1998). Although advocates of the MBTI believe that it is clear to those who view the instrument as a tool to understand personality and subsequent behaviors, that the direction of influence given by the J/P scale is essential to the power of the MBTI® (Hirsh and Kummerow, 1998).

Of the remaining 238 items the Research Advisory Board made the final selection of the "best" 93 items to make up the new MBTI® Form M.

The summary of the final Item to Scale Correlations is presented in Table 7.11 of the Manual (Myers, et al., 1998). These are reported to range from 0.36 to 0.76. This demonstrates the differentiational power of the Indicator. For example, E/I measures Extraversion/Introversion, and not the S/N, T/F or J/P items.

2.8.2 MBTI® Validity

A final question is the instrument's validity and has it been tested thoroughly and continuously throughout the 50-year development period. This research effort continues today with the latest revision of the MBTI® designated Form M (Myers, et al., 1998). In the evaluation of a psychometric instrument, typical criteria considered are *internal consistency* and *content validity*. In addition, to the measures investigated in the previous

sub-section, the question remains one of *construct validity*. This issue is evaluated and reported in the Manual (Myers, et al., 1998). Additionally, an independent literature review has compared numerous Meta-Analysis studies of not only the MBTI® but other psychometric instruments (Barrick and Mount, 1991, Lord et al., 1986, McCrae and Costa, 1987). If there is a clear *construct validity* between the MBTI® and the NEO-PI®, and there is a Meta-Analysis correlation of the NEO-PI® and MMPI® then a correlation of the MBTI and the MMPI follows (if A=B, and B=C, then A=C).

The construct validity of the MBTI® is established through the use of the continuous scores, accurate midpoint, and internal consistency through a test/re-test approach, and the view of a trait based scalar measurement. The reliability is further secured through consistency of a categorical reporting of results.

The approach used for *internal consistency* evaluation of the instrument is a simple procedure referred to as "half-split" tests. This is self evident, that with a random splitting of the instrument's questions and subsequent scoring there should be no significant difference in the results. This has been proven through the research efforts used in the development of Form M (Myers, et al., 1998).

The final validity consideration is that of *construct validity,* established through research studies correlating the MBTI® with other psychometric instruments. All of the industry standard tests; the *16 Personality factor Questionnaire, Million Index of Personality Styles, California Psychological Inventory, the NEO-PI, the Firo-B, the Adjective Checklist and the Strong Interest Inventory* are evaluated against the MBTI® for *construct validity.*

These correlation studies are included, and are presented by Myers (Myers, et al., 1998). The validity of the Indicator as a personality assessment inventory is established.

Based upon all of the above, as well as the extensive data provided by the MBTI principal investigators (Myers, McCaully, Quenk, and Hammer, 1998), the Myers-Briggs Type Indicator, Form M, is the instrument used in this study.

2.9 Suitability of a Critical Incident Behavioral Preference Instrument

A primary objective of this research is to develop a set of quantifiable predictive behavioral measures for individual professionals. Current work by other researchers has demonstrated that such are possible (Stevens, 1996). The checklists developed and published by Longo (1991), Wuellner, (1990), Saarinen, (1990) Ahmed, (1995) and Sanvido (1993) provide extensive guidance in the development of inquiry on behavior and performance, for the development of a CSF Questionnaire.

The literature recommends that the research instrument be refined for data collection to include biographical data of the respondents' (Maidique, 1984). While collecting biographical information relative to the respondent might appear less than highly informative, considerable research has concluded that one of the best predictors of future behavior is past behavior (Childs and Klimoski, 1986). Bio-data of personnel have consistently yielded relevant predictors of organization measures (Maidique, 1984).

A consideration to this research effort is to solicit responses of a reasonably general nature, not requiring respondents to rely upon a detailed and extensive memory of events. In this fashion the inquiry limits biasing (Ahmed, 1995). Furthermore, it is recognized that it is difficult to measure job success (Myers 1979). Two firms, or two supervisors may very well disagree on the success achieved by a particular employee or

by a particular approach to a problem. Specific job conditions, interpersonal relationships, and strengths or weaknesses of other project participants may all combine to create a very real problem in predicting successful outcomes that follow specific behavioral patterns. The *validity* of the research data, defining successful and less successful behaviors and outcomes, will form the basis of the research inquiry. The inquiry is critical to measuring successful behavior. The validity of the results of the research of others, and their measurement of success, is adopted as a true measure. It is on these issues that the research implies *content validity* (Stodola, 1967).

This research study allows for evaluation from the standpoint of *question fitness, consistency and reliability*. This investigation will not determine if the matters reported in the research of others, validly defines successful performance (*content validity)*. The present research inquiry however, will be evaluated for consistency of accurate measurement of success. The following items are important in the consideration of an inquiry's development (Sommer and Sommer, p 135):

1. Is the question necessary?

2. Is the item clear?

3. Is the question "double-barreled"?

4. Is the item short, unambiguous and precise?

5. Are the questions formatted to reduce bias?

6. Are the questions balanced to investigate the metrics of interest?

The wording of the inquiry within a pilot study will offer insight into the effectiveness of a *Critical Incidents Approach* in a draft questionnaire. Drawing from the literature, specific incidents defining or illustrating successful and less successful

performance will make up a pilot inquiry. From these responses, the evaluation of the *reliability* and *internal consistency* will be performed.

The process recommended is outlined in the following excerpt from Sommers' (1997, p.137):

Basic Steps: Constructing a Questionnaire

Content

1. Exploratory Interviews… and/or casual observation…

2. Decide aspects of the problem to be covered.

3. Generate Items.

Sommers' (1997) recommends the use of a closed format ranked response question for ease of scoring. The inquiries must ensure that the items meet the criteria for clarity and precision. Sommers' final recommendation is, to "*Pretest*- pilot test the questionnaire *before* putting it into final form". It is here that this research will address the performance measure questionnaire's issues of the *reliability and consistency*.

CHAPTER 3

HYPOTHESES

The research work evaluating individual and team performance as functions of personality traits or characteristics is generally conducted to evaluate specific attributes. Consequently, there are only limited studies pertaining to personality traits and team performance (Kichuk and Wiesner, 1997). It is the concept of this research that certain personality attributes may influence the performance outcome of the design services, as measured through the application of the Myers-Briggs Type Indicator ® (MBTI, Form-M), a commercially available personality test for normal adults.

3.1 The Null Hypothesis

The null hypothesis (Ho) of the research is: **In the population of Architectural and Engineering Professionals practicing in the Design Services Division of the Building Sector of the Construction Industry, based upon the measures of personality captured in the MBTI®, there will be no performance differences measured for the** *planning, design, construction administration and general firm management duties by these professionals*.

3.2 The Exploratory Hypotheses

The trait measures of the MBTI are through four distinct personality dichotomies, which are: Extraversion/Introversion, (E/I); Sensing/Intuition, (S/N); Thinking/Feeling, (T/F); and Judging/Perceiving, (J/P). The relationship of each of these dichotomies, along with the professional duties and functions of the design service phase of the building industry, are summarized below in the research hypothesis (H 1).

3.2.1 Planning Phase (Study and Report; Conceptual or Preliminary Design)

An individual member of a design group, performing the task of project *planning* will need to be open to alternative solutions towards achieving the desired results of the program. While a certain discipline is required in order to accomplish the goals of the planning effort, a rush to a solution will lead to a building program where options have not been thoroughly investigated and explored. The words that would describe the attributes hypothesized to yield an effective and successful performance in the conceptual design effort, through the completion of a formal *Planning Report* would include: openness to ideas, flexibility, tolerance, broad-mindedness and adaptability (MBTI, P).

In addition, it is hypothesized that the Planning Phase activity would likewise produce the best performance through the leadership and participation of professionals who demonstrate a sense of innovation, concept abstractions, connections, and a grasp of possibilities (MBTI, N).

The third section of this hypothesis is that when presenting ones ideas to a client it is an essential element of ones work to listen to exactly what it is the client expects. Just as in medicine, it can be argued that the most effective portion of a diagnosis is in the physician's active listening to, and empathy for the patient. The same holds true in the design professions. This listening and empathy does not stop at the initial meeting with the client. In fact, in the public building sector of the construction industry, some believe that the most critical understanding occurs during the public presentation portion of the project, where the public expresses their concern and asks questions of the design group. Here it is hypothesized that high performance will come from the professional who

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actively listens and contemplates the question behind the question, avoiding "thinking" aloud. Moderate introversion/extraversion provides balance (MBTI, E/I balance).

In addition, these attributes are those of persons showing a preference for understanding, values, and merits. These are indications of taking into account the effects of a planning decision, and the impact such a decision will have on the people involved (MBTI, F).

3.2.2 Design Phase and Detailed Preparation of Contract Documents

During the Design Phase of the project, it is imperative to begin work within the realm of time and budget. These two traditional measures of project success, "on time and on budget", may only be words during the Planning Phase work. Once project planning is complete, the scope for the work is agreed upon, as well as the project's schedule and cost allocation (time and budget).

As the detailed design work begins, a group of design professionals is set in motion who require a high level of interpersonal, yet independent action. These are inter-related and complementary functions, which must be finely integrated in order to avoid future conflict, a prime metric for an unsuccessful effort.

The first in a series of hypotheses for the detailed design work is that those participating in, and leading in this phase of a project should demonstrate the characteristics of discipline to task and do not, throughout the process, find themselves and their teams on a search for "a better mousetrap." The conception of the new and better mousetrap is the domain of the planning effort. The Design Phase is to produce a clear, concise, unambiguous and well integrated set of plans and specifications which meet code requirements, conform to the objectives set out in the *Planning Report* and

comply with the design firm's standards. This is the characteristic of a structured and organized design professional (MBTI, J).

The interpersonal interaction is hypothesized as being essential to providing a forum for the effective integration of various components of the design: site, structural, architectural, electrical, heating and ventilating and so forth.   With each of these ingredients of design, often times separate professionals must interact with one another in order to bring the project's components together in a coordinated fashion.   It is hypothesized that the higher the level of complexity, the more intense the inter-professional activities, followed by individual design and production efforts. Thus, it is hypothesized that success will associate with those whose preference is for a high level of interaction (MBTI, E).

While it is important for the designers to be solidly grounded in reality, the third in this series of hypotheses suggests that there is a need to deal in the "real world" of what is. The strength of a professional's ability to grasp the facts is a likely predictor of successful performance (MBTI, S).

The final basis of this hypothesis is that at this project phase individuals, leaders and the team will all demonstrate a preference toward logical, just, and impersonal application of reason, rather than "value based" decisions (MBTI, T).

3.2.3 Construction Administration Phase

During the Construction Phase of a project, the requirement for active communication is at its peak. This communication by the professional, designated as the design firm's representative on a building project, is at the center of the communication flow involving the owner and the design firm's office staff. This design interpretation and

coordination can force the construction administrator's communication to deal with separate architectural and engineering firms including structural, mechanical (MEP), interiors, landscape, etc. In addition, the construction administrator must interface with a multitude of contractors, subcontractors and suppliers.

While communication and interface with others seem to be the critical words to capture the talents of the construction phase professional, there are other characteristics equally important in achieving effective results. Each player in the mix of participants within the construction of a project is encumbered with their own company's goals, objectives and agendas. It is the duty of the construction administrator to interpret and respond to these forces, all the while maintaining an equitable balance on a path to the completion of the project in accordance with the plans, and to the standards of the design requirements.

The construction administration professional generally acts as an individual problem solver, who actively deals with a project when things at any time may not go as planned. This individual is typically called in specifically when things have gone wrong, or are getting out of hand. The role is then to assess the difficulties and create alternative solutions. The hypothesis is that the effective construction administrator will listen to what all have to say about a question or controversy, understanding "complex interactions, theoretical implications, or new possibilities of events" (McCaully, et al., 1987, p. 101). Developing alternatives, and establishing a strategy for action through a rational and logical decision for project direction requires what Myers-Briggs refers to as an innovative thinker (MBTI, N and T).

This research theorizes that the more effective construction administrator will tend towards openness to new ideas and possibilities for the concept of what can be, rather than a blind interpretation of what the contract documents specifically require through narrow interpretation of technical mandates (MBTI, P).

There is no prediction offered relative to performance associated with Introversion or Extraversion, associated with the construction administration phase.

3.2.4 General Management of the Design Firm:

It is hypothesized that the single personality whole Type most likely to offer a prediction of successful behavior in this category will be the recognizer of "standards and procedures", the super administrator. The adherence to regulations and policies, along with a respect for tradition, both offer predictions of successful management behavior and performance, and are predicted to be found in the traits of Extraversion, Sensing, Thinking and Judging (MBTI, ESTJ).

Table 3-1 below, and Figure 3-1 on the following page, demonstrate graphically the MBTI® functions and attributes hypothesized as being associated with the four primary activity domains of the engineering and architectural professional's duties within the design service field.

Table 3-1 Exploratory Hypotheses

X indicates where significant correlation is predicted in the Hypotheses

HYPOTHESES	E	I	S	N	T	F	J	P
Planning (Conceptual Design)				X		X		X
Design (Contract Documents)	X		X		X		X	
Construction Administration				X	X			X
General Management	X		X		X		X	

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Building Project Planning, Design and Contract Administration

Planning Phase
Investigations
Study and Report
Understanding, Empathy, Options
(MBTI _NFP)

Design Phase
Detailed Design, Construction Documents,
Plans and Specifications
Logical, Adherence to Regulations &
Standards
(MBTI ESTJ)

Construction Phase
Contract Administration,
Inspection and Construction Management
Options, Openness, Alternatives, Meanings,
Connections
(MBTI _NTP)

General Firm Management
Oversight of all Firm Activities

Follow Established Procedures, Experience
(MBTI ESTJ)

Occupancy

Figure 3-1 Four-Duty Areas of the Design Profession

CHAPTER 4

SCOPE LIMITATIONS AND GOALS OF THIS RESEARCH

The construction industry is one of the largest single sectors of commerce in the United States, representing nearly 10% of our gross national product. As such, it is beyond the scope of this work to investigate the construction industry as a whole. This research has as its first scope limit, a focus only on the Building Construction sector of the industry.

Likewise, it is recognized that to accomplish the overall delivery of a building project it necessarily includes the tasks of *pre-planning, design, procurement and construction and start-up or occupancy*, which "constitutes a complex situation" (Douglas, 1969, p. 1). Therefore, the second limitation of this research will be to restrict the investigation to the *design services* of a project. These project sub-phases encompass the services provided by the project's design professional, generally including planning studies and programming and detailed design, along with architectural and engineering oversight during the construction phase of the project. These, in total may be referred to as the Project Design Services. In addition, the management of the design firm is a distinguishing duty for which many A/E executives are responsible, along with their normal technical activities. This management activity can have a significant overall impact on the direction and performance of a project.

The objective of this research is to explore the relationship between individual personality characteristics of the technical and executive staff members of architectural and engineering firms, and the factors identified as Critical Project Success Factors (CPSF's). These success factors vary with project phases: 1) project planning, 2) project

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design, 3) project construction administration and, 4) overall management of the architectural and engineering firm.   Therefore, the goal of this research is to identify those personality traits correlated with CPSF's for the various phases of the design process, in order to use this information to supplement the traditional predictors of individual performance.

The findings of Ghiselli (1973), Barrick and Mount (1991) and Tett et al. (1991) all lead us to a conclusion that personality trait measurement has an important place in personnel placement for effective performance.   Tett, Jackson and Rothstein (1991) strongly support the continued research into personality based performance selection and prediction.   They state, in part, that there is a need for "research strategies employing personality-oriented job analysis…" and that the outcome of this work should become "standard practice for determining which traits are relevant to predicting performance on a given job…" (Tett, et al., 1991, p. 732).   The two top factors proposed by these authors for research considerations are: "(a) conceptual basis for trait selection; (b) exact job analysis procedures, results and applications."   In the case of this study, these factors are answered with the MBTI® Form M Psychometric Instrument and a Critical Success Factor Questionnaire, developed specifically for this research.

In order to appreciate the objective of this research, an appropriate question would be "why is there a need for improved performance of design teams?" The cover story of the May 11, 1998, issue of the weekly construction industry magazine, Engineering News Record, was dedicated to the question "Are Owners Satisfied?" (Post, 1998).   This question might be appropriately answered with another question; "Is there room for improvement?" This research holds that there is room for significant improvement and

further posits that this improvement is best invested at the beginning of the project delivery process.

The question then becomes, can we as an industry recognize that the way we deliver public works programs demand a continuing improvement in the design and construction process (Post, 1998)? Can we find the most effective way to ensure that the performance expectation of both public and private owners is fulfilled?

Current thinking seems to suggest that design and construction are most effective when they become a truly integrated process. That process begins with the owner's program. The project requirements are then reflected in design documents; plans and specifications, from which the procurement, construction and occupancy processes flow. Recognizing this reality, there is then a heavy burden for project success, or failure, placed at the feet of the Architectural and Engineering design team.

It is the position of this research work that:

A. Both successes and failures of the building sector of the construction industry can have significant impacts on our national economy, and,

B. The current methods used for project delivery, and the success of these construction activities rest largely with the quality of the planning and design effort of Architects and Engineers who form the teams of design professionals.

C. With the dramatic changes in the way business is performed in the construction industry, it is essential that the most effective methods of forming and managing the design function are critical for the delivery of successful projects.

D. That creating a new business program without considering the personnel, and personal implications is a certain formula for chaos, disruption and failure (Sanders and Eskridge, 1993)

E. An effective and high performance team is the result of effective and high performing individuals working together, in a coordinated and low stress environment (Useen, 1998). Stress, and subsequent panic, arises from people being forced to operate outside of their natural and preferred personality zones, thus individual personality characteristics must be considered in effective team formation.

The first critical phase of the Building Construction process is the planning and design of the project. As suggested, without proper plans and specifications, or in other words an excellent product of the design effort, all that follows will be in jeopardy. In particular, if design is poorly completed, there is little chance for a project to achieve success.

The main *objective* of this research is to (a) provide an unbiased evaluation of the predictability of job performance based upon measures of personality characteristics for individuals. The second *objective* is to (b) compare personality traits across job content areas and the project design sub-phases of planning, design, construction administration and general firm management, adopting a confirmatory research strategy utilizing a self-report personality measure and critical incident behavior instrument.
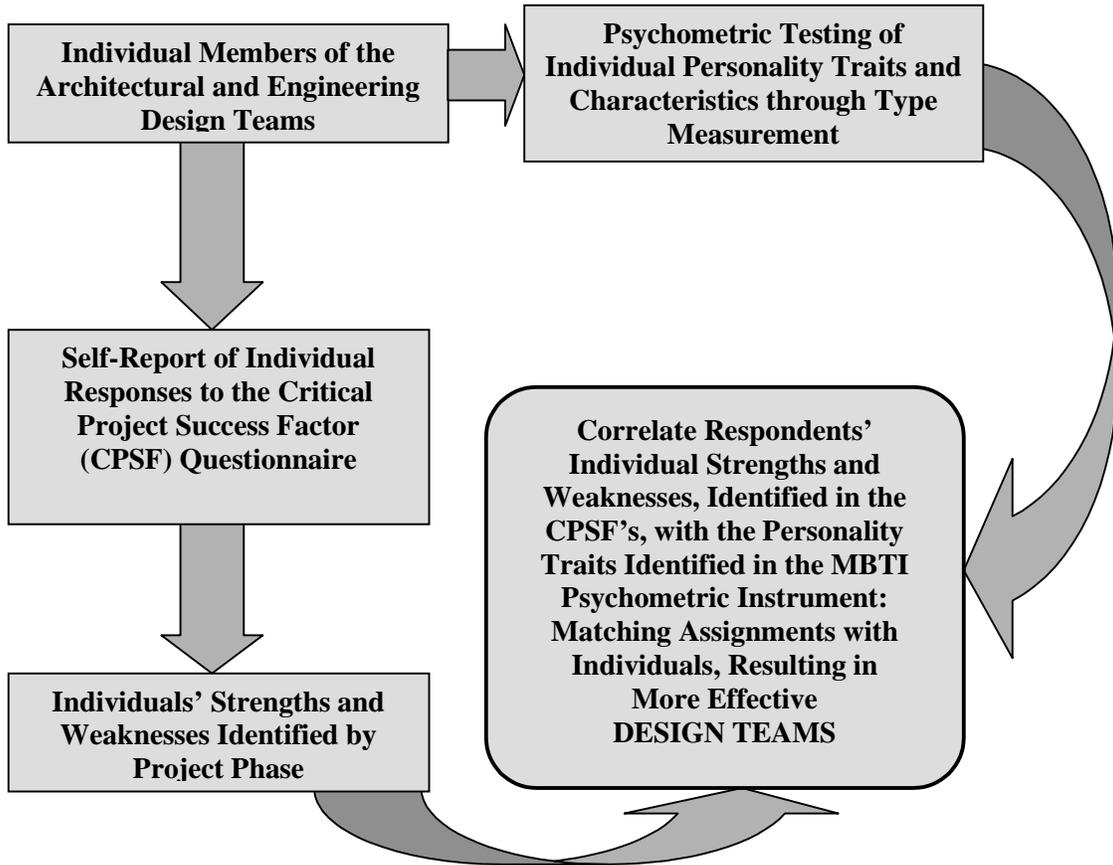
Figure 4-1 Method and Goal of the Research

CHAPTER 5

METHODOLOGY

5.1 Approach to Methodology

The Research Methodology for this investigation has been developed into a three part series. This series of investigations will first determine the psychometric instrument for use in the research. The Methodology will then develop, a valid and reliable, critical incident behavioral questionnaire; a Critical Project Success Factors (CPSF) Questionnaire. And finally, the Methodology will investigate the correlation of personality characteristics, reported in the psychometric instrument, and the behaviors captured in the Critical Project Success Factors (CPSF) Questionnaire.

The first step of the Methodology is the performance of an Exploratory Study to investigate the relationships between critical incident behaviors and MBTI® Types. The basis of this Exploratory work is the short form MBTI type of instrument developed by Holly M. Johnson and Amarjit Singh. This instrument is presented in their paper entitled the Personality of Civil Engineers (Johnson and Singh, 1998).

The Exploratory Study compares the Johnson and Singh questionnaire results for a sub-sample group of this research, and two versions of the MBTI® instrument. The Exploratory Study is to evaluate the utility of a short-form instrument.

The second step in the Methodology series is to develop a Critical Project Success Factors (CPSF) Questionnaire. This development is followed by a Pilot Test of the instrument, measuring its function. The Pilot Test results, then allow the Questionnaire to be evaluated for reliability and repeated measures validity. The questionnaire's reliability provides the measure of its refinement. The subsequent refinement, and

development of the final version of the Critical Project Success Factors (CPSF) Questionnaire leads to the third phase of the Research Methodology.

The third phase of the research is to administer the refined Critical Project Success Factors (CPSF) Questionnaire to a sample group, representing the various sectors of the Design and Construction Administration service providers, in the building sector of the construction industry. The Questionnaire captures behavioral preferences to critical incidents. These behavioral preferences are then correlated with the results of the selected psychometric instrument's measure of personality inventory items.

5.2 Exploratory Study

The Journal of Management in Engineering published a paper authored by Holly M. Johnson and Amarjit Singh entitled *The Personality of Civil Engineers* (Johnson and Singh, 1998). The stated objective of the study was to develop a short form survey to type categorize the personality of Civil Engineers in a state agency, noting any distinction of characteristics between design engineers and construction engineers. It is the basic work of Johnson and Singh that is used in this research as the Exploratory Study, testing for replication of the results.

The purpose of the Exploratory Study was to "test the test" with a control group, to determine if a short form, modified MBTI, psychometric instrument, would capture both personality types and behaviors within a single instrument. This evaluation is accomplished through administering the Johnson test to a control group. This is then followed with the administration the official MBTI® instruments (Form G and Form M) to the control group. The results are then compared and contrasted.

The Exploratory Study goal is to determine if a 'modified, short-form" MBTI can accurately and consistently determine a person's Type.

The reported MBTI Types of the Johnson modified MBTI Questionnaire were evaluated against the reported Types of the control group. The reported Types of the members of the control groups, 12 members common between the groups, are presented in Table 5-1. In addition to the Johnson Questionnaire, the control groups completed both the MBTI Form G (N=12) and Form M (N=19) instruments, as published and distributed by the Consulting Psychologists Press, Inc.

Table 5-1 Comparison of MBTI® Scores with Johnson and Singh Study

Respondent	ASCE J. Test Johnson, et al.	MBTI Form G	MBTI Form M	Agreement on Personality Dichotomies		
				S&J/Form G	S&J/Form M	Form G/Form M
1	ENFP	ISTP	INTP	1	2	3
2	ESTJ	ESFJ	ESFJ	3	3	4
3	INFJ	ESTJ	ESTJ	1	1	4
4	ESFP	ESTP	ESTP	3	3	4
5	ESTJ	ISTJ	ISTJ	3	3	4
6	INFJ	ISTJ	ISTJ	2	2	4
7	ISFJ	INTJ	INTJ	2	2	4
8	ENFP	ENTJ	ENTP	2	3	3
9	ISFP	ISFJ	ESFJ	3	2	3
10	ISFJ	ISTP	ISTP	2	2	4
11	INTP	ISTJ	ISTJ	2	2	4
12	ESFJ	ISFJ	ISFJ	3	3	4
13	ISFJ	No Form G	INTP		1	
14	ESFJ	No Form G	ESTJ		3	
15	ESTJ	No Form G	ESTJ		4	
16	ESFJ	No Form G	ISFP		2	
17	INFJ	No Form G	ISTJ		2	
18	ESTP	No Form G	INTP		2	
19	ISFJ	No Form G	ENTJ		1	
Dichotomy Agreement with the (3) Three Test Forms – Johnson, MBTI Form G and M				S&J/Form G	S&J/Form M	Form G/Form M
				56.25%	56.58%	93.75%

The results of this Exploratory Study demonstrate poor agreement between the Type reported in the Johnson study, and that of the CPP published MBTI® instruments (Forms G

and M). The ideal agreement on Type would have shown a consistent "4" in each column, representing complete agreement between all four of the measured personality dichotomies.

Evident in Table 5-1, the results of the Johnson study's modified MBTI classification, while reported to be internally consistent within the Johnson research study's test objective of job class discrimination, offer no reliable prediction of the Type captured in the official MBTI® instruments. The results of 56.25% and 56.58% offer a consistency of little more than chance (50/50). On the other hand, the test / re-test results of the two forms of the MBTI® instruments offers a 93.75% reliability. This is consistent with the reported results by the Consulting Psychologist Press (CPP), which range from 94% to 97% (Myers, et al., 1998).

These findings in the Exploratory Study lead to the conclusion that use of the published questionnaire of Johnson and Singh is not appropriate for the present research. While the basic concept of job discrimination and reported personality Type held promise, the use of the Johnson questionnaire would prove unreliable as a tool to measure the true and consistent personality dimensions of the MBTI® theory of Jungian psychology.

The decision resulting from this Exploratory Study was for this researcher to become trained and authorized to administer and interpret the Form M of the Myers-Briggs Type Indicator® (MBTI). It was the decision to utilize the officially published and tested MBTI® Questionnaire for the determination of personality dichotomous types and scalar measures of personality traits of the full research sample.

5.3 Questionnaire Development and Pilot Study

With the psychometric instrument selected for the measurement of personality characteristics established as the Form M-MBTI®, the second step in the Methodology is to

develop an instrument to measure the critical behavior patterns within the design sector of professional services. The measure of success or failure, in the day to day behaviors of the design professionals, needs to be captured in a reliable and valid behavioral assessment instrument.

The procedure for the development of the Critical Project Success Factors, or Critical Incidents, within the Questionnaire is an effort that relies primarily upon the research of other investigators. Numerous studies have been conducted, and are reported within the various professional journals, that identify success factors in the design profession. It is these previous research studies, and various professional practice guide documents, that are the primary sources of the questions that formed the initial Pilot Study CPSF Questionnaire.

The initial development of the proposed CPSF Questionnaire was accomplished through the refinement of what are referred to as critical incidents. These "critical incidents" are captured within the confines of successful performance actions. The successful performance actions, are as reported by the numerous researchers in the literature review sub-section 2.7, "Properties for the Measurement of Project Success: Critical Success Factors". A total of 52 potential questions were compiled and organized within the professional service domains of; *project planning*, including conceptual design and client interaction; *project design*, including the detailed preparation of contract documents; *project construction administration,* from the design office; and finally the overall *management of the design firm's activities*. These four service domains account for the majority of the work accomplished in the design sector of a building project. Please refer to Appendix C-1 for a complete copy of the original 52-item Questionnaire.

The questions were specifically developed from the works of eleven research studies and professional guidance document reports. There is considerable overlap between the research work of these authors and others (Carr 1997, Construction Industry Institute 1991, Construction Industry Institute 1994, Crowley 1996, Dias, W. P. S. 1990, Hakim and Wittenborn 1998, Lester and Bombaci 1984, Lutz, Hancher, and East 1990, Pocock, Hyun, Liu, and Kim 1996, Saarinen and Hobel 1990, Sanvido, et al. 1992).

For an example of the development of a specific question within the Questionnaire, Pocock's research on project interaction is offered (Pocock, et al., 1996). Pocock found that " (i)t is generally accepted that project performance can be enhanced when the interaction occurs on a regular basis, beginning at an early stage in a project, in an open and trusting environment" (Pocock, et al., p.165). He goes on to state "(m)ost engineers and architects could benefit from contractor input, but contractors are not usually involved in a project until bidding. They work from completed drawings and specifications without having had any input to their contents" (Pocock, et al., p.165). It is further presented that one of the "critical factors" identifying successful projects is "constructibility…information from and available to the project team in a timely manner" (Pocock, et al., p.166).

As an example of the type of critical incident inquiry of the Questionnaire, the Pilot Study sought a response to the following situation:

14. D. When completing the <u>Design</u> on a project, how important is it that it be reviewed by, and input received from suppliers and contractors,…? (Dias and Pocock)

A	B	C	D	E *
Minimal Importance	Most of the time – A)	Some of the time – A)	Most of the time – E)	Great Importance

This question is keyed for evaluation, where the "correct" answer is indicated with the asterisk. The five point Likert-scale was used to evaluate the scores of the respondents in the Pilot Study. This is one of the original 52 questions used for exploration in the Pilot Study. Fifty-one other questions were developed covering all four sectors of the design services areas, planning, design, construction and management. These questions, in their complete original form, are presented in Appendix C-1.

These questions were then administered to a group of thirteen (N=13) A/E executives in a Pilot Study, to provide the data for Questionnaire exploration, evaluation and refinement. The Pilot Study was accomplished, and the results were employed in the investigation of the Questionnaire's reliability. This work allowed the investigation of the correlation of personality traits measured in the MBTI®, with the Questionnaire's scalar performance measures. The Table 5-2 presents the results of the Bivariate Correlation of the Pilot Study test:

Table 5-2 Correlation of Original Questionnaire (Q=52) and Sample of Pilot Study Architects, Engineers, Surveyors and Construction Administrators – Sample N=13

		Extraversion (-) Introversion (+)	Sensing (-) Intuition (+)	Thinking (-) Feeling (+)	Judging (-) Perceiving (+)
Planning -	Pearson Correlation	.054	.043	.456	.497 *
	Sig. (2-tailed)	.862	.888	.117	.084
	N	13	13	13	13
Design -	Pearson Correlation	.480 *	-.422	.119	-.249
	Sig. (2-tailed)	.097	.151	.700	.412
	N	13	13	13	13
Construction	Pearson Correlation	.390	.696 **	-.191	.214
	Sig. (2-tailed)	.187	.008	.531	.483
	N	13	13	13	13
Management	Pearson Correlation	.344	-.184	.339	-.343
	Sig. (2-tailed)	.250	.548	.258	.252
	N	13	13	13	13

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.10 level (2-tailed).

As shown in Table 5-2, the Pilot Study results offer a significant correlation between personality characteristics, as captured in the Form M MBTI®, and the 52 Item Critical Incident Questionnaire. As an example, the measured behavior of the pilot group towards Construction phase incidents, is positively correlated with the personality preference for Intuition (Sig.< 0.01).   This is shown with a Pearson Correlation of +0.696**, indicating the direction toward Intuition, (+), as a positive correlate with a higher score on the construction questions of the CPSF Questionnaire. As a second interpretive example, the Sensing, (-), preference is correlated within the design questions in a non-significant relation (Sig. > 0.10). Even though there is a tendency for Sensing (-) to yield a higher score in the design questions, with a significance of 0.157, the findings in the Pilot Study offer only a suggestion of "approaching significance." This is indicated with the negative correlation, which indicates the direction of higher performance. In this example, a sensing personality tends toward improved design performance.

With the results obtained that correlation existed in the Pilot sample, the next stage of the research is to validate the Questionnaire. This is accomplished through an investigation of reliability, internal consistency and the validity of repeated measures.

In addition, the question of balance within the Questionnaire is considered. This is an inquiry of whether the Questionnaire presents a balanced collection of critical incidents, relative to the various questions' implied personality dichotomies and the professional service categories.

The draft Critical Project Success Factors (CPSF) Questionnaire was a "work in progress" throughout this research work's early stages. The Questionnaire's initial purpose was an attempt to capture, through a review of the current literature, what were

the documented issues that would define successful and less successful behaviors in the design and construction industry today. Each question had an accessory implied dichotomy of *success* or *failure*. This subsidiary "success or failure dichotomy" is the heart of the scoring of the "CPSF's" Questionnaire. Within each question, it is the thesis of the research that there is also an "implied association" with a dimension of personality, as captured in the Myers-Briggs Type Inventory, (MBTI®).

This approach to the research, the use of a Questionnaire to seize a respondent's preferred course of action, was intended to capture a pattern of behavior and performance within various categories of service. This research performed an evaluation of the Questionnaire to determine if it could accurately reflect the true "pieces" of what we intend to measure.

If it is the intent of the instrument to measure success and failure related to dimensions of personality, categorized by areas of service, then the Questionnaire must be properly balanced and of sufficient statistical power to measure these qualities. The concept of the Questionnaire was to capture a respondent's demonstrated inclination towards a particular pattern of behavior, within a service category (Planning, Design, Construction Administration or General A/E Managerial activities). This pattern may then be scored against researched success profiles, which in turn may be evaluated against tested dimensions of personality as measured in the MBTI®.

Unfortunately, the measurement of these behaviors is not a computation of a hard quality index. Such hard measurements, in contrast, might include items such as the number and/or value of Change Orders on a project (budget issues). It may be a measurement of schedule growth on a project (schedule issues). These measurements,

studied by others, have formed the basis of many of the inquiries of the Questionnaire. While measurements, such as schedule and cost growth were used in much of the research found in the literature, from which the Questionnaire was developed, they are not the direct metrics used in this survey. The metric used in this Questionnaire is more subjective. This Questionnaire results in a soft measure of perception, attitude and behavioral patterns to critical incidents.

The purpose of the Questionnaire is to formulate a comprehensive list of the important quality dimensions of an individual's behavior, in various service categories. Thus, it was important to ensure that each of the *service categories is balanced and represented*, and that each *dimension of personality is balanced and represented*. Furthermore, it is important that within each of the categories, the personality dimensions are balanced in accordance with the hypothesis and measurement goals of the research. These are the elements investigated in the following sections.

5.3.1 Dichotomies Implied in the Questionnaire

The dichotomy of personality implied in each of the Questionnaire's items might remain open to subjective judgment and expert opinion. What is "implied" to one, experienced in the use of Type, may or may not be implied to another. Each dimension of personality might be inferred in each question, related to a "critical incident" as described in each question. Within any critical incident question, an individual's behavior may be driven by each of the MBTI® personality dimensions. How one deals with the outside world (E/I), how one prefers to collect information (S/N), the values one uses in reaching a conclusion (T/F) or, whether or not one moves to close the issue or option (J/P), can easily impact behavior. The challenge then becomes, which of these

dimensions of personality, captured in the MBTI®, is the strongest driving force in each critical incident question. The most powerful MBTI® personality dimension is defined as the "implied" dichotomy associated with each question.

The question used in the following example, and explored here, was originally developed from the Construction Industry Institute (CII) Source Document No. 19, "Input Variables Impacting Design Effectiveness", January 1986. In this CII study, there were simple inquiries as to which factors influenced the success of a project most. The CII Document provides a list of factors in descending order of consequence, as determined through their research.

28. P. What is more important in the success of a project?(CII)

A	B	C	D	E *
Project Pre-Planning Effort	Most of the time – A)	Some of the time – A)	Most of the time – E)	Owner Experience

J/P: Systematic Discipline vs. Receptivity and Openness

When this question is inspected, it could be argued that it implies Extraversion/Introversion. If an individual prefers Introversion, he or she may suggest that success will be found internally, not needing to rely on the external activity of dealing with the experience of the owner. Likewise, it may imply to some that the Pre-Project Planning will yield success as a matter of factual data collection, while to others the Owner's Experience may offer connections and alternatives that will contribute to success. Therefore, it might then be held that this question implies an association with the Sensing/Intuition dichotomy. Further, this question may be inferred to suggest an associated dichotomy of Thinking/Feeling. If one were to hold a preference for Thinking (T), it could be viewed that Pre-Project Planning will itself yield success, with or without

an Experienced Owner. A preference for the Feeling (F) dimension, would suggest the recognition of the importance of the owner's values and experience to a successful outcome.

The method used in this research study, for the identification of the "implied dichotomy", is to refer to the Pilot Study. In Question 28 of the Pilot Study, it was none of the dichotomies outlined above that was implied with statistical significance, but rather it was the dimension of Judging/Perceiving. While there was a tendency toward identification of success by those with a preference for Introversion (sig. = 0.394); Sensing (sig. = 0.585); and Feeling (sig. = 0.522); it was the Perceiving preference that was statistically significant (sig. = 0.041*). In the Correlation Analysis of Appendix C-4, the item labeled VAR00028 refers to Question 28.

One view of the implication of the success in this question is that one might believe that only with the input of an experienced owner would overall success be achieved, even if it means postponing the planning effort's completion. Therefore, the implied dichotomy in this question, identified in and supported by the Pilot Study, is the Judging/Perceiving preference, with a prediction of higher performance with a preference towards Perceiving.

This method of identification of the "Implied Dichotomy" was followed for each of the questions. The results of this investigation are presented in Table 5-3. While not all of the questions yielded statistical significance of <0.05, each question was analyzed to identify the dichotomy that yielded the strongest association, and was thus identified.

Certain questions carried an implication of being driven by more than one dimension of personality, but it was the strongest relationship that is included in this

preliminary assessment of the "Implied Dichotomies." Those strongest identified "Implied Dichotomies" are noted in the Factor-Analysis of Appendix C-4, and are shown in Table 5-3, with the mark of an "X".

Table 5-3 Identification of Survey Question's Implied MBTI® Dichotomy

Question Number	MBTI Personality Dimension				Question Number (con't)	MBTI Personality Dimension			
	E/I	S/N	T/F	J/P		E/I	S/N	T/F	J/P
1			X		27				X
2				X	28				X
3			X		29		X		
4			X		30		X		
5			X		31		X		
6			X		32				X
7	X				33	X			
8		X			34				X
9				X	35			X	
10				X	36		X		
11	X				37			X	
12				X	38				X
13	X				39				X
14				X	40			X	
15				X	41	X			
16			X		42		X		
17	X				43	X			
18		X			44		X		
19		X			45				X
20	X				46			X	
21	X				47	X			
22				X	48	X			
23				X	49	X			
24			X		50				X
25		X			51			X	
26			X		52				X
						E/I	S/N	T/F	J/P
					Totals	12	10	13	17

The Questionnaire evaluation continued with the mapping of the Dichotomies. This was accomplished by modifying the Pilot Study Questionnaire, in that the preferred answer to the critical incident question was identified with a letter A, B C, D or E. A scoring template was based on a five-point Likert scale with a numerical value associated with the respondent's selected letter. A score range of 1 through 5 was assigned for each of the questions, with 5 associated with the "successful" or "correct" answer, and 1 being assigned to the "unsuccessful" or "wrong" answer. The Questionnaire was then scored by area of service. The identified areas of service in the A/E industry are Planning, Design (Construction Documents), Construction Administration and General A/E Management of the Design Firm. Each area of service was scored and analyzed independently.

Appendix C-1 contains the original 52-item questionnaire "mapped" by area of service and implied personality dichotomy based on the results of the Pilot Study. Each of the questions identifies the following information: which Dichotomy is implied in the question (from the Pilot Study); the "correct" direction of the dichotomy (underlined); which answer is the "right" answer (yielding a score of 5, and identified with and *). In addition the service area that is investigated, is identified with the letter after the question number (i.e., P = Planning; D = Design, etc.). This mapping allowed the research study to ensure that an overall balance existed in this Questionnaire.

In order to develop the Raw Point Ranges for each of the Dichotomies, it is necessary to identify the "strongest" dichotomy driving each question, and then associate that dimension with the a success or failure selection. As an example, if an individual holds a preference for Extraversion, the highest score of the Raw Score Range that this individual could theoretically achieve on the Questionnaire would be if he had selected a

5-point choice for each question where Extraversion or Introversion was the "correct" direction of the implied dichotomy. The lowest score of the Raw Score Range this individual could achieve would be if he selected the "wrong" answer for each of the Extraversion and the Introversion questions, and was assigned a score of 1 for each. Since there are a total of twelve questions where the Extraversion/Introversion Dichotomy is the strongest, (statistically, the most powerful dimension from the Pilot Study), the Raw Point Range for the E/I questions would be a low of 12, to a high of 60.

Since it is a basic premise of the research that people will choose an answer in the direction of their personality preference. While the Range may be 12 to 60, the actual score expected will fall within this range. It is anticipated that those with a preference for Extraversion will select the "correct" answer on the Extraverted favored E/I questions, scoring 5 points each. Additionally, that Extraverted individual, when faced with an Introversion "correct" question, will likely choose the wrong behavior (answer), and score only a 1. These scores form the predicted "toy" scores in Appendix C-3. This evaluation allows the exploration of a balance in the distribution of questions.

As presented in Appendix C-3's Raw Score Range, with each question there was selected and awarded a score of 1 or 5. These scores were awarded to the implied dichotomy, and the direction of the dichotomy, from the Pilot Study results. For example, in question 1 of the Questionnaire (Appendix C-1), the "Implied Dichotomy" is Thinking/Feeling, and the direction is Feeling as underlined (Appendix C-4, VAR00001, Correlation of –0.491, meaning F). Therefore in Appendix C-3, (T), Thinking receives 1 point and (F), Feeling receives 5 points. At the bottom of the Table, the Grand Total Predicted Score presents the predicted scoring of each dichotomy. Again, by way of

example we could predict that an ESTJ would have an overall score on this Questionnaire of 156 points, (E-32; S-38; T-37; and J-49). It can be seen that the Questionnaire is reasonably balanced with the national sample of percentages in each personality preference (Myers, 1998, MBTI® Manual, p. 298). In Appendix C-3 it can be observed that the lines *Percentage of Grand Total*, indicating the percentage of questions favoring a particular preference, are in balance with the *National Sample Percentages* (Figure-2-1, Chapter-2). This *National Sample Percentage* indicates the percentage of people in the United States with a preference for that dimension. When these percentages are viewed in light of the national sample's average, in the general population, the balance of questions favoring each preference may be judged.

By way of an example of the questionnaire's development effort to achieve balance, the range for the E/I Dimension has a high possible score of 60 (12 questions with an "Implied E/I Dichotomy" at 5 points each) and a low of 12 (12 questions at 1 point each). The average score within this Range is the 36, or ((32+40)/2)). The predicted score for this Dichotomy, assigning 5 points to each question with an Implied Dichotomy of E/I, and a preference indication of Extraversion, is 32 (44.4% of the questions) and Introversion, is 40 (55.6% of the questions). This indicates a reasonable balance with the percentages of the general population, at 49.3% Extraverts and 50.7% Introverts. The Sensing/Intuition dimension is also closely balanced, while both the Thinking/Feeling and Judging/Perceiving dimensions are well balanced. In all, the Questionnaire is judged to reflect a reasonable balance, both within, and between the dichotomies.

Through the exploration of the Implied Dichotomies, it has been shown that overall there was a reasonable balance and representation of the MBTI® dimensions of personality, both in the dichotomies, and the direction of preference in the Pilot Study CPSF Questionnaire.

5.4 Reliability and Validity Analysis – Questionnaire Refinement

In order to develop a powerful Questionnaire that measures what it is intended to measure, in a valid and reliable fashion, certain methods and procedures are undertaken to ensure this is the case. The primary effort of this sub-section of the Research Methodology, is to refine the Questionnaire, and remove those items that on the surface offer face validity, but through the Pilot Study were identified as being poor discriminators of personality and behavioral patterns. This is accomplished through a statistical evaluation of the reliability of the Questionnaire's items.

The computation of a *reliability coefficient* provides an estimate of the consistency of respondent's scores along a meaningful continuum (Stodola, 1967). Clearly for the results of the Questionnaire to be meaningful, they must report differences which are a true measure of variations in character, rather than reporting that which is attributed to chance. It is here that this research explores the *reliability* of the CPSF Questionnaire.

The approach taken is to evaluate the entire set of 52 test items of the Questionnaire, considering the measures of the personality traits scored in the pilot-study of thirteen design industry executives. The correlation analysis offered confirmation of the implied dichotomies of the MBTI, with the various questions of the instrument. Does the Questionnaire actually measure and track with the four dichotomies of the MBTI?

For example, if within a question there is an implied dichotomy of the Extravert/Introvert attitude of the MBTI, is the question answered consistently by those respondents with either Extravert or Introvert personalities? Is there a high degree of *reliability* computed for each of the eight-(8) elements of personality? The personality traits explored in the MBTI®, as explained in previous sections, of *Extravert, Introvert; Sensing, Intuition; Thinking, Feeling; Judging and Perceiving*, when identified, join to form a personality Type.

5.4.1 Reliability

The evaluation of the *reliability* of the draft 52 item Questionnaire is to conduct a *factor analysis* of the questions. This is conducted on the questions identified as test items of each factor, or group, used in the evaluation (i.e. Planning, etc.). This *factor analysis* allows the observation of those test items, or questions that were inter-correlated. Those items that are inter-correlated are then grouped; confirming or rejecting the assignment of the Questionnaire items based on *critical incidents.* As the positive inter-correlation of questions is identified, the Questionnaire is refined through selection of the more powerful items, or conversely the removal of items weakly correlated. This is a multi-step activity, with the objective to improve the instrument's overall reliability, through the removal of items with weak value of discrimination. This process will begin to reduce the number of questions in the CPSF Questionnaire, from the initial 52, to some final form number of questions.

The Questionnaire items are evaluated within the SSPS statistical program for *Repeated Measures and Reliability*. Considering the sample size, (N=13), and the "pilot" nature of the Questionnaire, the task of this sub-section of the Methodology is not to

"validate" the instrument, but rather to adjust and improve the instrument's (Questionnaire's) *reliability*.

In order to improve the Questionnaire's reliability, the inter-correlation output of the questions is studied. These original inter-correlation results are included in Appendix C-11. The exploration of the test items (questions) is conducted to determine if there are particularly strong and/or weak inter-correlations. The next action selects the weakest of the questions, removing them from the next phase analysis. It is here that the alternative of *validity* of the Questionnaire might be improved. In order to increase validity and reliability, either the removal of the "worst items" (Smith, 1934), or the future re-wording of the items, could capture more reliably the performance, and behavior of a critical incident, which formed the initial basis for the item. Since a semantic differential might result from a "re-wording" of the questions in the Questionnaire, and might distort the results being evaluated, the simple removal of the weak items from the factor's group was the method chosen. The removal of the "weak" items then allowed for the re-evaluation of the *reliability test.*

Once this is completed, the results are examined again, modified and re-tested a third time for *reliability.* These results of the improved reliability are shown in Table 5-4.

The reliability of the Questionnaire in its various, and improved forms, is evaluated using the SSPS Statistical program's feature of *Repeated Measures and Reliability.* Table 5-4 reports the results of the *alpha-value reliability* tests for the three iterations of Questionnaire refinement. This successive improvement is noted, as weak questions are removed from the instrument, from the original 52 items, to 42 items and then to the 33 final items. These results demonstrate a continuing positive improvement

in the instrument's *reliability* across each service area. These improvements are noted with each successive iteration.

Table 5-4 Critical Success factors Questionnaire Refinement (*Alpha values)

TABLE of RESULTS:	Planning	Design	Construction	Management.
1.FIRST RUN QUESTIONS	0.4276	0.0190	0.1509	-0.6234
Number of Items	(13)	(19)	(10)	(10)
2.INITIAL REFINEMENT	0.6746	0.5898	0.5311	0.2428
Number of Items	(11)	(14)	(9)	(8)
3.FINAL ELIMINATION *	0.7292	0.7101	0.6454	0.5691
Number of Items	(9)	(10)	(8)	(6)

The results of the Questionnaire refinement are demonstrated in Table 5-4. There is an overall improvement in the *Reliability* of the Questionnaire with the initial re-ordering of the Questions within each group or factor. The first iteration (1. First Run Questions) of the reliability analysis is for the test items as originally written (all 52) and identified for the various factors (Planning, etc.).

As stated above, there is a subsequent attempt at improvement (2. Initial Refinement) in the *Reliability* of the Questionnaire, with the elimination of the test items (questions) that demonstrated low, or weak inter-correlation with the other items of each particular factor or group. The third, and final trial, for the improvement in the Questionnaire's reliability (3. Final Elimination) is the most effective effort, with the removal of the items of questionable reliability, as demonstrated in the pilot study inter-correlation analysis. With *alpha values* ranging between 0.57 and 0.73 the instrument's ability to ensure reliability, based on the Pilot Study results, is established.

For the research to be effective, the Questionnaire needs to be *Valid, Reliable* and offer *Repeatable Measures* that may be replicated through any of the standard means: split sample, test/re-test and the like.

The overall Questionnaire is thus reduced from an initial group of 52 questions to a final of 33 "reliable" test items. The Pearson Correlation Analysis of the Pilot Study group (N=13), comparing the final Questionnaire Items with the MBTI® personality trait scores is presented in Table 5-5.

Table 5-5 Pearson - Correlation of Refined Questionnaire (Q=33) and Pilot Study Architects, Engineers, Surveyors and Construction Administrators Sample N=13

		Extraversion (-) Introversion (+)	Sensing (-) Intuition (+)	Thinking (-) Feeling (+)	Judging (-) Perceiving (+)
Planning -	Pearson Correlation	0.147	-0.133	0.683 *	0.177
	Sig. (2-tailed)	0.632	0.664	0.010	0.563
	N	13	13	13	13
Design -	Pearson Correlation	0.481	-0.386	-0.100	-0.315
	Sig. (2-tailed)	0.096	0.193	0.746	0.294
	N	13	13	13	13
Construction	Pearson Correlation	0.365	0.613 *	0.002	0.575 *
	Sig. (2-tailed)	0.220	0.026	0.995	0.040
	N	13	13	13	13
Management	Pearson Correlation	0.105	-0.163	-0.226	-0.565 *
	Sig. (2-tailed)	0.734	0.594	0.457	0.044
	N	13	13	13	13

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

This analysis presented in Table 5-4 shows a marked improvement in the CPSF Questionnaire's reliability, while removing 19 weak items (questions). The correlation presented in Table 5-5 demonstrates no significant loss in the strength of the relationship between performance measures and personality, using the final 33 item Questionnaire, compared to the pilot study results, using all 52 original test items (Table 5-2). As an example, it may be observed that in the Design category of performance measures, the relationship between the Extraversion/Introversion dichotomy remains unchanged in the

52 item correlation and the 33 item correlation, (0.480, sig. = 0.096 versus 0.481, sig. = 0.097). As the Questionnaire's reliability increases with its refinement, the Construction phase questions revealed an improvement in the Judging/Perceiving dichotomy, (0.575, sig. = 0.044). These examples demonstrate the consistency of the Questionnaire's correlation of personality and behaviors in the pilot study sample, while improving the Questionnaire's reliability.

The previous paragraph addresses the question of the relationship and impact of improved *reliability,* with instrument *validity*. It is demonstrated that the questions offer a positive and reliable relationship to internal consistency of the instrument. A respondent, who answers in one direction on one of the grouped test items, is likely to respond in a similar fashion on the other questions. The Questionnaire's *reliability* is improved through the elimination of the 19 "weak" questions. The questions that have been removed from the original questionnaire are presented in Appendix C-2.

5.4.2 Validity

The *validity* of the Questionnaire is its ability to measure what is intended for measurement (Thorndike, 1997). In this case, the measurement is the behavior or performance of a respondent in a successful, or less successful manner. *Reliability* is the consistency and precision of the Questionnaire. For valid research, the instruments used must be statistically reliable (Glass and Hopkins, 1996). In the previous sub-section of the Methodology, the effort to investigate, evaluate and improve the *reliability* of the Questionnaire is demonstrated. This effort, however, does not examine the instrument's *validity*. The Literature Review, and the research of others, defines successful behaviors in the design and construction industry. As presented in earlier sections, this research was

used in the formulation of the original 52 *"critical incident"* questions. While the data presented in Table 5-4 demonstrated *reliability,* this does not address the instrument's *validity*. It is through the evaluation of the instrument (Questionnaire) by means of correlation with the collected MBTI scores of the pilot study respondents, that the existence of continuing *validity* can be detected. These results are presented in Table 5-5 above, and discussed previously.

In addition, the correlation test of the factored, or ranked responses to the test items (Planning, etc.), and the "scaled" scores of the pilot study respondent's MBTI data is performed. This is presented in Table 5-6.

Table 5-6 Spearman Rho - Correlation of Questionnaire (Q=33) and Pilot Study Architects, Engineers, Surveyors and Construction Administrators Sample N=13

Spearman's rho		Extraversion (-) Introversion (+)	Sensing (-) Intuition (+)	Thinking (-) Feeling (+)	Judging (-) Perceiving (+)
Planning -	Pearson Correlation	.083	-.077	.713 **	.254
	Sig. (2-tailed)	.788	.803	.006	.402
	N	13	13	13	13
Design -	Pearson Correlation	.405	-.399	-.083	-.180
	Sig. (2-tailed)	.170	.176	.788	.556
	N	13	13	13	13
Construction	Pearson Correlation	.280	.793 **	-.170	.501
	Sig. (2-tailed)	.354	.001	.580	.081
	N	13	13	13	13
Management	Pearson Correlation	.050	-.317	-.186	-.627 *
	Sig. (2-tailed)	.871	.291	.542	.022
	N	13	13	13	13

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

In this case, there is supplementary evidence of the pilot-test research hypothesis validity. When subjected to the "scaled" scores in the Correlation analysis, both the Pearson Correlation (0.683*, sig. = 0.010), from Table 5-5, and the Spearman Rho Correlation (0.713**, sig. = 0.006), from Table 5-6; demonstrate a powerful connection between the test items and the *Feeling* component of the MBTI.

The Construction group of questions provided broad based significant results. The Pearson Coefficient favored both the *Intuitive* function (0.613*, sig. = 0.026) and the *Perceiving* attitude (-0.575*, sig. = 0.040). The Spearman Rho of (0.793**, sig. = 0.001) for *Sensing/Intuition* supported this finding; while the *Judging/Perceiving* measure of Spearman Rho approaches significance, (0.501, sig. = 0.081).

For the Management factor, the Pearson Coefficient of (-0.565*, sig. = 0.044) and the Spearman Rho of (-0.627*, sig. = 0.022), correlate with the MBTI *Judging* attitude.

Thus, the questionnaire finds support as both, a reliable and valid test instrument when evaluated for the pilot study data. Its reduction, from the initial 52-item matrix to a 33 item Questionnaire, resulted in a substantial increase in internal consistency and reliability, while maintaining the Questionnaire's validity.

The final version of the "33 Item" Questionnaire is included in Appendix B of this research study.

5.5 Focal Study

With the selected psychometric instrument, the Myers-Briggs Type Indicator ® Form M, and the finalized version of the Critical Project Success Factors Questionnaire, the focal study of the research work could be undertaken. The administration of these two research instruments would provide the data for testing the research hypotheses.

5.6 Subjects

It is generally recognized that the suitability of the data collected for use in any survey or questionnaire emerges from the choice of the people selected to respond (McCormack and Hill, 1997). In the case of this research, the population of interest comprises the entire group of professionals engaged in the performance of duties within

the planning, design and construction administration phase services of the general building segment of the construction industry. It is clearly not practical that this entire, or even the bulk of this population can be surveyed. The steps for conducting this research involve the identification of a sampling pool, and the verification that this pool is representative of the population of interest.

In order to set a global sampling frame, a list of firms, and professionals, drawn from the population of interest was established. There are a number of national organizations that comprise the population of interest. These organizations include *The American Consulting Engineers Council, The National Society of Professional Engineers, The American Society of Civil Engineers and The American Institute of Architects.* These four national professional societies comprise the "sampling frame" for our "population of interest".

The method used in the sampling and application of the psychometric instrument (MBTI, Form M) and CPSF Questionnaire is not a random method, but rather a non-probability sampling approach (McCormack and Hill, 1997). The primary element that limited the selection of the final sample, and the subsequent application of the investigative instruments, was a decision of the management of each viable and invited firm, for or against participation.

Member firms of the American Consulting Engineers Council were recruited for participation in this research study. Representatives of five firms participated in the study. The "compensation" for participation was feedback on the respondent's personality profiles, as measured with the Myers-Briggs Type Indicator. The ethical use of Type, and an essential aspect of the promotion of the Type theory, is the feedback

given to respondents. This feedback and individual counseling has been available to all respondents, in strict accordance with the standards for the "Ethical Use of Type", as published and distributed by the Association for Psychological Type.

Five firms offering engineering, architectural and construction management services agreed to participate in the study. The firms were located in the northeast, with offices in Boston, Philadelphia, Buffalo, Utica and Syracuse. Four of the five firms had branch offices, also primarily in the northeast.

According to Engineering News Record (April 10, 2000), 96 of the 100 Top design firms in the United States provide planning, design and construction administration in a full-service business format. These full-service activities encompass planning, conceptual design, design development, detailed design (architecture, civil, structural and MEP engineering), construction documents, bidding, negotiation, construction administration and start-up supervision. This is in contrast to the sometimes mistaken view that engineering and/or architectural design is predominantly provided by firms with singular specialties. Seventy-one of the ENR Top 100 Construction Management firms were engineering design firms, while less than 30% are reported to be construction firms. Thus, a major component of the professional services offered by the engineering design community includes construction administration in the form of Construction Management.

As such, the sample selected for participation in this research was from the broad market of full-service firms. It was a requirement that the participating firms offer engineering and architectural planning and design services. In addition, each firm was

required to offer as a significant component of their services, the management of the construction process, within an agency relationship with the projects' owners.

The following Table presents the service offering of each of the firms who participated in this research.

Table 5-7 Service Offerings by Research Sample Firms

Firm	Services			
	Planning and Concept Design	Detailed Design, Plans & Specs	Construction Administration	Construction Contracting
1	X	X	X	X
2	X	X	X	
3	X	X	X	
4	X	X	X	X
5	X	X	X	
Firm	Planning and Architecture	Civil & Structural Engineering	M, E & P Engineering	Construction Management
1	X	X	X	X
2	X	X		X
3	X	X		X
4	X	X	X	X
5	X	X	X	X

This population sample offers a somewhat homogeneous group of professionals. In many respects, the sample's cognitive abilities will offer some consistency, since all study participants have achieved a similar level of professional attainment. This is also true of education, both type (technical) and intensity (college). The design professionals all work in the same industry, have achieved a similar level of responsibility, and are architects, engineers, surveyors or construction administrators involved specifically in the building process.

The suggestion of Jerry Burger has thus been addressed, to make the theory and subsequent experiment *parsimonious* (Burger, 1997). Burger's contention is that the simplest theory to explain an outcome is the most appropriate.

With this in mind, the selection of professionals for the application of the MBTI® psychometric instrument was based upon individual assignments within their respective organizations, and their duties within project groups or teams. A randomly selected sample, representing various project teams, was invited by the target firms' management to participate in the study. The sample necessarily included individuals who perform the planning, design, construction administration and general managerial duties within the sample firms.

The total number of employees of the participating businesses exceeded 500. The number of technical employees of these firms is somewhat less than 300. Of those employees, the internal criteria for the principals making the final selection of the participants, within their respective businesses, was that the research sought project managers and above. Within the design sector of the construction business, this designation generally means those employees in responsible charge of the planning, design or construction administration of public works. The principals identified, and invited 136 project managers to complete the MBTI and the Questionnaire. Of those, 98 completed forms were returned. Of the 98 returned, 85 were completed adequately for inclusion within the study. In the event that there was missing information, such as age, education or sex, these items were verified and the information added by the researcher. When questions were not answered, either in the MBTI, or in the CSF Questionnaire, these responses were discarded, and not included in the sample. The average response

rate was 72%. Four firms ranged from 60% response to 100% response. One firm had a 35% participation rate. An inquiry was made of this firm, where the response rate was lower than the others. The answer was that they, as a business, were extremely busy during this period, and the low response rate was likely attributed to that. This firm was also in the process of relocating their main office during the two-month period provided to complete the instruments, attributing to the lower than expected response. The principal in this firm declined the re-distribution of the Questionnaires to the non-respondents.

The first step of the research effort had the engineers, architects and project managers complete the Form M of the Myers-Briggs Type Indicator. The second step of the study's data collection was for each of those respondents who completed the MBTI, to then complete the Critical Project Success Factors Questionnaire. Once completed, each was placed in a sealed envelope by the respondent, and returned to Virginia Tech for inclusion in the research.

The sample provided 85 subjects (86% male n = 73; 14% female n = 12). The professional distribution was 22% architects (n=19) and 58% engineers (n = 49), 6% surveyors (n = 5) and 14% construction administrators (n =12).

The age range of the respondents was 22 years to 72 years, with the average age of 36.9 years. The average tenure (time in the current line of work) was reported to be 12.8 years, with a range of 1 year, to 41 years of experience.

Table 5-8 Research Sample Demographic Data

Research Sample Data				
	Number	Percentage	Range	Average
Male	73	86%		
Female	12	14%		
Architects	19	22%		
Engineers	49	58%		
Surveyors	5	6%		
Construction Administrators	12	14%		
Age			22 to 72	36.9
Tenure (years)			1 to 41	12.8

The question arises as to the size of the sample required for the research work. This consideration is one of the "power" needed for the statistical procedures to be employed in the study. The following summary outlines the considerations of sample size, statistical procedures and assurances of discovery of significance where such exists.

The primary concern of most statistical procedures is to maintain a high probability of avoiding an unsubstantiated finding of a "statistically significant result" where none exists. This is commonly referred to as avoiding a Type I error. The Type I error occurs when the experiment or research finds a positive result that is not true (convicting the innocent).

The second statistical error, a Type II error, occurs when there is a relationship between the elements being investigated, but no relationship is noted in the research findings. This is akin to letting the guilty go free. While a situation may exist that a false null should be rejected, it is possible that the statistical investigation may be unable to detect this result, and present such a finding, if there is inadequate evidence. The protection against this form of flawed research is to improve the experimental research

design, to ensure the investigation has adequate "Power" to detect the results if they do exist.

The evaluation of the Power of this research is to ensure an appropriate sample size. An adequate sample is needed to secure the detection of statistical significance where it exists, or, in other words, to assure the research design is powerful enough to reject a false null, Ho.

An essential consideration in determining the "Power" of an experiment, or research investigation, is the effect size. This is a function of the standard error, which is computed based on a particular sample size. This is, of course, the answer sought in the investigation of power. As such, absent a fixed sample number, there are other alternative methods of estimating the effect size.

Several methods to determine the Power of an experiment rely on data referred to as *special conventions.* While one may choose to use the approach of a *special convention*, one of the most reliable approaches is to use data from prior research. In this case, where the primary statistical approach is a correlation study, (the fundamental statistic of this research), the correlation coefficient, ρ, is the equivalent of the effect size, d**.** In the case of personality research, correlation coefficients in the range of 0.20 to 0.50 are not uncommon. The work of Barrick and Mount, Tett, et al., Myers, et al., and Ghiselli each offer numerous examples of such coefficients for "personality factors" studies. Table 9.15 (Myers, et al., p. 194) presents a correlation of the MBTI® with the *Kirton Adaption and Innovation Inventory* where the average ρ of 0.343 was significant. This example, along with reference to the works of other researchers, has led to the selection of a ρ of 0.35 for the sample size estimate.

The non-centrality parameter, δ, is a function of the effect size, d, and the sample size. If both the non-centrality parameter and the effect size can be established, then the recommended sample size can be estimated. The published "power" tables present the non-centrality parameter for different levels of significance desired. In the case of this research, an α level of 0.05 is selected for a two-tailed test. Additionally, the probability of experiencing a Type II error may be selected by the researcher, which is then used to determine δ, the non-centrality parameter. The minimum Power determined for this research to be acceptable was 0.80, or an 80% probability of the discovery of an effect, if one truly exists. In this case the parameter has been selected for this level of protection against a Type II, *80% Power*. This then yields a δ, non-centrality parameter of 2.80 for a two tailed α of 0.05 (95% confidence).

The sample size is then estimated from the following formula:

$$\delta = \rho \sqrt{N\text{-}1}$$
$$2.80 = .35 \sqrt{N\text{-}1}$$

or

$$(2.80/0.35)^2 + 1 = N = 65$$

Therefore, the minimum recommended sample size for the research being conducted was 65 participants. Since it is now established that the total number of responses to the MBTI® and the Critical Project Success Factors Questionnaire is 85, this response would present an experimental Power of approximately 89%. This analysis indicates that the design of this research offers appropriate Power against the occurrence of a Type II error. It also highlights the caution to avoid "splitting" the sample into sub-categories (i.e. Architects vs. Engineers, etc.) since the categorical sample size is thus

decreased, increasing the probability of encountering a Type II error. Thus, the primary evaluation of the data will be the simple correlation, comparing the entire set of responses indicating preferred behaviors (Critical Project Success Factors Questionnaire), with the personality traits of the respondents (MBTI).

Evaluating the data within a categorical context is possible. This will offer insight into data relationships, however, if the sample were split in half, the power of the experiment then drops from 89% to approximately 63%, increasing the likelihood of a Type II error. Continuing this example, if the respondent group were divided into four groups for analysis, the Type I error would continue to be protected by the statistical analysis chosen. However, the potential of a Type II error increases considerably, from 11% to over 65%.

5.7 Task

The MBTI Instrument and Critical Project Success Factors Questionnaire are to be completed by each of the invited participants. Specifically, the procedure is for each respondent to receive the MBTI Questionnaire and Answer Form from the designated source within each office, returning it completed in an envelope which is provided. Next, the Critical Project Success Factors Questionnaire is completed, and returned in a sealed envelope. These responses are then forwarded to the author's attention at Virginia Tech.

5.8 Comparative Study

This research attempts to address the performance issues in the design segment of the construction industry. This is accomplished through a combination of applying the standardized psychometric instrument, (MBTI), and an open-ended survey of the measurement of Critical Project Success Factors (CPSFs). The MBTI®, however, offers

a *multi-independent variable* measure, through its investigation and identification of four independent, self-reported, dimensions of personality.

One of the challenges of this work is the measurement of individual performance through the research (*dependent variable*). The specific challenge is to achieve a non-biased and balanced measure of actual behavior and achievement. The criterion for measurement of performance is the individual rating, scored on the Critical Project Success Factors Questionnaire, for each performance service area.

This scoring of the CPSF Questionnaire may be found in the data presented in Appendix C-9. The respondents complete the CPSF Questionnaire's answer sheet, by indicating their preferred answer to each question. These answers are each rated on a five-point Likert scale, with the value of each response entered in a data collection form (answers are presented in Appendix C-9). The answer values for individual questions of each category of service are added together. The total is then divided by the number of questions in the respective service category, to form an average score for each respondent and each service area (*planning, design, etc.)*. These averages, as presented in Appendix C-9, are the data to be correlated with personality measures of the MBTI®.

5.9 Independent Measures

5.9.1 Individual Profiling (MBTI ®)

This research study is based on the principles of hypothesis testing, investigating key predictors of behaviors and the dimensions of personalities as defined through the Myers-Briggs Type Indicator. The subjects were administered the Form M of the MBTI®, (Myers, et al., 1998) in order to determine their preference on the four dichotomies of personality: Extraversion or Introversion, Sensing or Intuition, Thinking

or Feeling and Judging or Perceiving. The participants were asked to respond to 93 items, both phrase questions and word pairs. An example of the phrase question would be (Myers et al., 1998, p. 141):

>*When you go somewhere for the day would you rather:*
>
>>*A – plan what you will do and when, or*
>>
>>*B- just go?*

Examples of the word pairs (Myers et al., 1998, p. 141) would be:

>>*scheduled*   *A*   *B*   *unplanned*
>>
>>*gentle*   *A*   *B*   *firm*

The total score for each personality dimension is determined by the summation of the respondent's score for each preferred direction. While the results of the Form M were hand scored for an indication of whole Type, they were also subjected to a weighted computer scoring of the instrument that provides the highest degree of accuracy for Type discrimination and preference clarity on individual dichotomies. The responses to this study were scored with the CPP Software System distributed by the Consulting Psychologist Press (CPP, 1999), and are presented in Appendix C-10.

Extensive testing of this personality instrument has been performed with measures of internal consistency ranging from 0.86 to 0.95 (Myers et al., 1998, p. 161). The Form M has been tested for consistency across gender, age and ethnicity with internal consistency reliabilities ranging from 0.80 to 0.95 (Myers et al., 1998, p. 161).

5.10 Dependent Measures

5.10.1 Critical Project Success Factor Questionnaire

The CPSF Questionnaire was developed as an output of the literature review of the construction industry research. This research establishes the criteria for determining successful and less successful behaviors. The intent of establishing these success standards is to develop a predictive test to assess performance in various job assignments. In the case of this research, the assignments are within the domains of; *Planning, Design, Construction Administration and General Management* duties within the firms providing Architectural, Engineering and Construction Management services. It is through the Questionnaire, that this research seizes the respondent's preferred course of action on various critical incidents. In this fashion, the research questionnaire captures the pattern of behavior and performance within various service categories. With this concept, it is the goal to capture a respondent's demonstrated inclination towards a particular pattern of behavior within a service category (Planning, Design, Construction Administration or General Managerial activities). This pattern is then scored against researched success profiles on a five-point Likert-type scale with ranges of*: Prefer A, Tend Toward A, Equally Split, Tend Toward B, Prefer B*. Another example scale used was: *Very Important, Quite Important, Somewhat Important, Seldom Important, Minimally Important.* These scales were then scored by the five-point Likert-type method, with 5 points awarded to the "correct answer", to be followed by 4, 3, 2 and finally 1 point for the "incorrect answer."

For example, a respondent might have answered the six (6) questions involving General Management of the design firm in the following fashion. Question 1, answer B

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(=2 points); Question 2, answer C (=3 points); Question 3, answer E (=5 points); Question 4, answer B (=4 points); Question 5, answer A (=5 points); Question 6, answer D (=4 points) with a total value of 23 points. The total score for this service category is then divided by the number of questions, to establish the average score, on the five-point scale, which in this case would be 3.83. The full answer profile, along with the categorical averages, for the 85 respondents are presented in Appendix C-9.

The final Critical Project Success Factors Questionnaire is presented in Appendix B. The final items, included within the 33 questions, are those that endured the reliability and internal consistency evaluation of the initial 52-item questionnaire. The internal consistencies (*alpha coefficient)* of the four service categories of the final pilot study questionnaire ranged from 0.57 to 0.73.   These consistencies were the result of the evaluation of the pilot study results (N= 13). The small sample may have limited the reliability estimate.

Considerable improvement in the Questionnaire's reliability and internal consistency was found in the administration of the instrument to the full research sample. With this increased sample size, and the subsequent reliability analysis, the Questionnaire's overall reliability and internal consistency has been documented.

The final reliability, with the full response sample completing the CPSF Questionnaire is presented in the following summary.

Table 5-9 Refined Questionnaire Reliability Analysis

Reliability Analysis (*Alpha values)				
TABLE of RESULTS:	Planning	Design	Construction	Management.
1.FINAL 33 QUESTIONS	0.8099	0.8740	0.9425	0.8783

The alpha coefficients for the internal consistency of the Critical Success Factors Questionnaire, as administered, were 0.8099 for the Planning questions, 0.8740 for the Design questions, 0.9425 for the Construction questions and 0.8783 for the General Management questions. These results offer validity that the Final 33 Item Questionnaire, as administered to the respondents, is highly reliable, with substantial internal consistency.

5.11 Procedure

The subjects initially completed the Myers-Briggs Type Indicator ®. The subjects were instructed to complete the Indicator in a non-work environment, (preferably at home). Once completed, the scoring sheet, and the question booklet were placed in an envelope and returned to the researcher, through the corporate contact in each of the participating firms.

Once the MBTI® scoring packets were received, they were template-scored by the researcher, and checked for consistency and completeness. Following the template scoring, the data from the responses was entered into the Consulting Psychologists Press, Inc. (CPP) Software System for item-weighted computer scoring of the MBTI strengths of the four personality dichotomies. The scoring range for each dichotomy was from minus 30 points to plus 30 points. On a categorical basis, the scores of 0 to +/-5 are classified as *slight* preference clarity. The scores of 5 to 15, either plus or minus were classified as *moderate* in preference clarity. Fifteen to twenty-five classified as *clear*, while 25 to 30 are classified as *very clear*.

The MBTI® Form M may be self-scored, template-scored, or computer scored. The self-score and template-score options use a unit weight scoring method of one point per each response count. Each of the instrument's 93 items identifies a preference for one of the four MBTI dichotomies. In the template-scored method, the respondent's preference on a given scale is the measure that it chosen most often (for example, Sensing – S, or Intuition – N). While this method offers an instant indication of Type and preference clarity, it lacks the overall balance of the item-weighted tabulation of the computer scoring method. The template-scored method is generally limited to situations of one on one counseling, where refinement of Type may be explored with expert input. In the research and development of the Form M instrument, certain questions provided a higher, or lower, power in the IRT (item response theory) evaluation. These questions are thus weighted accordingly, and adjusted in the CPP Software scores. When the response data is used in research, an item-weighted scoring afforded with the CPP Software offers higher reliability for true Type measures. This data is presented in Appendix C-10.

The second phase of the research is the completion of the Critical Project Success Factors Questionnaire. Each subject is provided a copy of the Questionnaire and asked to complete it. The CPSF instrument is completed in the work environment. The responses to the work related questions (critical incidents) were to be completed in the environment in which the decisions being queried are normally made.

As before, these documents were then placed in an envelope, sealed and returned to the researcher in the same fashion that the MBTI instruments were returned. Each Critical Project Success Factors Questionnaire is hand-scored, the data collated and prepared for analysis. The procedure for scoring the CPSF Questionnaire is to cluster the

professional service phase questions, by category, *planning, design, construction administration, and management.* The results for each respondent were then determined by computing the average response value for the questions of the service category.

As presented previously, the Questionnaire was developed on a five-point Likert scale scoring response. Each respondent indicates his or her choice of behavior. Each of the five possible choices, to each question, is valued at 1, 2, 3, 4 or 5. For example, the respondent's answers to the 9 final questions for *planning* service activities were then averaged to determine his, or her, preferred behavior toward the *planning* critical incidents. These scores for the 85 respondents are presented in Appendix C-9.

5.12 Analysis

The statistical technique commonly used in the analysis of continuous scale measurements of behavioral science data, in particular personality research, is the *correlation coefficient.* Therefore, the primary examination of the relationship between the measured traits of personality, (MBTI Type), and the measured behavioral responses to the Critical Project Success Factors Questionnaire, is the Pearson Product-Moment Correlation Coefficient. This examination allows the research to determine if there exists a statistically significant relationship between the measure of successful performance behaviors, in the areas of planning, design, construction and firm management; and the measured dimensions of personality (MBTI®).

In addition, there is considerable support for the evaluation of MBTI measures of personality, as dichotomous. The Association of Psychological Type, among others, views the dimensions of the MBTI as categorical *Types*, rather than measured *Traits* of personality. As such, a second statistical technique, the ANOVA, is used. This allows

the determination of the statistical significance of the variance in the mean scores reported on the Critical Success Factors Questionnaire, by sub-category. These scores are analyzed with the respondent's MBTI reported Type (i.e.; Extravert or Introvert; Thinker or Feeler, etc.). As shown in Table 5-9, the Simple Correlation Coefficient and the ANOVA (Analysis of Variance), are the procedures utilized in over 79 % of psychological research studies, as reported in the *Journal of Personality Assessment*, during a five-year period.

Table 5–10 Common Statistical Procedures (Glass and Hopkins, 1996)

	Use of Various Statistical Procedures in Studies Published in the *Journal of Personality Assessment* **from 1990 through 1994**
Procedure	*Percentage of Studies Employing Procedure*
Descriptive statistics only	12.7%
Analysis of variance	29.2%
Analysis of covariance	5.1%
Chi-squared	21.8%
Cluster analysis	3.8%
Discriminant analysis	6.8%
Factor analysis	16.9%
Multivariate analysis of variance	11.8%
Multivariate analysis of covariance	2.4%
Multiple linear regression	12.0%
Simple correlation	50.1%
Structural equation modeling	0.7%
T test	24.5%

After completion of the MBTI®, and the Critical Project Success Factors Questionnaire, the descriptive statistics are initially computed. For the subsequent analysis of the research hypotheses, a series of Pearson Product Moment correlation coefficients were computed.

In addition, since each of the dimensions of personality may be viewed as a dichotomous classification, these traits, or characteristics of personality, then form categorical independent variables (Type). While the grouping of each of the four dimensions of personality is categorical, the scores on the Critical Project Success Factor Questionnaire provide responses on a continuous scale. These data may then be analyzed with an ANOVA. A reduced statistical power is a penalty for splitting the sample to compare two independent means, and unequal sample sizes.

Of the thirteen common statistical procedures utilized in personality studies, it is reported that over 50 percent employ as a primary statistic simple correlation. Another 29 percent rely on analysis of variance (ANOVA) (Glass, 1996, pg. 491). These results are presented in Table 5-9. While two statistical methods were used in this research, it is the degree of the relationship between variables which is the ultimate aim of this work therefore, the primary statistical analysis is the Pearson Product Moment correlation, and the test of significance.

CHAPTER 6

RESULTS

6.1 Descriptive Statistics and Personality Trait Effects

The means, standard deviations and the correlations for each of the variables utilized in the analysis of the research findings, are presented in Table 6-1. These results represent the 85-respondent sample of the research. In addition, Appendix C-10 presents the full scoring results for the research sample. This appendix presents the respondents MBTI Type, the computer scored intensity (clarity) of personality dimensions and the scores to the Critical Project Success Factors Questionnaire by service category.

Table 6-1 Descriptive Statistics and Correlation for Variables Sample N=85

	Variable	M	SD		1 E/I		2 S/N		3 T/F		4 J/P		5 P		6 D		7 C	8 M
1	Extraversion (-) Introversion (+)	-1.59	16.17	Corr.	1													
2	Sensing (-) Intuition (+)	-7.22	12.79	Corr.	-0.13		1											
3	Thinking (-) Feeling (+)	-10.51	11.26	Corr.	-0.04		0.06		1									
4	Judging (-) Perceiving (+)	-10.81	14.16	Corr.	0.05		0.36	**	0.29	**	1							
5	Planning-Concept Design	2.60	0.50	Corr.	-0.04		0.23	*	-0.01		0.24	*	1					
6	Design- Contract Documents	3.33	0.48	Corr.	-0.07		-0.11		-0.13		-0.24	*	-0.07		1				
7	Construction Administration	2.99	0.53	Corr.	-0.11		0.37	**	0.02		0.33	**	0.35	**	-0.23	*	1	
8	Firm Management	3.25	0.53	Corr.	-0.08		0.02		0.07		-0.13		0.12		0.04		0.08	1

* Correlation is significant at the 0.05 level of significance
** Correlation is significant at the 0.01 level of significance

The relationships or inter-correlations across the independent variable (*four dimensions of personality)* are largely non-significant with the exception of the (4) J/P scale. The individuals with a preference for (2) *Sensing* were correlated with a preference for (4) *Judging*, while (4) *Perceiving* were correlated with (2) *Intuition* ($\underline{r}$ = 0.36, $\underline{p}$ <0.01). Likewise, those with a preference for (4) *Judging* (or conversely

Perceiving), also had a preference for (3) *Thinking,* (or conversely *Feeling*), ($r = 0.29$, $p <$ 0.01). These two findings are uncharacteristic of the research findings for the MBTI®, since correlations between personality variables are not typically found (Myers, et. al., 1998, pages 175-185).

The findings of this study, however, support those personality researchers who question the interference of the non-Jungian J/P scale with the S/N and the T/F dichotomies (McCrae and Costa, 1989). These researchers found that the J/P and the S/N scales were inter-correlated, $r = 0.38$ in their 1989 study, as well as in the research normative data. This inter-correlation also supports the theory of Type Dynamics (Hirsh and Kummerow, 1998).

The core of the research hypotheses, being that the correlation between the independent variables, (*personality dimensions*), and the dependent variables, (*performance measures*), exhibits several significant relations. Individuals with higher scores on the (5) *Planning Phase* had a significantly higher preference towards (2) *Intuition* ($r = 0.23$, $p < 0.05$), as well as a preference for (4) *Perceiving* ($r = 0.24$, $p <0.05$). This finding is consistent with prior research studies that demonstrated *Perceiving* and *Intuition* were positively correlated with Openness to Experience ($p < 0.001$) (McCrae and Costa, 1989). It is also reported that Openness to Experience was positively correlated with the generation of creative ideas (Costa, 1996, and Barron and Harrington, 1981). Respondents with higher scores in the (7) *Construction Administration Phase,* also showed a significantly higher preference for both (2) *Intuition* and (4) *Perceiving* ($r = 0.37$, $p < 0.01$; and $r = 0.33$, $p < 0.01$) respectively. Once again, this prediction of new ideas and Openness to Experience tracks with the Construction

Administration Phase challenges. It is here where conflicts in the Contract Documents and the methods of construction can create a need to find *alternative solutions to problems* in the building process, vis-à-vis, the poet Robert Burns "The best laid plans of mice and men gang aft aglay (often go astray)."

The (6) *Design Phase* critical incident questions were positively correlated with the (4) *Judging* dimension of personality ($\underline{r}$ = -0.24, $\underline{p}$ < 0.05). This result is consistent with the hypotheses, and is supported in the theoretical rationale that compliance with rules and regulations, and the desire for closure, would result in better Contract Document preparation services.

The results also showed an emergence of a number of correlations among the dependent variables. The (7) *Construction Administration* scores were positively correlated with the (5) *Planning* scores, ($\underline{r}$ = 0.35, $\underline{p}$< 0.01), while negatively correlated with (7) *Design – Contract Documents* ($\underline{r}$ = -0.23, $\underline{p}$ < 0.05). The strong connections between Planning and Construction services are supported by the research of others where innovation and quantity of new ideas were positively related (West and Anderson, 1996).

Chapter 3 presented a Null Hypothesis, which states that in the population of Architectural and Engineering Professionals practicing in the Design Services Division of the Building Sector of the Construction Industry, based upon the measures of personality captured in the MBTI®, there would be no performance differences measured for the *planning, design, construction administration and general firm management duties* by these professionals. The exploratory hypotheses were then presented. Those included a projection of the relationship between each phase of service in the industry, and the

measures of personality, as captured in the MBTI®. These are graphically presented in Table 6-2 – Exploratory Hypotheses and Research Findings. As indicated, the findings of the research are also presented in this Table 6-2. It may be noted that of the fourteen exploratory predictions, five were found to offer a significant relationship between the performance measures (CPSF Questionnaire) of the respondent group, and dimensions of personality (MBTI®).

This research found significant correlation between improved *Planning* performance and levels of *Intuition and Perception.* In the *Design* service area a positive correlation was found with the *Judging* dimension of personality. In *Construction Administration* higher performance was positively correlated with *Intuition and Perception.* No correlation was found between *General Management* performance and personalities as measured by the CPSF Questionnaire and the MBTI®.

<u>Table 6-2 Exploratory Hypotheses and Research Findings</u>

X indicates significant correlation was predicted in the Hypotheses

HYPOTHESES	E	I	S	N	T	F	J	P
Planning (Conceptual Design)				X		X		X
Design (Contract Documents)	X		X		X		X	
Construction Administration				X	X			X
General Management	X		X		X		X	

RESEARCH FINDINGS	E	I	S	N	T	F	J	P
Planning (Conceptual Design)				X		O		X
Design (Contract Documents)	O		O		O		X	
Construction Administration				X	O			X
General Management	O		O		O		O	

X indicates significant correlation exists, O indicates no significance was detected

6.2 Personality Type Effects

The basic premise of MBTI® Type theory is that each person holds a preference for each of the four dichotomies of personality. Type theorists suggest that this preference is not a continuous scale trait, but rather a categorical identification of Type. The combination of preferences forms a whole type, such as ESTJ: extraverted, sensor, thinker, judger. As such, the data analyzed in the previous section, via correlation, have been subjected to an ANOVA to confirm the relationship of performance and preferred type in each of the four personality dichotomies. The respondent cases that measure *slight* on the MBTI® preference clarity scales, (the range of –5 to +5), are recommended to be excluded from any categorical analysis (Harvey, 2000, McCrae and Costa, 1989). This is further supported by Myers, (1980) in that it is suggested that each individual along with his counselor, explore the "true type" through a one on one evaluation. This is particularly true where there is a significant chance of misclassification where individuals are near the mid-point. The logic is that when a "preference clarity" is in the *slight* range the likelihood of a test/retest repeatable result is between 22% and 52% (Ave. 41%) (Myers, et al., 1998). Once the classification of "preference clarity" moves to the *moderate, clear and very clear* ranges, the average test/retest repeatable results move to 81%, 93% and 99% respectively. Therefore, to increase the power of the analysis, recognizing a split of the sample, the "preference clarity" range of *slight* has been excluded.

Table 6-3 ANOVA Extraversion – Introversion Slight Cases Removed

		SS	df	Mean Square	F	Sig.
Planning	Between Groups	0.0938	1	0.0938	0.369	0.546
	Within Groups	17.545	69	0.254		
	Total	17.639	70			
Design	Between Groups	0.02855	1	0.02855	0.119	0.731
	Within Groups	16.503	69	0.239		
	Total	16.532	70			
Construction	Between Groups	0.204	1	0.204	0.753	0.388
	Within Groups	18.678	69	0.271		
	Total	18.882	70			
Management	Between Groups	0.008162	1	0.008162	0.027	0.87
	Within Groups	20.788	69	0.301		
	Total	20.797	70			

In the (1) *E-I* – ANOVA there was agreement with the correlation evaluation. As presented in Table 6-3, under the right hand column, Significance (Sig.), there is no result observed that meets the threshold level for significance of $p < 0.05$. This analysis relates the personality dimension of *Extraversion – Introversion* to success factors in the four service categories: *Planning, Design, Construction and Management*. The number of respondents whose MBTI® results indicated a "preference clarity" higher than "slight" for the *E-I* dichotomy was 71.

Sixty-two respondents scored higher than "slight" on the *Sensing – Intuition* dichotomy as shown in Table 6-4. Therefore, sixty-two respondents were "clear" in their dichotomous preference for either sensing or intuition. The results obtained in the Pearson Product Moment Correlation analysis showed a significant correlation between the S/N dichotomy and both the (5) *Planning* and the (7) *Construction* service areas. Similar results were found in the ANOVA. Statistical significance was detected in both the *Planning* and the *Construction* Phase services, [$F (1, 60) = 7.428$, $p < 0.01$ and $F (1, 60) = 5.063$, $p < 0.05$] respectively. This result indicates that there is not only a

difference in the intensity of ones preference for sensing or intuition, (scalar measure of traits- Correlation), but that personality Type is also a discriminator of performance, (categorical measure of Type- ANOVA).

Table 6-4 ANOVA Sensing – Intuition Slight Cases Removed

		SS	df	Mean Square	F	Sig.
Planning	Between Groups	1.799	1	1.799	7.428	.008
	Within Groups	14.535	60	.242		
	Total	16.334	61			
Design	Between Groups	.331	1	.331	1.487	.227
	Within Groups	13.338	60	.222		
	Total	13.668	61			
Construction	Between Groups	1.545	1	1.545	5.063	.028
	Within Groups	18.310	60	.305		
	Total	19.856	61			
Management	Between Groups	7.022E-02	1	7.022E-02	.222	.640
	Within Groups	19.019	60	.317		
	Total	19.090	61			

Agreement with the correlation analysis was also found in the (3) *Thinking-Feeling* dimension of personality. As presented in Table 6-5, there were 62 respondents with "moderate" through "very clear" preference clarity indices for this dichotomy. Consistent with the correlation analysis, but contrary to the research hypothesis, no statistically significant relationships were detected in *Thinking-Feeling* dichotomy of personality. It had been predicted in the exploratory hypotheses that the *T-F* dimension would be a discriminator of performance since this is the decision making function of Type. No significant relationship was detected in this research.

Table 6-5 ANOVA Thinking – Feeling Slight Cases Removed

		SS	df	Mean Square	F	Sig.
Planning	Between Groups	.208	1	.208	.821	.369
	Within Groups	15.214	60	.254		
	Total	15.422	61			
Design	Between Groups	8.826E-02	1	8.826E-02	.334	.565
	Within Groups	15.836	60	.264		
	Total	15.925	61			
Construction	Between Groups	.285	1	.285	1.054	.309
	Within Groups	16.212	60	.270		
	Total	16.497	61			
Management	Between Groups	.492	1	.492	1.673	.201
	Within Groups	17.650	60	.294		
	Total	18.142	61			

Table 6-6 presents the findings of the dimension of (4) *Judging – Perceiving* ANOVA results. These were found to be consistent with the correlation study, however, not a complete agreement, vis-à-vis, statistical significance. While the correlation of the "trend" in the *J-P* score as a trait was significantly correlated with the (5) *Planning Phase* responses, when viewed as a categorical dimension the significance dropped to sig. = 0.091, or non-significant. This inconsistency may be the result of a Type II error since the total sample of 85 is reduced by dropping the *slight* respondents. The "*moderate to very clear*" preference clarity group numbered 67. This was further split to a distribution of 10 perceivers and 57 judgers, thus reducing the Power of the inquiry. In fact, the analysis of statistical power for this case clearly demonstrates the problem of sample splitting, where the power of two independent means of unequal sample sizes of 57 and 10 will result in the probability of a Type II error of over 68%. Simply stated, under this statistical condition there is only a 32% chance of actually rejecting the null if it is false. This demonstration clarifies the use of the ANOVA as a supporting investigation only, with the primary results found in the Pearson Product Moment Correlation statistic.

Table 6-6 ANOVA Judging – Perceiving Slight Cases Removed

		SS	df	Mean Square	F	**Sig.**
Planning	Between Groups	.604	1	.604	2.945	.091
	Within Groups	13.340	65	.205		
	Total	13.944	66			
Design	Between Groups	2.240	1	2.240	9.881	.003
	Within Groups	14.738	65	.227		
	Total	16.978	66			
Construction	Between Groups	3.218	1	3.218	15.205	.000
	Within Groups	13.755	65	.212		
	Total	16.972	66			
Management	Between Groups	.275	1	.275	.871	.354
	Within Groups	20.493	65	.315		
	Total	20.768	66			

The box-plot of the results where significance was detected in the Judging –
Perceiving dichotomy is presented in Figure 6-1. This is a graphical demonstration of the
scoring pattern for the Design and Construction phases. The Design scores for those with
a preference for Perception (M = 2.85, S.D. 0.3866) are lower in contrast with those
preferring Judging (M =3.36, S.D. = 0.4890). The Construction scores favor those with a
preference for Perception (M = 3.50, S.D. 0.6397) when contrasted with those preferring
Judging (M =2.885, S.D. = 0.4241).
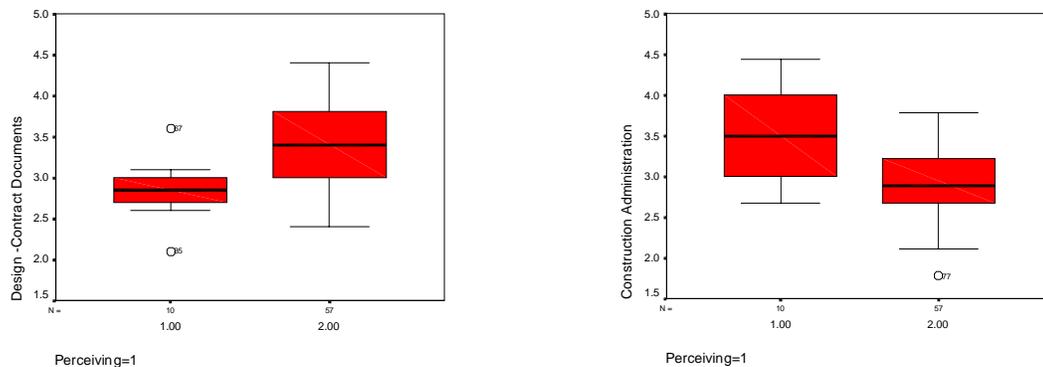
Figure 6-1 Box-Plots of Judging – Perceiving v. Design and Construction Phase

As shown above, the ANOVA supports the correlation findings in both Design
Documents and Construction Administration, yet offers only an "approaching
significance" finding in the Planning Phase. However, with the reduced experimental
power this result does not negate the correlation results; it simply cannot confirm the
result.

6.3 Analysis of Hypotheses

The null hypothesis that no relationship between the research sample's personality
measures and the performance differences measured in the Critical Success Factors
Questionnaire is rejected. While this research discovered non-significant results in a
number of personality/performance categories, there were several significant correlations

detected, thus the null, that there is no relationship between performance and personality, does not find support. These findings as they relate to the research hypotheses are presented below.

For the hypotheses that a significant relationship would be found between personality measures and performance in the *planning, design, construction administration and management* duties of a design firm, a correlation was found. These findings are repeated from Table 6-2, and presented in the Table 6-7.

Table 6-7 Correlation Research Findings and ANOVA Confirmation

CORRELATION FINDINGS	E	I	S	N	T	F	J	P
Planning (Conceptual Design)				X				X
Design (Contract Documents)							X	
Construction Administration				X				X
General Management								

ANOVA FINDINGS	E	I	S	N	T	F	J	P
Planning (Conceptual Design)				X				
Design (Contract Documents)							X	
Construction Administration				X				X
General Management								

X indicates significant correlation exists

6.4 Other Measures

The correlations of personality measures (MBTI) and behavioral preferences measured in the Critical Project Success Factor Questionnaire were the primary elements of this research. In addition, other measures evaluated that could potentially influence the performance outcomes include professional affiliation (architect, engineer, surveyor or construction administrator) and firm affiliation (firms n>3).

When subjected to an ANOVA, it was found that whether the respondent was a professional architect, engineer, surveyor or construction administrator, there were no performance differences detected. This finding is presented in Table 6-8, where it may be observed that a significance of $p < 0.05$ was not achieved. Therefore, there is no evidence from this research that would suggest that, for example, an architect would outperform an engineer in any particular phase of service tested, or vice versa. This holds for each of the other services areas and professional affiliations. This is not to say, with certainty, that no relationship exists; it simply observes that this research offers no such finding.

Table 6-8 ANOVA of the Architects , Engineers, Surveyors and Construction Administrators v. Performance Measures of the CPSF Questionnaire

		SS	df	Mean Square	F	**Sig.**
Planning	Between Groups	.874	3	.291	1.196	.317
	Within Groups	19.740	81	.244		
	Total	20.615	84			
Design	Between Groups	.979	3	.326	1.416	.244
	Within Groups	18.669	81	.230		
	Total	19.648	84			
Construction	Between Groups	.590	3	.197	.691	.560
	Within Groups	23.048	81	.285		
	Total	23.638	84			
Management	Between Groups	.821	3	.274	.963	.414
	Within Groups	23.012	81	.284		
	Total	23.832	84			

There was a particular, interesting difference detected in the personality for the respondents in the professional service categories of Architect, Engineer, Surveyor and Construction Administrator. The difference, presented in Table 6-9, was found in the intensity, or preference clarity within the *Sensing-Intuition* dichotomy, where the Surveyors' reported a mean score of –24.60, versus an overall mean of –7.22. The range was +30.00 to –30.00.

Table 6-9 Descriptive Statistics of Sensing-Intuition Dichotomy

Sensing (-) Intuition (+)		N	Mean	Std. Deviation	Std. Error			Min.	Max.
	Architect	19	-3.8947	15.2239	3.4926			-28.00	30.00
	Engineer	49	-6.6531	11.2297	1.6042			-30.00	13.00
	Surveyor	5	-24.6000	5.8138	2.6000			-30.00	-16.00
	Const. Mngr.	12	-7.5833	12.2509	3.5365			-22.00	15.00
	Total	85	-7.2235	12.7936	1.3877			-30.00	30.00

The statistical results that a difference in the *Sensing-Intuition* dichotomy existed between the service categories of the respondents were: [Sensing/Intuition- $\underline{F}$ (2, 77) =3.906, $\underline{p}$ < 0.012], and is presented in Table 6-10.

<u>Table 6-10 ANOVA of the Personality Results of the Four Service Categories</u>

		Sum of Squares	Df	Mean Square	F	Sig.
Extraversion (-) Introversion (+)	Between Groups	1176.171	3	392.057	1.527	.214
	Within Groups	20792.418	81	256.697		
	Total	21968.588	84			
Sensing (-) Intuition (+)	Between Groups	1737.745	3	579.248	3.906	.012
	Within Groups	12011.008	81	148.284		
	Total	13748.753	84			
Thinking (-) Feeling (+)	Between Groups	519.769	3	173.256	1.386	.253
	Within Groups	10127.478	81	125.031		
	Total	10647.247	84			
Judging (-) Perceiving (+)	Between Groups	161.535	3	53.845	.261	.853
	Within Groups	16681.453	81	205.944		
	Total	16842.988	84			

The results report that the Surveyors in this study differed significantly from the other respondents in the *Sensing - Intuition* dichotomy. This difference is graphically presented in the Box-Plot results in Figure 6-2.


Arch=1 Eng=2 Surv=3 Const=4
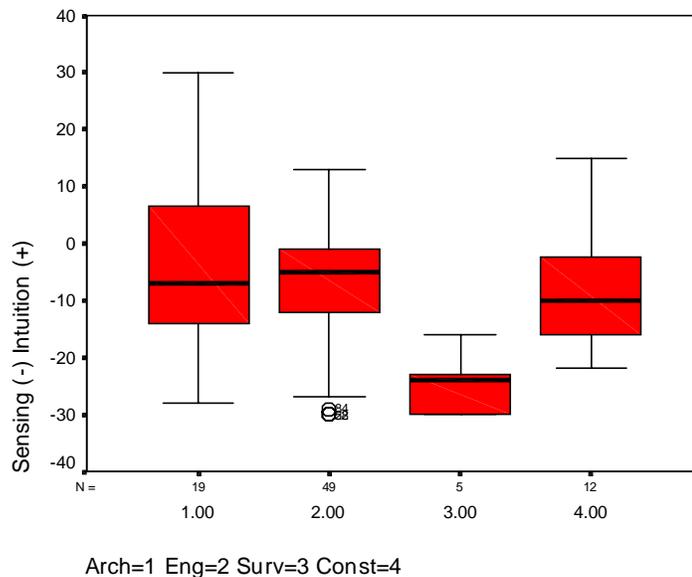
<u>Figure 6-2 Box-Plot of Sensing-Intuition Dichotomy</u>

Overall, these general findings of little or no difference in the various professional service categories are in contradiction of earlier studies by others, which suggest significant differences in personalities between architects, design engineers and construction engineers. Hall and McKinnon (1969) found in a sample of 62 architects a predominance of E, N and P. McCaully, MacDaid, and Walsh (1987) report the predominant dichotomies for graduate civil engineers (N = 168) were reported to be I, S, T and J.

The McCaully report findings are consistent with the findings of this research. The sample respondents showed a consistent preference for Sensing, Thinking and Judging, while the results reported an approximately equal split between Extraversion and Introversion. As shown in the descriptive statistics of Table 6-11, the Architects and Surveyors reported a Type preference for Introversion, while the Engineers and Construction Administrators reported a Type preference for Extraversion.

The descriptive statistics for each of the service categories of the respondents in this research are presented in Table 6-11. The group's (architect, engineer, etc.) Type is determined from the mean reported scores of the MBTI® by dichotomy. This result is indicated in the Type sub-title block for reference to research studies by others.

Table 6-11 Descriptive Statistics for Each Service Category

Architects - ISTJ
Descriptive Statistics

	N	Mean	TYPE
Extraversion (-) Introversion (+)	19	3.0000	I
Sensing (-) Intuition (+)	19	-3.8947	S
Thinking (-) Feeling (+)	19	-10.4211	T
Judging (-) Perceiving (+)	19	-9.7368	J

Engineers - ESTJ
Descriptive Statistics

	N	Mean	TYPE
Extraversion (-) Introversion (+)	49	-3.2653	E
Sensing (-) Intuition (+)	49	-6.6531	S
Thinking (-) Feeling (+)	49	-9.0204	T
Judging (-) Perceiving (+)	49	-10.3469	J

Surveyors - ISTJ
Descriptive Statistics

	N	Mean	TYPE
Extraversion (-) Introversion (+)	5	7.6000	I
Sensing (-) Intuition (+)	5	-24.6000	S
Thinking (-) Feeling (+)	5	-11.4000	T
Judging (-) Perceiving (+)	5	-15.0000	J

Construction Administrators - ESTJ
Descriptive Statistics

	N	Mean	TYPE
Extraversion (-) Introversion (+)	12	-5.8333	E
Sensing (-) Intuition (+)	12	-7.5833	S
Thinking (-) Feeling (+)	12	-16.3333	T
Judging (-) Perceiving (+)	12	-12.6667	J

Overall, the research sample's categorical preferences are as presented in Table 6-12. The research sample's reported preferences for the four dichotomies of personality, are contrasted with the general population's National Distribution of categorical preferences (Myers, et al., 1998). The complete research distributions are presented in Appendix C-7.

Table 6-12 Research Sample's Distribution of Preferences v. National Sample

	N	**Research Sample %**	**National Sample %**
Extraversion	41	48.24%	49.30%
Introversion	44	51.76%	50.70%
Sensing	67	78.82%	73.30%
Intuition	18	21.18%	26.70%
Thinking	69	81.18%	40.20%
Feeling	16	18.82%	59.80%
Judging	63	74.12%	54.10%
Perceiving	22	25.88%	45.90%

Of note in the above table is the strong preference within the research sample of technically oriented respondents for Thinking, versus the general population's preference

for Feeling. Additionally, 74% of the respondent group prefers Judging versus the general population's 54%. The dichotomies of Extraversion – Introversion, and Sensing – Intuition track closely with the general population.

The results for firm affiliation were investigated. It was found that there was no detected difference in the performance scores among participating firms. The results were: [Planning - $\underline{F}$ (2, 77) = 1.371, sig. = 0.260; Design - $\underline{F}$ (2, 77) = 1.216, sig. = 0.302; Construction - $\underline{F}$ (2, 77) = 0.641, sig. = 0.530 and Management - $\underline{F}$ (2, 77) = 0.090, sig. = 0.914]. Therefore, a consistency of performance across firms would suggest that corporate culture was not a significant moderator in responses from the participating firms' respondents.

Likewise, the sample was evaluated across the reported levels of education. When educational level was correlated with both performance (CPSF), and personality (MBTI), no significant relationships were found.

Table 6-13 Correlation of Respondent's Educational Level and Variables

		EDUCATION
Planning - Conceptual Design	Pearson Correlation	.068
	Sig. (2-tailed)	.538
Design –Contract Documents	Pearson Correlation	-.073
	Sig. (2-tailed)	.509
Construction Administration	Pearson Correlation	.061
	Sig. (2-tailed)	.579
General Firm Management	Pearson Correlation	-.015
	Sig. (2-tailed)	.891
Extraversion (-) Introversion (+)	Pearson Correlation	-.094
	Sig. (2-tailed)	.390
Sensing (-) Intuition (+)	Pearson Correlation	.160
	Sig. (2-tailed)	.143
Thinking (-) Feeling (+)	Pearson Correlation	.038
	Sig. (2-tailed)	.733
Judging (-) Perceiving (+)	Pearson Correlation	-.080
	Sig. (2-tailed)	.465
	N	85

With the "other measures", by and large, resulting in non-significant relationships, the continuing analysis of the data focuses on the independent variable (personality measures, i.e., MBTI TYPE) versus the dependent variable (performance measures, CPSF Questionnaire). The basic research hypotheses were that the primary influencing metric of performance, in critical incident behavior is attitude, or personality. It was a premise of the research that the impact of education, firm and professional affiliation would not significantly mediate performance. This position was due principally to the homogeneity of the research sample. Based upon the review of the literature, the one mediating factor that is reported to influence performance is tenure (Kichuk and Wiesner, 1997; Tett et. al. 1991, Tizner, 1985; Maidique and Zirger, 1984; Barrick and Mount, 1991; Day and Silverman, 1989).

Moreover, with the concern for the Power of the test minimizing the likelihood of a Type II error, the Correlation of the data, rather than the Analysis of Variance provides the focus of the evaluation for the research hypotheses. While the ANOVA supports the correlation findings, evaluating the results on a Type basis does not find broad support in the research (Costa and McCrae, 1989, Striker and Ross, 1964, and Mendelsohn, Weiss and Feimer, 1982). The work of McCrae and Costa called into question the dichotomous nature of the MBTI categories, and offers solid support in the utilization of the MBTI scores on a continuous scale for research (1989). As such, the work of this research continues to focus on the continuous scoring of the MBTI and the Critical Project Success Factors through a simple correlation analysis. The simple correlation analysis is utilized since each of the measures, MBTI and CPSF Questionnaire responses, were continuous and represents random variables (Schulman, 1992).

6.5 Research Hypotheses Results

Table 6-1 is repeated in part within Table 6-14. This Table presents the *Pearson Product Moment Correlation* value, and the *Significance* of the correlation.

Table 6-14 Correlation Results

			Extraversion (-) Introversion (+)	Sensing (-) Intuition (+)	Thinking (-) Feeling (+)	Judging (-) Perceiving (+)
1	Planning - Conceptual Design	Pearson Correlation	-0.039	0.232 *	-0.011	0.236 *
		Sig. (2-tailed)	0.723	0.033	0.919	0.030
2	Design -Contract Documents	Pearson Correlation	-0.074	-0.106	-0.134	-0.239 *
		Sig. (2-tailed)	0.501	0.334	0.220	0.028
3	Construction Administration	Pearson Correlation	-0.112	0.366 **	0.019	0.333 **
		Sig. (2-tailed)	0.309	0.001	0.862	0.002
4	Firm Management	Pearson Correlation	-0.079	0.020	0.075	-0.133
		Sig. (2-tailed)	0.474	0.857	0.496	0.226

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Research *Hypothesis A* focused on the Planning Phase of the design process; the time when the conceptual design ideas are coalesced into a formal study and report, forming the basis for all future phases of the project effort. The hypothesis predicted that the better performers would be those with a preference for Intuition (N), Feeling (F) and Perceiving (P). The results indicate that the respondent's level of intuition (N) significantly affected the planning score, ($r = 0.232$, $p < 0.05$). The respondent's preference for perceiving (P) was also significantly correlated with more successful scoring in the Planning Phase services ($r = 0.236$, $p < 0.05$).

Contrary to the research hypothesis there was no finding of significance within the subject's thinking/feeling dimension of personality and Planning ($r = 0.11$, sig. = 0.919).

The projection that higher performance was expected with a balance in the subject's preference for introversion/extraversion also found no support in the research results. This dimension, given the research hypothesis of moderate influence was investigated with the non-linear regression. The alternative curve estimation techniques resulted in a finding of non-significance (F = 0.32, sig. = 0.727).

Hypothesis B focuses on the Design Phase of an Architect's and/or Engineer's services. This is the project phase where strict adherence to codes, rules and regulations is highly important to ensure that the detailed Contract Documents comply with industry and regulatory standards.

The hypothesis had projected that the dimensions of personality that would positively impact performance of the work in the Design Phase of a project were E, S T and J. There was no finding of significance in three of the four dimensions of personality, with the exception being the Judging – Perceiving dichotomy. The non-significant findings were: [Introversion / Extraversion - r = -0.074, sig. = 0.501; Sensing / Intuition- r = -0.106, sig. = 0.334; Thinking / Feeling- r = 0.134, sig. = 0.220].

Supporting the "imperative" of strict compliance with time and budget issues, as well as code compliance matters, *Hypothesis B* is supported with a significant finding in the correlation of performance improvement, with the increase in the clarity of preference for Judging versus Perception, [Judging/Perceiving- r = -0.239, $p < 0.05$].

Hypothesis C was directed to the performance behaviors of the Construction Administration project phase. *Hypothesis C* was partially supported, as the high performing personality was predicted to present a preference for the MBTI factors of Intuition, Thinking and Perception (N, T and P). The respondents possessing a

preference for Intuition (N) demonstrated a significantly higher level of performance than those with a preference for Sensing (S) [Sensing/Intuition - $\underline{r} = 0.366$, $\underline{p} < 0.01$]. The subjects with a preference for Perceiving also demonstrated a significantly higher performance score than Judging [Judging/Perceiving- $\underline{r} = 0.333$, $\underline{p} < 0.01$].

The prediction of a preference for the MBTI dichotomy of Thinking, (T), was not supported by the research findings. There was no hypothesis for the Extraversion / Introversion personality dimension related to the Construction Phase.

Hypothesis D was directed to the General Management activities of the design firm's services. The correlation of the scores in this phase of service failed to support the hypothesis that E, S, T and J would yield a higher performance than I, N, F and P respectively. Superior performance did not differ significantly among the four preference groups ($\underline{p} > 0.05$), failing to support the hypothesis.

6.6 Other Measures and Predictors of Success

Although not formalized in the research hypotheses, several interesting measures of performance mediation were noted in the analysis of the data. Tenure has been found in earlier research to mediate performance in a number of studies (Kichuk and Wiesner, 1997; Tett et al. 1991, Tizner, 1985; Maidique and Zirger, 1984; Barrick and Mount, 1991; Day and Silverman, 1989). These researchers' findings were of particular interest in this study, once the responses were provided, and the profile of the subjects was observed. The Architectural and Engineering professions require a minimum of four-years of experience in an intern position prior to being qualified to sit for the national licensing exam. This four-year internship period then became an element of interest, when the number of subjects with less than five years tenure was observed. These

subjects were reported by their supervisors to be in project manager – decision-making positions, therefore, these dimensions of personality/performance were explored. The correlation matrix of performance (CPSF Questionnaire), with the MBTI dimensions for those with four or less years of experience, is presented in Table 6-15.

Table 6-15 Descriptive Statistics and Correlation for Sample of Tenure < 5 Years

	Variable	M	SD	1 E/I	2 S/N	3 T/F	4 J/P	5 P	6 D	7 C	8 M
1	Extraversion (-) Introversion (+)	-1.44	15.60	1							
2	Sensing (-) Intuition (+)	-5.88	11.01	-0.478	1						
3	Thinking (-) Feeling (+)	-5.88	10.46	-0.431	0.497	1					
4	Judging (-) Perceiving (+)	-12.19	12.97	-0.033	0.440	0.031	1				
5	Planning-Concept Design	2.46	0.42	0.309	-0.024	-0.276	0.048	1			
6	Design- Contract Documents	3.37	0.27	-0.166	-0.104	-0.152	-0.353	-0.029	1		
7	Construction Administration	2.84	0.31	0.117	-0.294	0.105	0.048	0.031	-0.273	1	
8	Firm Management	3.31	0.43	-0.145	0.005	-0.207	0.103	0.588 *	0.092	0.123	1

* Correlation is significant at the 0.05
** Correlation is significant at the 0.01
N = 16

As noted, there are no significant findings of any relationship between performance and personality for this sub-group of respondents. The implications of this are addressed in the Discussion Chapter of this work. It is recognized, however, that with a small sub-sample (N=16) the statistical power of the investigation is well below the recommended N of 65, which does lead to the possibility of a Type II error. It is also noted that within this group, there are no "approaching significance" findings either. Consequently, the investigation of this data was subjected to a curve estimation, with a relationship between performance and *Extraversion/Introversion* noted, and presented in Figure 6-3, along with the ANOVA of Table 6-16.

Table 6-16 ANOVA Planning – Extraversion/Introversion - Tenure < 5 Years

Dependent variable.. PLANA Method.. QUADRATI	
Multiple R .87829	
R Square .77140	
Analysis of Variance:	
F = 21.93359 Signif F = .0001	

Planning - Conceptual Design

Extraversion (-) Introversion (+)
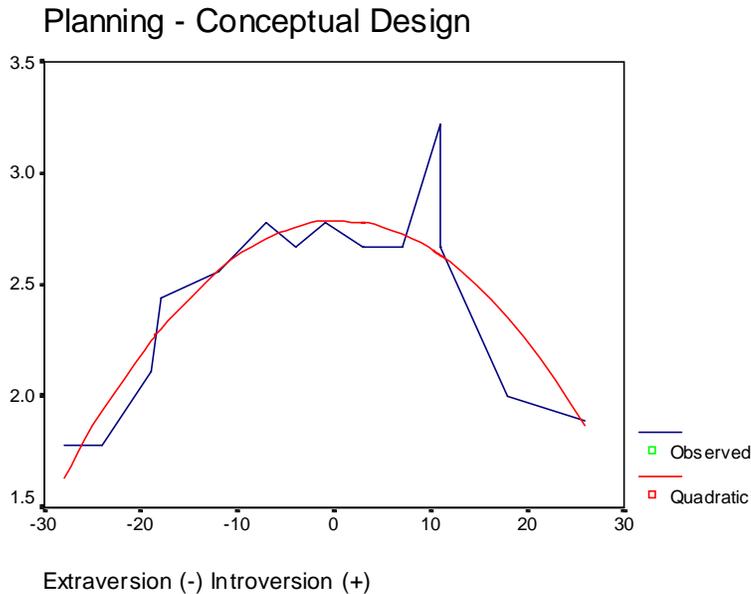
Figure 6-3 Curve Estimation of Sample with Tenure < 5 Years

This interesting finding was observed only in the *Extraversion / Introversion* personality dimension. The higher the non-tenured (less than 5 years experience) respondents' preference for either extraversion or introversion, the lower the score in the Planning phase service questions of the CPSF Questionnaire. The implications are considered in the Discussion Chapter.

The second area where other factors were investigated for their impact on the personality – performance exploration was the impact of gender as a discriminator. The sample was split male – female and the correlation performed. Even though the small sample of females, N=12, might subject the investigation to a Type II error, a statistically significant relationship was found (F = 6.798, sig. = 0.0262).

The graphical representation of the female only sample, with the design service inquiry is presented below, with the implications addressed in the Discussion chapter:
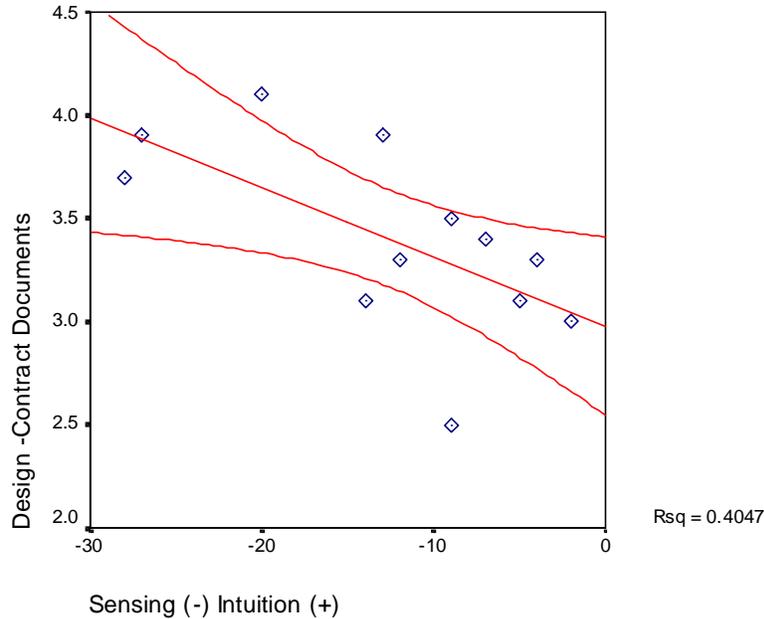

Figure 6-4 Design Scores v. Sensing/Intuition Dichotomy Female Respondents N=12

The third finding, through the exploration of the data, that is considered material to the investigations underway, is the education level versus service phases. When the sample was split into those with graduate level education, (Masters Degree or more), compared with those holding a Bachelors Degree or less, there was a significant finding in the Planning Phase (F = 10.171, Sig. = 0.002). This is graphically presented in Figure 6-5.
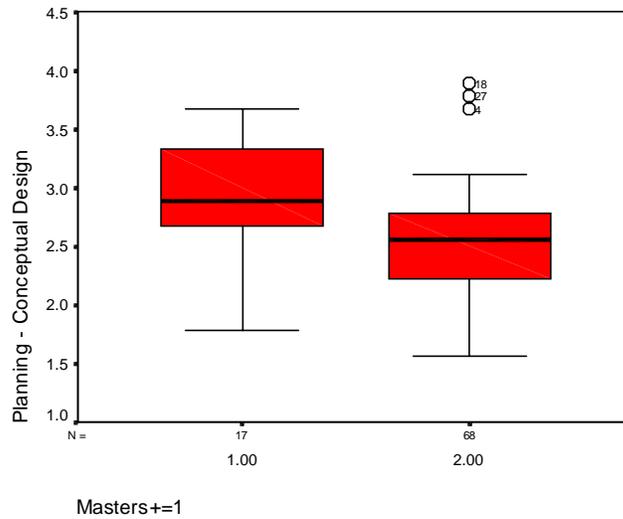
Figure 6-5 Box-Plot of Graduate Education v. Planning Scores

No other significant findings were noted in the exploration of the data collected. Implications of these three findings, which were beyond the stated research hypotheses, are discussed in 7.2, the Future Research section of the Discussion chapter.

CHAPTER 7

DISCUSSION

7.1 Critical Success Factors, Personality Traits and Performance

The findings that personality traits impact, and therefore, correlate with individual performance, are not a unique discovery of this research (Kichuk and Wiesner, 1997; Tett et al. 1991, Tizner, 1985; Maidique and Zirger, 1984; Barrick and Mount, 1991; Day and Silverman, 1989, Barry and Stewart, 1997). Many authors have shown that performance is enhanced when teams are composed of members with appropriate personality characteristics for the tasks to be accomplished. Various researchers have discovered that the measures of personality found in Judging (Conscientiousness), Intuitiveness (Openness to Experience), and Extraversion are related to positive performance in individual tasks. The unique contribution to the body of knowledge of this particular research study is not the connection of personality traits to broad areas of performance, but rather specific connections of those dimensions of the *dichotomous personality traits* of the Myers-Briggs Type Indicator® with *industry specific* performance.

7.1.1 Planning (Conceptual Design) Phase Services

The finding of the investigation of the first hypothesis, suggesting that individuals with higher levels of Intuitive data gathering would outperform those with higher preferences for a Sensing approach to data collection, seems logical and makes sense. In the Planning Phase of a project, the service activities require a sensitivity to "complex interactions" (McCaully, et al., 1987, p. 101), a uniquely Intuitive function. Furthermore, the theoretical possibilities and the continuous flow of new implications are actions most common to the planning process, a process in which the Intuitive is quite comfortable

(Myers, et al., 1998). The Sensor, on the other hand, looks for a "practical, hands-on, common-sense view of events" (McCaully, et al., 1987, p. 101). This approach coupled with the Judging preference to gather "only enough data to make a decision before setting on a direct path to a goal", (McCaully, et al., 1987, p. 102) would miss the many opportunities that need to be discovered in the planning process for a project. With the preference for Perceiving, supporting that of Intuition, an individual develops an optimal pattern of personality, for optimal individual performance in the Planning Phase of the designer's service. These were the hypothesized predictors of higher individual performance outcomes.

The prediction of Feeling as a positive Type preference for Planning Phase performance did not find support in this research, as evidenced by the finding of insignificant results among those with opposing personality preferences of the T/F scale. The research suggests that persons with a preference for making judgments objectively and analytically perform no better than those respondents who allow personal values to be brought into the decision process. Clearly, the result would suggest that both personal values and the need for making dispassionate decisions are of value in the planning of public work construction projects.

Myers (1980) compares the preferences of Thinking and Feeling with tactfulness and truthfulness. Clearly, in the Planning of a capital improvement project both tactfulness and truthfulness would be needed for a successful outcome, albeit at different times in the process and to differing degrees. It is here that once good alternatives are discovered, considered and evaluated (within the S/N actions), the tactfulness and

truthfulness of the decision will not be a factor in performance; good data (from the S/N functioning) will lead to good performance.

The research findings suggest that Planning services are influenced from a whole type perspective as a result of the data gathering functions rather than the decision making function. Type dynamics promote the theory of interaction and directional preference between Perceiving and the Sensing/Intuition dichotomy. This research found those with a preference for Perception, or a personality "finely tuned to changing situations, alert to new developments which may require a change in strategy, or even a change of goals" (McCaully, et al., 1987, p. 102) will outperform in project planning.

7.1.2 Design (Contract Documents) Phase Services

Contrary to the *Hypothesis A*, within *Hypothesis B* addressing the Design Phase services, neither data gathering nor decision-making personality dimensions impacted performance. This result is somewhat surprising given the strong inter-dimension correlations of both the S/N and T/F dichotomies with the J/P MBTI scale. The research results, however, only conveyed a connection of the J/P scale with the performance improvements in the Design Phase services. While the personality pattern prediction of the hypothesis was for the whole type ESTJ to outperform on the design phase services, the conjecture that those with a preference for extraversion, sensing and thinking found no basis for support within this research study.

The Design Phase preparation of detailed Contract Documents needs professionals who are "decisive, not curious", "live according to plans, standards, and customs", "make very definite choice(s)", "take real pleasure in getting something finished", "aim to be right", and "are self-regimented, purposeful and exacting" (Myers

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and Myers, 1980, p. 75). These descriptions are those of a person whose personality preference is for Judging (J).

According to *Hypothesis B*, and the findings of this research, Contract Documents should not be prepared by those who "are more curious than decisive", "live according to the situation of the moment", "like to keep decisions open as long as possible before doing anything" (Myers and Myers, 1980, p. 67). This description is of one who has a preference for Perception (P).

This finding is consistent with the literature in that high levels of a Judging preference are connected with achievement and a focused discipline to the task at hand (McCrae and Costa, 1987, Barry and Stewart, 1997, Buchanan, 1998). Superior performance in the preparation of Contract Documents in the Design Phase of a project was found in those subjects who demonstrated a preference for Judging (J).

7.1.3 Construction (Administration) Phase Services

The powerful effects of the data collection and life structure personality dimensions, Intuition (N) and Perception (P), were detected in the research to be connected to the third hypothesis, the Construction Phase services. The Construction Phase services are those likely to need immediate attention in a "crisis" situation. As more participants are involved in the process and its immediate implications, the more complex the data collection and decision-making process becomes. As predicted in *Hypothesis C*, the research found that the optimal personality pattern for the generation of the best performance model included those who would not rush to judgment (P), and who keep the options open until all possibilities for alternative solutions were considered (N). This personality pattern offers the traits of Intuition and Perception, or Openness to

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Experience. These personality characteristics have also been consistently shown in the literature to be connected to the consideration of new ideas, as well as generating novel methods to solve problems (Barry and Stewart, 1997, Costa and McCrae, 1987) which is consistent with good planning results.

As discovered in the first hypothesis, for Planning Phase services, the decision-making dimension of personality did not predict performance improvement in the Construction Phase. A modified theory which one might promote, is a situation where too much in the way of dispassionate logic (T), or too much in the way of value based judgments (F), would be worse than those with a moderation of these two preferences. However, the research did not support this either. The finding of insignificance is solid in that the way the subjects prefer to arrive at their conclusions for action, the decision-making process (T/F), did not impact the performance scores in the Construction Phase services.

The implication of this result is that this research has found that the greatest improvement in performance in the Construction Administration of a project is in the way one is open to alternatives and the way options are thoroughly explored. Once options and alternatives are fully considered, the individual's Thinking/Feeling personality dimension preference did not impact performance. The idea that "thinking is not always first-class thinking" (Myers and Myers, 1980, p. 67) quite possibly offers the reason for the high correlation of performance and data gathering. The product, or decision, "is no better than the facts it started with" (Myers and Myers, 1980, p. 67), thus for improved Construction Phase decisions, this research finds that an array of alternatives and exploration of possible solutions is needed (N & P).

7.1.4 General Management of the Firm

The final hypothesis, which was associated with the Management of the Firm, did not find any significant relationships between subjects' performance and personality preferences. This finding is somewhat surprising, in that, in the pilot study a strong finding of significance was found on the Judging/Perceiving dimension. The expansion of the full research study to a broad base of project managers, or decision-makers, yielded results different from when only the partner level executives are investigated. The pilot study was a group of executives from a single firm who formed the study respondents. The homogeneity of the pilot group is a possible cause of this disparity, where there was a hypothesized expectation of a significant relationship between performance and personality, when according to this research none exists.

7.1.5 Individual Personality Traits and Personality Type

Considered as a whole, the result of this research study underscores the consequences of placing the individual with the right personality traits in the right assignment. As stared earlier in this study, Thomas Jefferson, in 1823, is credited with the observation that one of management's most difficult tasks was "to put the right person in the right place" (Jefferson, 1823). With the support of this study, the strength of individual personality dimensions in the prediction of optimal performance is solidified.

A number of researchers promote whole-type, or personality patterns, as the predictor of behavior and a discriminator of performance measures. These whole types, as well as a plethora of composite MBTI letter combinations were investigated. Forty (40) personality dimension combinations designated by letter pairs and whole types (four letter combinations) were investigated without significant findings of personality –

performance relationships beyond those found in single personality traits. These results are presented in Appendix C-8, and demonstrate a lack of support for the MBTI measurement claims of "qualitatively distinct Types", and suggest that the "instrument measures four relatively independent measures" (McCrae and Costa, 1989, p. 17). There is some disagreement in the literature over this issue, in that Myers (1998) promotes the view of whole-type, while Hirsh and Kummerow (1998) recognize combinations of personality dimensions forming patterns. The temperament theory of Keirsey (Keirsey and Bates, 1976, Keirsey, 1998) employs the discrimination of Temperaments within the MBTI theory and Jungian psychology, to combine traits and predict behaviors.

While these combinations have been reported to support the behavior theories of other researchers, there was no support found in this study for that finding, beyond that found in single dimensions of personality. However, this does not suggest that the four independent personality traits do not interact with one another in specific situations. These interactions may then direct behavior patterns in these situations, however, further industry specific study is required in order to offer any meaningful predictions (McCrae and Costa, 1989).

Numerous studies have reported on the strength of the predictive power of individual personality traits (Mendelson, Weiss, and Feimer, 1982, McCrae and Costa, 1989, Buchanan, 1998). The results of this research are in agreement with the findings of these earlier studies namely that individual personality traits provide significant predictive power for specific performance behaviors. In particular, the findings of Buchanan (1998) held that individual traits are all that are needed for the prediction of creative outcomes. This finding firmly supports the power of the creative task findings of

the Planning Services Phase and the Construction Administration Phase results, with independent significant performance improvements from those with preferences for Intuition (N) and Perceiving (P). In future research the *quantity* of creative solutions to Planning and Construction problems, and the relationship to the J/P dimension, versus the *quality* of creative solutions, along with a relationship to the S/N dimension, could serve to clarify the relationship between intuition and perception.

The findings of this research also supported the earlier work of Jackson (1996) in that the personality trait of Perceiving (P) required for open-ended and creative tasks, (Planning and Construction) were contrasted with the personality trait of Judging (J) which is needed for more structured tasks (Contract Documents-Design).

Table 7-1 Research Findings

"X" Indicates a Personality/Performance Relationship

RESEARCH FINDINGS	E	I	S	N	T	F	J	P
Planning (Conceptual Design)				X				X
Design (Contract Documents)							X	
Construction Administration				X				X
General Management								

Overall, the findings of this research add to the broad array of literature reporting the influences of personality traits on performance. This study's results of an industry specific performance measure open the way for future studies into the different phases of the construction industry's delivery of projects for public and private use.

7.2 Future Research: Gender, Educational Level and Tenure

The additional findings of this research, relating to sub-groups split by gender, educational level and tenure as discriminators, uncovered significant results that are considered here. The sub-groups where these findings were noted are generally offered with the caveat that due to the small sample sizes, the study is of limited power. They are presented to form a basis for consideration of future areas of research.

The first finding of significance noted is the result of dividing the sample into male – female categories. This allowed the opportunity to investigate the correlation of the personality – performance measures for men and women separately. The significant correlation of design performance with the clarity of the Sensing dimension (r = -0.636, p < 0.05) was found. It should be noted that there were no females in the sample reporting a preference for intuition (N). This is not out of the ordinary, since the general population of females is reported with Sensors outnumbering Intuitives, 3 to 1 (Myers et. al., 1998, p. 298). In addition, when the male and female subjects were compared in the ANOVA, investigating variance in performance within all categories of service, no significant differences were detected. This data is somewhat confounding and may be appropriate for further investigation in future research.

The second sub-group finding was the impact of graduate level education on the performance measures in the Planning Phase service. The present research detected that those with graduate degrees in architecture and engineering significantly outperformed in the Planning Phase. The hypothesized results of this research concluded a significant correlation of the Intuitive personality with Planning services. Numerous studies have reported Intuitive personalities positively correlated with higher education, particularly

graduate work (McCrae and Costa, 1989, Myers et al., 1998). The finding of the literature review suggests that since those with graduate educational experiences have a significantly higher preference for an intuitive personality trait, (N), than that found in the general population. This research has found that higher performance is expected in the Planning Phase from those with a preference for intuition, (N). One might then conclude that those with graduate degrees should perform the Planning function. This research study offers no support for any cause and effect conclusion. A relationship between intuition, (N), graduate education, and Planning performance, has been shown to exist, and this offers fertile ground for further exploratory research.

The third, and possibly most interesting of the sub-group research findings is one of tenure. A large collection of research work has demonstrated a relationship between tenure and performance (Kichuk and Wiesner, 1997; Tett et al. 1991, Tizner, 1985; Maidique and Zirger, 1984; Barrick and Mount, 1991; Day and Silverman, 1989). Much of this work, however, has focused on tenure as a function of team interaction. With this research, using professional architects and engineers as the sample, and the requirement for an internship period prior to the issuance of a license to practice professionally, the tenure variable takes on a potentially significant offering of data for further investigation.

It was discovered in this study, that those with less than 5 years experience, in other words, those who do not yet have tenure equal to the mandatory period of professional internship, showed no correlation of personality traits with performance measures, with one exception. This suggests experience as a mediator of performance. The one exception noted was in the Planning Phase activities, where there was a curvilinear negative relationship between clarity of Extraversion and Introversion and

measures of performance. In other words, those with moderate levels of extraversion/introversion significantly outperformed those with either higher levels of extraversion, or higher levels of introversion.

The Planning Phase services are those where many of the critical incidents carry an intimation of interaction with others. This one area, of a significant finding, suggests that interaction and subsequent performance of persons without requisite professional experience will revert to the core personality dimension in how we deal with others, Introversion or Extraversion. Those who would participate in the Planning work, with high Extraversion, might resort to a unique form of self-centeredness, through talkative and gregarious behavior so intense, that people compete to voice their opinions and offer ideas for consideration. Those with extreme levels of Introversion may prove so shy and reserved, that even for a person with good ideas and creative solutions, it becomes impossible for them to share openly. The implication of this finding for professional mentors to these younger staff is that caution should be exercised in the intern's participation in "Planning" work sessions. An assessment of the intern's preference for introversion or extraversion should be made, and counsel offered to assist them in proper participatory behavior.

Further research in this area may be warranted, since early career success or failure can have a lasting impact on people. If further research into the personality factors and professional development could enhance positive career growth, this potential area of study should be considered.

7.3 Limitations and Future Research

Overall, the findings of this research work suggest a number of areas for future study. First, a more detailed research study investigating the patterns of personality, or whole-type personality, with performance could be undertaken. The sample size of the present research work (N = 85) lacked sufficient power to reliably perform any analysis splitting the sample into sub-groups. In the investigation of whole-type personality for example, the sample size would need to be substantially increased to ensure sufficient power to reliably avoid Type II errors. Even so, with the discrepant results of this and other studies on type patterns versus single traits, further study in this area is needed.

Additionally, the personality traits utilized in this study were limited to the four measured in the Myers-Briggs Type Indicator. While the validity, reliability and widespread use and endorsement of this instrument make it one of the most recognized psychometric tools, further investigation into performance and other measures may be of value. A longitudinal study comparing the results of this research with other popular psychometric tools, such as the NEO-PI or the Predictive Index, might make widespread interpretation of the findings of this research available to firms already using instruments other than the MBTI®.

Since this study focused on the primary work elements of the Design Firm's services in a very specific sector of the construction industry, a multitude of other service sectors, both within the contractors' organizations and the owners' ranks might provide valuable findings. Likewise, the team personality may provide territory for investigation, both within individual organizations, and between organizations, which form co-participation teams on construction projects.

In addition, short duration project teams versus longer tenured project teams, along with the influences of personality traits, both of the team and the individuals, may provide interesting investigations. With the changing nature of the construction industry through consolidation of services and the current experiences with transitory professional personnel, the direction of future project teams is difficult to predict. If the relationship of personality traits to performance is established under different team forms, guidance to executives responsible for personnel assignments and team tasks may prove of value.

As a whole, this research work contributes to the ever-expanding body of knowledge demonstrating that individual personality characteristics influence performance. The period of employment in any one firm is becoming less; this results in the professional's lack of job security, as well as his or her willingness to change jobs frequently. These factors emphasize the increasing importance of capturing a measure of a person's personality preferences through psychometric instruments, as opposed to expert managerial observation over time.

This research supports the possibility of predicting job performance based upon the natural preferences of behavior, driven by individual personality traits. The research suggests a utility for personality measures as a diagnostic tool for individual performance interventions, rather than a tool for team selection or team-building. The essential need to provide employees with positive work experiences, keeping staff satisfied and improving the overall performance to clients, supports using all available tools and knowledge to achieve this goal. It is to that end that this engineering research contributes to a design firm's better understanding of the natural abilities of staff, where improvements in individual assignments can be enhanced, and overall firm performance optimized.