THE EFFECT OF GENERAL COGNITIVE ABILITY, TEAMWORK KSA'S, AND THE "BIG FIVE" PERSONALITY FACTORS ON THE PERFORMANCE OF ENGINEERING DESIGN TEAMS: IMPLICATIONS FOR THE SELECTION OF TEAMS

BY

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THE SELECTION OF TEAMS

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TITLE: The Effect of General Cognitive Ability, Teamwork KSA's, and The "Big Five" Personality Factors on the Performance of Engineering Design Teams: Implications for the Selection of Teams.

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ABSTRACT

General cognitive ability, Teamwork KSA's, and the "Big Five" personality factors (Conscientiousness, Extraversion, Neuroticism, Agreeableness, and Openness to Experience) were examined as potential selection measures for three-person Engineering design teams. This study used objective product evaluations as the performance criteria for the teams rather than measures of satisfaction and self-reported performance which had been used as proxies for performance in past studies. Self-reports of satisfaction and performance were measured in order to test the validity of using these measures as proxies for objective performance.

In the short period of time over which this study took place, it was apparent that some teams were able to perform at a minimally acceptable level, and some were not. Successful teams were characterized by higher composite levels of general cognitive ability, Extraversion, Agreeableness, Emotional Stability, and Teamwork KSA scores than their unsuccessful counterparts. However, from a selection standpoint, only general cognitive ability and Neuroticism provided unique variance in differentiating successful from unsuccessful teams. The heterogeneity of Conscientiousness was negatively related to the performance of successful teams.

Team member self-reports of satisfaction and performance were moderately related to the team's product performance, although the relationships were not sufficiently large to suggest that a proxy relationship exists.

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ILLUSTRATIONS

CHAPTER 1: INTRODUCTION

Self-managed teams are a growing phenomenon in the workplace as organizations face constant pressure to flatten the traditional hierarchy and maintain a structure that allows constant adaptation to the changing business environment (Cohen 1993). One of the first logical steps in formulating successful teams, is selecting the optimal members of the team (Campion, Medsker, and Higgs 1993). However, despite the potential benefits that may be realized by composing the team of the "right" people, the relative ease of manipulating the team's composition prior to the task, and the identification of team member selection as an important area of research (Landy, Shankster-Cawley, and Moran 1995), there has not been much attention given to the effective staffing of teams (Klimoski and Jones 1994) nor to the relationship between team composition variables and subsequent team performance (Sundstrum, DeMeuse and Futrell 1990; Terborg, Castore, and DeNinno 1976; Tziner 1985; Tziner 1988; Tziner and Eden 1985). In this thesis, the relationship between team composition variables and the subsequent performance of the team will be investigated with the view of proposing an integrative model of team selection using currently available personnel selection measures.

In individual personnel selection, one characteristic that has been found to have a high degree of validity in predicting job performance across a variety of jobs is the

measure of "general ability" (Campbell 1990; Gatewood and Feild 1994; Schmidt, Hunter, and Pearlman 1981). "General ability" (also referred to as the "g" factor) is usually measured by paper-and-pencil tests which are administered to job applicants in a standardized manner and measure such abilities as verbal comprehension, deduction, and numerical fluency (Gatewood and Feild 1994). The factors measured by the ability tests represent basic cognitive abilities that are necessary for successful functioning across a variety of situations. This is illustrated by the success of "g" in predicting an individual's future job performance across a variety of jobs (Campbell 1990; McHenry et al. 1990).

The logic that a person's level of basic cognitive ability is predictive of his/her job performance can easily be extended to the realm of teams. In order for a team to be successful, each member must fulfill a certain role (e.g. job) in the pursuance of the team's mandate (e.g. the team's task, or "reason for being"). Given the success of "g" in predicting job performance across a variety of situations, and the existence of valid and reliable general ability tests, it may be argued that the combination of team member general ability levels may prove to be an effective predictor of team performance on any task. Further extending this line of reasoning, if the purpose of staffing a team is to choose members that will lead to increased team performance, the "g" factor may prove to be a simple and effective staffing tool for team membership.

There has been some research relating the "initial ability level" of team members to the subsequent performance of the team. However, most of these studies did not

operationalize[1] "initial ability" as "g". Instead, initial ability was defined as the individual's performance on an identical task later performed by the team. That is, team members were required to perform the task under study, first as individuals, and then as members of a team. Team member "initial ability" was operationalized as the performance attained by the individual on the task prior to becoming a team member. Although some studies found a positive relationship between the team member initial ability defined in this manner and the subsequent performance of the team (Comrey and Staats 1955; Heslin 1964; Kabanoff and O'Brien 1979; Mann 1959; Terborg, Castore, and DeNinno 1976), there are a number of reasons why this method of operationalizing "initial ability" is of limited usefulness in the effective staffing of teams. First, operationalizing "initial ability" in this manner is situation-specific, thus any findings in these studies with regard to using "initial ability" as a predictor for performance are generalizable only to tasks identical to those in the study. Second, it is highly unrealistic in terms of time, and inefficient in terms of organizational resources, to use an involved task as a selection criterion when a quick and established measure of "g" may serve as a suitable proxy. Third, teams are often formed because the task required of the team cannot be done by one individual. Thus, requiring the individual to perform the team's task as a test of "initial ability" is not feasible. Lastly, there is little evidence that measures of specific abilities (e.g. performance on a specific task) offer incremental validity over that provided by "g" to the prediction of performance

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[1] "Operationalize" is defined as assigning a tangible measure to an intangible construct (Schmitt and Klimoski 1991, 159).

in most situations (this will be discussed in greater detail later in the paper). Thus, in this thesis, initial ability will be operationalized by "g" and will be tested to ascertain its value as a team selection measure.

At the team level, the selection process must simultaneously consider both the characteristics of the individuals comprising the team and the team itself (Klimoski and Jones 1994). It has been suggested that a competent team member is one who has the necessary technical skills and abilities to achieve the desired objective and the personal characteristics required to achieve excellence when working with others (Larson and La Fasto 1989). These two broad requirements are echoed by Klimoski and Jones (1994) who suggest that in addition to considering the knowledge, skills, and abilities required for successful completion of the task, that attributes which would facilitate team functioning should also be considered. Two of their suggestions with respect to this requirement included considering both the personality and teamwork KSA level (the knowledge, skills and abilities possessed by the members that facilitate team functioning) of potential team members when staffing a team.

Personality, as defined by the "Big Five" personality typology ("Extraversion", "Agreeableness", "Emotional Stability", "Conscientiousness", and "Openness to Experience") has recently received support in the personnel selection literature as a potentially valuable predictive device for selecting successful job incumbents (Barrick and Mount 1991; Hogan, Hogan, and Roberts 1996; Tett et al. 1994). Similarly, it has been

suggested that personality may be useful in predicting the potential success of team members in performing certain tasks (Driskell, Hogan, and Salas 1987). At the team level, personality may also be valuable in selecting certain combinations of people in order to improve team performance. This is based on the logic that the interactions of team members will influence the team's performance and that team member interactions are a function of the team members' personalities. Early group research investigated the effect of personality under the larger variables of compatibility, cohesion, and heterogeneity. However, much of this research focused on the effects of these variables on subsequent process variables or team member attitudes instead of team performance (Shaw 1976). The meager research that does exist relating team member personality to team performance (see Driskell, Hogan, and Salas 1987 for a review) uses a variety of personality measures making the results across studies hard to compare and aggregate. In this thesis, the use of personality as a predictive device for subsequent team performance will be investigated. Personality will be defined in terms of the "Big Five" typology and measured using a validated instrument of the "Big Five" currently used in the individual personnel selection literature.

Teamwork KSA's (the knowledge, skill, and abilities that contribute to the effective functioning of teams) have recently been recognized as a potential factor in the successful performance of teams. Stevens and Campion (1994a), in an extensive review of the sociotechnical systems theory literature, the industrial engineering literature, and the

social psychology literature, have identified fourteen teamwork KSAs that they claim lead to effective team functioning. In addition to this, they have developed a test that purports to measure the level of teamwork KSAs that an individual possesses. Stevens and Campion (1994a) go on to suggest that their KSA test should be used as a selection measure for employment situations requiring teamwork and for the actual staffing of teams. In preliminary studies done by Stevens and Campion (1994b), there have been some promising results of the test's success in this regard. The test has been shown to add incremental validity, over that demonstrated for general ability ("g"), to the prediction of an individual's "teamwork performance" (as rated by one or more supervisors). Although the results from this preliminary study provide some support for the usefulness of the Teamwork KSA test in predicting individual attributes assumed to be indicative of "teamwork performance" (i.e. an individual's interpersonal and self-management performance), the results from this study may not be generalized to the performance of a self-managed team. This study did not take into consideration how the combination of Teamwork KSA scores impacted on the quality of a team's product. Therefore, the validity of the Teamwork KSA test in predicting the performance of a team from the scores of the team members has not yet been established. However, the potential contribution of such an instrument in staffing teams warrants investigation. In this thesis, the predictive validity of the Teamwork KSA test in predicting team performance will be investigated. The claim of incremental validity of this test over that of cognitive ability

will also be investigated for actual teams (instead of teamwork-related job performance of individuals).

The usefulness of some selection criteria (e.g. personality; Barrick and Mount 1991; Tett et al. 1994) in predicting job performance may vary in response to different job requirements and performance criteria (which are usually derived from the purpose of the job). Similarly, in teams, the mandate of the team (that is, the task or purpose of the team) sets the expectations/limitations for the group and helps define the characteristics required for optimal performance (Klimoski and Jones 1994). The usefulness of the selection criteria must therefore be defined in terms of the team's purpose and task. The focus of this thesis will be on teams charged with an Engineering Design task. The team is required to design and build a product in accordance with pre-defined constraints and performance criteria. Team effectiveness will be evaluated in accordance with the team's mandate (Guzzo 1986; Guzzo and Shea 1992). That is, the effectiveness of the team will be defined as the quality of the team's product. The utility of the selection devices in predicting team performance must therefore be interpreted in the context of teams performing similar tasks against objective performance criteria.

In summary, the purpose of this thesis is to lay the groundwork for developing a model of team selection by investigating the potential validity of various selection measures with respect to the performance of Engineering design teams. Performance will be defined as the quality of the team's product. The primary independent variables in the model include general cognitive ability ("g"), Teamwork KSA's, and the "Big Five"

personality factors (Extraversion, Agreeableness, Emotional Stability, Conscientiousness, and Openness to Experience). In addition to these variables, the effect on performance of team members' attitudes toward teamwork and gender will also be investigated and integrated into the model if appropriate. Where the literature provides evidence of a relationship between the independent variables outlined above and the dependent variable (team performance), hypotheses will be suggested and tested. However, for the majority of the relationships possible between the independent and team performance variables, the literature has not yet advanced to the point where hypotheses are possible. In these cases, an exploratory analysis will be carried out in an attempt to ascertain if relationships do exist. The model which will be proposed at the end of this thesis will endeavour to integrate both the confirmatory relationships (those for which hypotheses were offered and tested) and the relationships uncovered by exploratory analysis.

CHAPTER 2

LITERATURE REVIEW

Context of the Review

As alluded to in the introduction, this study is concerned with self-managed (or autonomous) teams. In this type of team, members are responsible for a whole task, and have discretion over both the work task assignments within the group (e.g. management of the work required to fulfill the task), and the group maintenance functions (e.g. norms, rules, feedback) (Cummings 1978; Cummings 1981; Cannon-Bowers, Oser, and Flanagan 1992; Goodman, Devadas, and Griffith Hughson 1988). Of particular interest in this thesis are those self-managed teams where there is no appointed leadership role. Thus, although for some teams leadership is very important, and there is substantial literature on what traits make a good leader (Bass 1985), and how small group performance is affected by certain leadership styles (e.g. Hogan, Curphy, and Hogan 1994), review of this literature is beyond the scope of this thesis. From this point on, the terms "team" and "group" will be used interchangeably to refer to leaderless, autonomous work teams.

The survival of many organizations is dependent on the success of the products they produce. One of the dimensions of a successful product is the "relative product quality", that is, the quality of the product as defined by the customer, and as compared to

the quality of the competitors' products (Cooper 1994). From a business perspective, the team responsible for the design of the product should be evaluated in a way that is in line with the organizational objective of producing a superior product. Thus, the design teams should be evaluated on their ability to design a product that adheres to the requirements and constraints that are defined in response to customer demands. In order for the results of this study to be applicable to the business community, the success of the Engineering design teams will be defined as the degree to which the product they produce adheres to, and exceeds pre-defined conditions. This differs from the traditional psychological approach of studying teamwork which defines team success as the ability of the team to increase team member satisfaction (although this would be a pleasant secondary outcome).

Since the main concern of this thesis is how to best staff a product design team in order to improve the quality of the team's product, much of the small group literature which relates group composition variables to team member satisfaction without providing an objective evaluation of team performance is not applicable and will not be included in the literature review.

Although there is no question that the characteristics of the team's interaction processes affect the team's capacity to improve performance, the details of team interaction are beyond the scope of this thesis. The interaction process is a function of the team members' characteristics (e.g. combinations of personality) and will be reflected in the performance of the team. Once it is determined what combinations of people are

effective in teams for the completion of certain task types, future research may be warranted to improve the accompanying group process. Therefore, much of the small group literature from the social psychology perspective is not relevant here due to its focus on team process (e.g. studies in which the dependent variable is a process variable such as team member participation, reaction to others, accuracy of communication, ability to resolve conflict, etc. without consideration of an objective outcome measure) rather than the team's performance (as defined by objective product measures). In addition, much of the work team literature from the sociotechnical literature which focuses on simultaneous redesign of the technological and sociological organizational systems is also beyond the scope of this thesis. However, studies from both of these bodies of literature are reviewed if they investigated characteristics of team composition and related them to the team's subsequent performance (as defined by objective measures).

As briefly stated in the introduction, this investigation is concerned with the performance of an Engineering Design team which is charged with the task of designing and building a certain product according to pre-determined constraints and parameters. The literature review was conducted with respect to teams or small groups engaging in tasks with similar characteristics. Tasks which were deemed similar included those termed as "intellective"(Shaw 1976) or "intellectual" (Carter, Haythorn, and Howell 1950) in that cognitive functioning was a primary requirement for the task; "problem-solving" (Hackman 1968; Hackman, Jones, and McGrath 1967; Hackman and Morris 1975) in that

there are competing constraints involved in obtaining a solution; and "decision making" (Laughlin 1980) or "complex problem solving" (Hill 1982) in that there is more than one acceptable or correct solution (the team must try to discern an "optimal" solution to the problem). Tasks which fulfill all of these characteristics are henceforth referred to as "optimizing" tasks.

Only studies which addressed team composition variables with respect to performance for "optimizing" tasks are reviewed since only these tasks were deemed to have similar characteristics to the Engineering Design task. This means that studies from the small group research that investigated composition/performance relationships for additive tasks (Steiner 1972) such as anagrams; "eureka" (disjunctive; Steiner 1972) tasks which have only one demonstrably correct solution; "brainstorming" tasks which required only a list of ideas as their output; and predictive tasks such as playing battleship, estimating armistice dates during the war, guessing the number of dots on a page, predicting which horse will win a race, were not included in this literature review.

The Dependent Variables

Team Performance

In this thesis, team effectiveness and team performance are synonymous. The team's performance will be defined as the quality of the group's product as measured against an external set of pre-determined standards. Many models of group effectiveness (e.g. Gladstein 1984; Guzzo and Shea 1992; Hackman 1987; Nieva, Fleishman, and

Rieck's study as cited by Goodman, Ravlin, and Argote 1986; Steiner 1972; Sundstrum, DeMeuse, and Futrell 1990) recognize task performance as a component of effectiveness, however, other outcomes such as satisfaction and group longevity are deemed equally important. The primary reason that satisfaction of group members is considered important in the above models but not here is that these models are derived primarily from the "small group" literature which has tended to focus on groups established to satisfy members' own sociopsychological needs rather than on groups formed in an attempt to optimize a product (Tziner 1982). Shea and Guzzo's model (as cited by Goodman, Ravlin, and Schminke 1987) defines team effectiveness situationally in terms of the extent to which a group fulfills its charter. Thus, if a team is formed to design a product, the quality of the product should be the criterion on which the team is evaluated - not the satisfaction of the team's members.

Group longevity is also deemed important in many of these models. If a team is to work together for a long period of time, this variable is important. However, with Engineering Design teams, often team members are brought together for relatively brief and defined (e.g. "until the project is complete") amounts of time. Thus, propensity of the team to work together in the future is not as important as the quality of the product which results from the brief encounter. However, it is recognized that this variable may be valuable for long-term design projects or for situations where it is possible that the same people from the team will work together in the future. Thus, after the Engineering Design

problem has been completed, the subjects will be asked if they would be amenable to working together on future projects with the same team. The team's preference for working together in the future in relation to the team's performance will be investigated in an exploratory manner.

Many of the authors of the group effectiveness models (referenced above) suggest that task performance be operationalized by performance criteria external to the team (e.g. satisfaction of the customer with the product, quality of the product as determined by "experts", evaluation of the product against external criteria). However, in many of the studies of group effectiveness, the performance of the group (including the quality of the product) has been construed either from the satisfaction of the members based on the "logic" that teams of satisfied members perform better than those with unsatisfied members, or, on the self-reported performance of the team members.

It is argued here that the operationalization of performance as team member satisfaction is not appropriate (unless perhaps, the only team mandate is to improve the members' satisfaction levels). In the personnel performance literature, there has been little empirical support linking employee satisfaction with actual performance measures. A meta-analysis by Iaffaldano and Muchinsky (1985) investigating the relationship between individual satisfaction and individual performance measures found an overall correlation of only 0.17 between these two variables. It is therefore inaccurate to assume that satisfaction and performance are substitutes from a measurement standpoint.

There are also two studies which call into question the practice of equating satisfaction with performance at the team level. In a study by Gladstein (1984), group effectiveness as defined by an objective measure of team performance (sales revenue) did not significantly correlate with team satisfaction. A second study also supported this finding. In an exploratory study done by Kichuk (1996) it was discovered that for product design teams, the satisfaction of the team members did not correlate significantly with their actual performance as measured by the quality of the product produced.

The Gladstein (1984) and the Kichuk (1996) studies also offered evidence against the use of self-reported performance measures at the team level. Self-reported performance of the team was significantly correlated with the team members' satisfaction level ($r = 0.86$, $p<.01$, Kichuk 1996; correlation not reported, $p<.001$, Gladstein 1984), but it was not correlated with the team's actual performance. Further evidence against the use of self-reported performance measures was found in a meta-analysis done by Mabe and West (1982) investigating the relationship between self-reported job performance and actual performance ratings received. This analysis reported that self-perceived performance and actual performance had an overall correlation of only 0.29 with high (SD = 0.25) variability. Given this moderately low relationship between perceived and actual performance, it is questionable whether self-reported performance is justifiable as a measure of actual performance to the degree it has been used in previous small group research. Even the noted authority, McGrath (1984) briefly lamented that small group

research needed to use other measures in addition to self-reports for performance in order to assess the performance of the team.

Given the management focus of this thesis, that is, the concern with product quality rather than team member satisfaction, neither the satisfaction of the team members nor the self-reported performance of the team members are deemed to be appropriate measures of effectiveness. The measure of performance that will be used in this study involves measuring the product against external objective criteria instead of reliance on team member self-reports of performance or satisfaction. Self-reported performance and satisfaction will be measured, however, to further investigate the relationship between objective measures and self-reported measures of performance in a team environment.

The Independent Variables

Initial Ability

General ability ("g")

Cognitive ability testing (also called "mental ability testing", Gatewood and Feild 1994) is one of the oldest methods used to select personnel. Ability tests are usually in paper-and-pencil form and are administered to applicants in a standardized manner. They are designed to measure the "overall" ability of a person to function in a variety of situations. Empirical evidence suggests that mental ability tests are valid predictors for a wide variety of jobs (Campbell 1990; Gatewood and Feild 1994; Ghiselli 1973; Schmidt,

Hunter, and Pearlman 1981) with validities of up to 0.65 in predicting job task performance (Campbell 1990; McHenry et al. 1990; Lubinski and Dawis 1991).

There is also evidence that people high in cognitive ability are faster at cognitive operations on the job, are better able to prioritize between conflicting rules, are better able to adapt old procedures to altered situations, and are better able to learn new procedures quickly as the job changes over time (Hunter 1986). General ability tests have been found to be especially useful in predicting the probability of success in jobs that have information processing and problem-solving components (Schmidt, Hunter, and Pearlman 1981). Thus, the general ability level of team members is expected to be positively related to the performance of the Engineering Design task under investigation.

Some studies from the "small group" literature suggest that team performance is positively related to the initial ability level of the team members (Comrey and Staats 1955; Heslin 1964; Johnson and Torcivia 1967; Kabonoff and O'Brien 1979; Mann 1959; Terborg, Castore, and DeNinno 1976; Tuckman and Lorge 1962) and in some cases is better than the performance possible from any individual on the team (Watson, Michaelson, and Sharp 1991). However, as stated in the introduction, these studies have operationalized initial ability as the individual members' performance on a prior task that is the same or similar to the task performed by the team. Although these studies do not provide direct evidence that the level of "g" possessed by the team members is related to the subsequent performance of the team, the results of these studies may be interpreted as

an indication that "g" may be useful in predicting subsequent team performance. Since "g" is predictive of a person's performance across a variety of situations (Campbell 1990; McHenry et al. 1990), it may be argued, that "g" and the individual's performance on a task are related. That is, there is overlap between the measures of initial ability used in the studies (the individual's performance on a task) and "g". With this line of reasoning, the results from the studies which operationalize initial ability as previous task performance and relate this measure to subsequent team performance, may be interpreted as evidence that the initial ability level of the team members (as defined by "g") might correlate with the subsequent performance of the team for optimizing tasks. This reasoning linking the two measures of initial ability, in addition to the evidence from the personnel selection literature which shows the success of "g" in predicting subsequent job performance, leads to the first hypothesis.

H1: The team's level of general cognitive ability ("g") (operationally defined as the sum of the scores received by each individual on the team on the cognitive ability test) will be positively related to the team's performance (operationally defined as the score that the team receives on their product according to a pre-defined objective scoring guide).

Specific Abilities

The question of whether subsets of ability have incremental validity over that of general ability in predicting job performance is a hotly debated issue (Lubinski and Dawis

1991). However, the majority of the evidence seems to indicate that subsets of ability do not add statistically significant nor practically meaningful incremental validity to the prediction of job performance (McHenry et al. 1990; Ree, Earles, and Teachout 1994). Incremental validities for specific abilities in predicting job performance over general abilities were not found in the Project A experiments which spanned 7 years and investigated all of the entry-level positions in the United States army (Campbell 1990; McHenry et al. 1990). Further, Hunter (1986) contends that scores obtained on general mental ability tests are as good as composite scores of specific abilities designed for specific jobs. Thus, specific abilities as related to the design task in this thesis will not be used for predictive purposes.

Although measures of general ability seem to be adequate in predicting job performance for individuals, the performance of teams relies on both the individual's ability to perform the task and the ability of the individuals on the team to effectively work as a team. Thus, in spite of the lack of support for using specific abilities at the individual level, at the team level, it may be necessary to evaluate the team members' abilities to work on teams as well as their general ability level to accurately predict team performance.

Stevens and Campion (1994b) have recently developed an instrument that they claim measures the knowledge, skills and abilities (KSA's) of a person that are required to successfully work on a team. These authors extensively reviewed the team literature, including the sociotechnical literature, the organizational behavior literature, the industrial

engineering literature, and the social psychology literature in order to propose an overall taxonomy of KSA's that may be related to effective teamwork. The two major categories of KSA's included those addressing interpersonal KSA's and Self-management KSA's demonstrating both a concern with the individual and team level of analysis. Within the interpersonal KSA's, three subcategories emerged: conflict resolution KSA's, collaborative problem solving KSA's, and communication KSA's. The subcategories of self-management KSA's included: goal setting and performance measurement KSAs as well as planning and task coordination KSAs. The theory from which this test was derived focuses on team member interaction and process variables (e.g. ability to handle conflict, identification of positive versus negative conflict, communication, decision-making processes, listening skills, social-loafing, free-riding). As previously established in the "Context of the Review" section, some of these process variables are proposed to be a function of individual characteristics of the team members (e.g. a person's propensity to participate, or loaf, or engage in conflict) and will be captured when considering the team members' characteristics (e.g. personality). Other process variables such as specific decision-making processes (e.g. the nominal group technique, the Delphi method) and communication processes (e.g. structured interaction) are actual process interventions that may be imposed on a group to influence performance. This study is concerned with potential selection measures and criteria (e.g. ability, personality, attitude, experience) that are conducive to team performance. Process interventions were not considered in this

study. Thus, the literature used to develop the Teamwork KSA test, and the Teamwork KSA test itself, is relevant to this thesis to the degree that the test scores of the individuals on the team impact the performance of the team.

Preliminary tests done by Stevens and Campion (1994b) indicate that individual scores on the teamwork KSA test significantly correlate with supervisor ratings (86% of the cases in study 1 and 100% of the cases in study 2 were evaluated by two or more supervisors) of current job performance. Performance ratings were divided into technical performance (e.g. items which evaluated task proficiency), teamwork performance (e.g. items which evaluated interpersonal and self-management performance), and total performance (e.g. an average across all performance items). The results from the two studies indicated significant correlations between individual KSA test scores and individual technical performance (Study 1: $r = 0.56$, $p<.01$; Study 2: $r= 0.25$, $p<.05$), individual teamwork performance (Study 1: $r = 0.44$, $p<.01$; Study 2: $r= 0.21$, $p<.05$), and individual overall performance (Study 1: $r = 0.52$, $p<.01$; Study 2: $r = 0.23$, $p<.05$). In study 2, the Teamwork KSA test was found to also significantly correlate ($r = 0.23$, $p<.05$) with peer ratings of teamwork performance. In the first study, the teamwork KSA test was found to show a significant increase in explained variance for both teamwork performance ($\Delta R^2 = 0.08$, $p<.05$) and overall performance ($\Delta R^2 = 0.06$, $p<.05$) over that provided by a score of general ability (the general ability score was a composite score derived from the results of nine standardized aptitude tests administered to the employees).

These preliminary results of the Teamwork KSA test investigate the relationship between test scores and the performance of individuals in a "teamwork environment". The Teamwork KSA test scores have not been related to the performance of individuals on actual teams, nor to the performance of teams. Thus, the results from the study do not directly provide evidence that the Teamwork KSA test is a valid predictor of team performance. However, there are several reasons to expect that this test potentially is a predictor of team performance. First, the fourteen teamwork KSAs were derived from a careful synthesis of three bodies of relevant literature (the sociotechnical systems theory literature, the industrial engineering literature, and social psychology literature) where underlying similarities were identified and condensed into a taxonomy. These specific KSAs are thus in-line with the existing theories on how group process variables affect group performance (e.g. conflict resolution theories, collaboration theories, communication theories, goal setting theories, and co-ordination theories). Thus, the KSA teamwork ability test is high in face validity (e.g. it "makes sense" that teams whose members have these abilities SHOULD perform well). Second, the authors propose that the Teamwork KSA test's construct validity received support from the results of the two studies carried out by Stevens and Campion (1994b). Specifically, the teamwork KSA test correlated significantly ($r = 0.81$, $p<.01$) with the composite derived from the battery of nine general aptitude tests. It should be noted that although the authors use the correlation of the Teamwork KSA test with the general ability battery as evidence of

construct validity, the strength of this correlation could also be used as evidence that the Teamwork KSA test is actually a measure of "g". However, despite the high correlation between the Teamwork KSA test and the general ability test battery, the teamwork KSA test was found to provide incremental validity over and above that offered by the general ability composite in predicting teamwork-related (as defined above) job performance in one of the authors' studies. Thus, this test may be of value in predicting behavior conducive to team functioning and may be of some use as a selection tool for the effective staffing of teams.

A variety of relationships between the scores obtained by team members on the Teamwork KSA test and the subsequent performance of the team will be investigated. First, scores obtained by each individual member on the team will be correlated with the performance score that their team received. It is not known if this will produce any significant relationships since team performance is obviously a function of more than just one team member. Thus, the team level of analysis will also be investigated. Specifically, it is of interest in the teamwork KSA measure to find out if a compensatory relationship exists for the team member scores on the KSA test. That is, if the team members differ in their level of KSAs for teamwork, can a high scoring member compensate for a low scoring member? That is, does the teamwork "know how" brought to the team by one member influence the behaviour of another who is not as knowledgeable about effective team functioning? This will be examined by calculating a composite score (the addition of

the individual team member scores) for the team and relating this score to the team's performance score.

Heterogeneity of Member Ability Levels

Other things being equal, groups composed of members having diverse abilities that are relevant to the task perform more effectively than groups composed of members having similar abilities (Shaw 1976). This is based on the assumption that most group activities require a variety of skill and knowledge in order to be completed. Thus, the more heterogeneous the group, the more likely the necessary abilities and information will be available and the more effective the group is likely to be (Bantel and Jackson 1989; Shaw 1976; Shaw 1983). When tasks assigned to the group are diverse, membership heterogeneity in terms of abilities positively affect performance (Gladstein 1984; Goodman, Ravlin, and Argote 1986; Hackman 1987; Pearce and Ravlin 1987).

It is important to make a distinction here. Heterogeneity of abilities in this context does not mean heterogeneity of ability levels. Unfortunately, some researchers have used heterogeneity of ability levels as equivalent to heterogeneity of ability types and have wondered why there is a negative relationship between the heterogeneity of group member ability and subsequent group performance (Campion, Medsker, and Higgs 1993). It is not logical that groups high in heterogeneity of ability levels would always outperform those with low heterogeneity. For example, it may be expected that groups with members all

possessing high ability levels (low heterogeneity) may outperform groups made up of members possessing various ability levels (high heterogeneity).

The work of Laughlin and his colleagues proposed the "division of ability" model which tried to predict team performance as a combination of group member ability levels. This model assumed that a person of greater ability on a particular task-relevant dimension possesses all of the resources of a person of lesser ability, but does not necessarily possess the same resources as a person of comparable ability. Thus, a person working with a partner of greater or comparable ability will improve relative to his performance alone, while a person working with a partner of less ability will not improve relative to his performance alone. Further, as the ability level of a person increases, the overlap of abilities with a person of comparable ability decreases. Thus, the improvement in performance possible for multiple high ability people is more than that possible for multiple lower ability people. This model was extensively tested by Laughlin and his colleagues and was supported for the majority of the predictions made for dyads (Egerbladh 1976; Laughlin and Johnson 1966), triads (Egerbladh[2] 1976; Laughlin, Branch, and Johnson 1969), and tetrads (Laughlin and Branch 1972).

Tziner (1985) proposed hypotheses relating the combination of group member ability levels to subsequent group performance based on the logic of similarity theory (he

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Egerbladh (1976) actually tested Steiner's complementary model which states that group members have shared and unshared abilities. Group performance is thought to be less than the values of the summed abilities of the members but greater than the values of the individual performing alone. This is a similar theory to that proposed by Laughlin and his colleagues. Egerbladh (1976) claims support for Steiner's complementary model, but discusses his results in terms of the Laughlin et al. studies.

also proposed competing hypotheses based on Equity theory which were displaced by the support found for the similarity theory-based hypotheses). Similarity theory states that the homogeneity of group members evokes positive mutual attraction while heterogeneity introduces divisive tensions. Tziner (1985) hypothesized that for triads, homogeneously high ability teams would perform in accordance with a rule of positive nonadditivity (the product would be superior to that predicted by simply adding the individual ability levels of the group members - deemed "process gain" by Steiner 1972), while heterogeneous groups (those in which there are either two high or two low ability members) and homogeneously low ability groups would perform in accordance with a rule of negative nonadditivity (the product would be inferior to that predicted by adding the group members' ability levels - deemed "process loss" by Steiner 1972). In a task characterized by high interdependence, Tziner and Eden (1985) found that the performance of homogeneously high ability members was in accordance with a rule of positive nonadditivity while the performance of homogeneously low ability members was in accordance with the negative nonadditivity rule thereby offering support for his similarity theory hypothesis.

The findings of Laughlin and his colleagues and those by Tziner and Eden (1985) relating team member abilities and team performance are similar with respect to homogeneous teams. That is, they both infer that teams consisting of high ability members exhibit an improvement in performance relative to an individual team member's prior

performance greater than that exhibited by teams consisting of low ability members. However, the researchers differ in the extent to which this improvement takes place in homogeneous teams[3], and the relationship between heterogeneous team member ability levels and team performance. Accordingly, the findings do not offer absolute guidance in the establishment of hypotheses with regard to how the heterogeneity of team member ability levels may affect performance. However, it does seem plausible that heterogeneity of ability levels will play a role in the performance of the team especially as the degree of heterogeneity interacts with the composite score of the team on the ability. Exploratory data analysis investigating the effect of team member ability level heterogeneity within the team as well as the interaction of this heterogeneity level with the composite team ability level will be conducted for both general cognitive ability and teamwork KSA scores.

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[3] If we let HHH = the performance of a team with three high ability members, H = the performance of one high ability member, LLL = the performance for a team with three low ability members, and L = the performance of one low ability member, we can summarize the findings of Laughlin and his colleagues and Tziner and Eden in equation form (the differences in findings become clear when expressed in this form):

Laughlin and his colleagues:

$HHH > H$ and $LLL = L$

Tziner and Eden:

$HHH > 3H$ and $LLL < 3L$

Personality

Personality traits are relatively enduring characteristics of individuals which are not easily changed by interventions such as behavioural training (Helmreich 1984). Although there is a multitude of research on personality, most of it is in the clinical psychology literature and deals with the relationship of personality type with abnormal behaviour. There has been relatively little effort put forth to determine the personality factors associated with exceptional performance (Driskell, Hogan, and Salas 1987). As well, there is little consensus on the personality test/scale that should be used which makes comparison across studies difficult. However, there has been some work in developing an overall classification system for personality traits. Although not without its critics (e.g. Briggs 1989; Hough 1992; John 1989; McAdams 1992), "The Big Five" ("Extraversion", "Emotional Stability", "Agreeableness", "Conscientiousness", and "Openness to Experience") classification system (which will be described in greater detail later in the paper), has received the most support (Barrick and Mount 1991; Costa 1996; Digman 1990; Digman and Inouye 1986; Fiske 1994; Goldberg 1990; McCrae 1989; McCrae and Costa 1985, 1987; Norman 1963; Peabody and Goldberg 1989; Tett, Jackson, and Rothstein 1991; Tupes and Christal 1961; Wiggins and Pincus 1992) and will be used as a comparator in this study.

Several researchers have suggested that team member personalities may predict future performance (Cattell 1951; Golembiewski 1962; Hackman and Morris 1975;

Ridgeway 1983). However, there are also many opponents to this notion (Kahan et al. 1985; Mann 1959; Sorenson 1973; Whyte 1941). Those who are pessimistic about the usefulness of personality tend to refer to studies done in the 1950's which attempted to make sweeping generalizations about personality traits to a wide array of situations. Current reviews and meta-analyses, using more sophisticated analysis techniques, a consistent taxonomy of personality traits (e.g. the "Big Five"), and specific performance criteria (George 1992) suggest that there is potential to use personality measures in selection decisions (Schneider 1996). Furthermore, some researchers have found that managers implicitly use personality factors in their hiring decisions (Dunn et al. 1995).

Research in the personnel selection literature indicates that if relevant personality factors are identified for a specific job or role, future performance can be predicted (Barrick and Mount 1991; Borman, Rosse, and Abrahams 1980; Day and Silverman 1989; Lord, DeVader, and Alliger 1986; Tett, Jackson, and Rothstein 1991). Extending this logic into the realm of teams, if relevant personality traits are identified for a specific team task , the personality profile of the team can be helpful in predicting future team performance (Driskell, Hogan, and Salas 1987). The application of such knowledge would help organizations to improve the effectiveness of the team simply by ensuring that the personality profile of the team (e.g. the combination of team member personality factors) matched the requirements of the task (Klimoski and Jones 1994). After reviewing much of the team personality literature, Driskell et al. (1987) proposed various hypotheses

relating Hogan's six personality factors (Hogan uses four of the "Big Five" factors: "Agreeableness", "Openness to Experience", "Emotional Stability", and "Conscientiousness" and splits "Extraversion" into "Sociability" and "Ascendancy") to certain task types. The hypotheses that were proposed relating team member personality factors to team performance for optimizing tasks (those tasks where more than one possible solution exists and the team's mandate is to create the best possible product/solution that they can) are included below in the discussion under the appropriate personality factor. Although Driskell et al. did not directly propose how to operationalize the team's personality profile, they suggested that "any single individual or composite of individuals can be described in terms of these dimensions [Hogan's six personality factors]" (Driskell et al. 1987, 99) suggesting that each personality factor should be considered separately and that a combination of scores on the factors may be used.

The use of personality in the realm of team staffing is more complex than simply using it to predict success in a particular job. Not only must the personality profile of the team match the demands of the task, the people on the team (and hence, their personalities) must be compatible. Organizations are beginning to realize the importance of considering personality mixes when designing self-managed work teams. For example, at Eastman Kodak, teams were constructed using the best technical people available. However, despite the attention to ability level, sometimes the teams were successful, and sometimes they were not. Once the company started to take personal compatibility into

account when organizing teams, the teams have had a higher success rate (Moad 1994).

Thus, personality seems to have a definite contribution to make in helping organizations to staff effective teams.

Review of the literature in terms of the Big Five

The studies relating team member personality to team performance is sparse. Most of the studies that do exist measure and relate specific personality traits (which compose a minute piece of one of the five factors) to team performance or team satisfaction. There is almost no replication of any of the results due to the task specificity and the situational nature of the experiments. There are therefore no specific conclusions relating personality as classified within the "Big Five" framework to team performance. However, the preliminary results from the available studies indicate that some personality traits may affect performance for certain tasks in certain situations (Driskell, Hogan, and Salas 1987). A brief overview of the findings to date for each factor will be described.

Conscientiousness. A person displaying the factor of "Conscientiousness" has been described as being dependable, careful, thorough, responsible, organized, planful, hardworking, persevering, and achievement-oriented (Barrick and Mount 1991; Digman, 1990). In the personnel selection research, the factor "Conscientiousness" has been shown to be a valid predictor of future job performance for all occupational groups

(Barrick and Mount 1991; Barrick and Mount 1993; Costa 1996; Hough et al. 1990; Piedmont and Weinstein 1994; Tett et al. 1994). Furthermore, some researchers contend that the factor of Conscientiousness (as operationalized by an integrity test) provides incremental validity in predicting future performance over that provided by general ability (Landy, Shankster-Cawley and Moran 1995; Ones, Viswesvaran, and Schmidt 1993). Given that each person in the team is performing his/her job by participating in the team task, it is logical that the factor of "Conscientiousness" may also be related to task performance of the group. This extension of logic is also supported by recent findings by Thoms, Moore, and Scott (1996) which show that "Conscientiousness" is positively related to self-efficacy (which the authors contend is predictive of performance) for participation in self-managed work groups.

It should be noted that there is some controversy over the classification of the term "achievement oriented" or "need for achievement" included in the "Conscientiousness" definition above. Hough (1992) found that "need for achievement" loaded on both the factor of "Ambition" (which is part of the Big Five "Extraversion" factor) as well as the Big Five factor of "Conscientiousness". However, the traits given as representative of the "Extraversion" factor (sociable, gregarious, assertive, talkative, and active) do not suggest that "achievement-orientation" is a necessary part of this construct, whereas traits associated with "Conscientiousness" (hardworking and persevering) do. Furthermore, Costa and McCrae (1992) include the sub-factor of "achievement striving" in the main

factor of Conscientiousness. Thus, literature that investigated the "need for achievement" or "achievement orientation" factor in relation to team performance was interpreted as evidence for the relationship between the "Conscientiousness" factor and team performance.

There are several studies that investigate the "need for achievement" or "achievement orientation" in relation to group performance. Groups whose members showed a high need for achievement outperformed groups whose members had a low need for achievement (French 1958; Schneider and Delaney 1972; Zander and Forward 1968) on a variety of tasks. Leadership orientation (which presumes "need for achievement") was also found to correlate positively with group performance (Shaw and Harkey 1976). In addition to this, Driskell, Hogan, and Salas (1987) propose that "ambition" (which includes "need for achievement") may be predictive of team performance for a variety of tasks.

H2: The team's level of Conscientiousness (operationally defined as the sum of the scores received by each individual on the factor of Conscientiousness) will be positively related to the performance of the team.

Extraversion. "Extraversion" is exemplified by such traits as sociability, gregariousness, assertiveness, talkativeness, and activeness (Barrick and Mount 1991; Digman 1990). In the individual personnel selection literature, "Extraversion" is positively correlated with

interpersonal relations (Piedmont and Weinstein 1994) and has been shown to have positive validity in predicting future individual job performance for those occupations that have a large social component (Barrick and Mount 1991; Barrick and Mount 1993; Tett et al. 1994). Given that an optimizing task performed as a team requires frequent social interaction among the members, it may be argued that the factor of "Extraversion" could be related to the team's performance for an optimizing task.

The research that has been done with respect to components of "Extraversion" in the realm of the team environment has been diverse.

Dominance, (which is closely related to the factor of "Ambition" (Hogan 1991), which in turn loads on the factor of "Extraversion" (Hough 1992)) has been shown to be positively related to the performance of the group (Altman and Haythorn 1967; Bouchard 1969; Driskell, Hogan, and Salas 1987; Haythorn 1953; Shaw and Harkey 1976; Smelser 1961; Williams and Sternberg 1988) as well as the degree of participation within the group (Aries, Gold and Weigel 1983[4]; Mann 1959; Watson 1971).

The level of "Sociability" (which is part of "Extraversion" according to Hogan, 1991) of group members has been shown to relate positively to team performance (Bouchard 1969; Shaw 1976). In addition, an early review of studies relating personality factors to team characteristics by Mann (1959) reported a positive relationship between

[4] Dominance was correlated with time talking, verbal acts initiated, and interruptions for male group members.

the factor of "Extroversion" (which consisted of "Sociability" and "Surgency") and the degree of group member task-related participation.

The degree of participation within the group is usually operationalized as the amount of talking done by each group member. Williams and Sternberg (1988) found that both the average amount of talking done by members of the group and the maximum amount of talking done by any member of the group was positively correlated with the performance of the group.

The factor of "Extraversion" as measured by the Eysenck Personality Questionnaire was not found to correlate significantly with team performance (Williams and Sternberg 1988). However, Thoms, Moore, and Scott (1996) found that "Extraversion" as measured by the NEO-FFI (Costa and McCrae 1992) was positively correlated with self-efficacy (and hence performance - according to Thoms et al. 1996) for participation in self-managed work groups.

The majority of the evidence seems to suggest that there should be a positive relationship between the factor of "Extraversion" and team performance. Thus,

H3: The Team's level of Extraversion (operationally defined as the sum of the scores received by each individual on the factor of Extraversion) will be positively related to the performance of the team.

Neuroticism. The factor of "Neuroticism" may also be thought of as a lack of "Emotional Stability", or "Adjustment" (which is the degree to which one exhibits "Emotional Stability"). "Neuroticism" is characterized by traits such as anxiety, depression, anger, embarrassment, emotionality, and insecurity (Barrick and Mount 1991; Digman 1990).

In the personnel selection research, "Emotional Stability" has been found to positively correlate with interpersonal relations and adaptive capacity (Piedmont and Weinstein 1994), and performance in service jobs (McDaniel and Frei's study as cited by Hogan, Hogan, and Roberts 1996). Barrick and Mount (1991) hypothesized that once a certain threshold of stability had been attained by the person tested, the degree of "Emotional Stability" was no longer relevant in predicting performance.

However, in the realm of groups or teams, both Mann (1959) and Heslin (1964) claimed that "Adjustment" was one of the best factors in predicting group performance. Others also noted that "Emotional Stability" or lack of nervous tendencies was positively correlated with group effectiveness (Haythorn 1953; Mann 1959; Shaw 1976) and distinguished leaders from nonleaders (Cattell and Stice 1954; Richardson and Hanawalt 1952). "Neuroticism" was also found to be negatively related to self-efficacy (and performance) for participating in self-managed work groups (Thoms, Moore, and Scott 1996). Driskell, Hogan, and Salas (1987) hypothesized that "Emotional Stability" should be positively correlated with group performance for all tasks. In sum, the consensus

seems to be that "Emotional Stability" should be positively correlated with subsequent group performance, or, that "Neuroticism" should be negatively correlated with subsequent group performance. Thus:

H4: The Team's level of Neuroticism (operationally defined as the sum of the scores received by each individual on the team on the factor of Neuroticism) will be negatively related to the team's performance.

Agreeableness (Likability). A person exhibiting traits included in the "Agreeableness" factor is courteous, flexible, trusting, good natured, cooperative, forgiving, soft-hearted, and tolerant.

In the individual selection literature, McDaniel and Frei (as cited by Hogan, Hogan, and Roberts 1996) found that customer service measures (which contain facets of Agreeableness) predict job performance in service jobs.

The results linking "Likability" with group performance are not consistent across studies. Most studies did not find a significant relationship between group member likability and performance or productivity (Berkowitz 1959; Haythorn 1953; McGrath 1962; Terborg, Castore, and DeNinno 1976; Tziner and Vardi 1982), while some found a negative correlation between likability and performance (Adams 1953; Bass 1954; Weick and Penner 1969). Positive relationships between social insight and group performance (Bouchard 1969); "Agreeableness" and self-efficacy for working in self-managed work

groups (Thoms, Moore, and Scott 1996); and the person-orientation of the team leader and team satisfaction (Stogdill 1974) have been found. From these results, Driskell, Hogan, and Salas (1987) hypothesized that "Likability" would only be positively related to performance on social (e.g. training, assisting, or serving others) and manipulative/persuasive (e.g. organization or motivation of others) tasks. Given the intellectual nature of the optimizing task, it is not known if the factor of "Agreeableness" will be related to team performance, and thus no hypotheses are proposed.

Openness to Experience. This factor of the "Big Five" is also commonly referred to as "Intellect". Of the five factors, "Openness to Experience" is the least well defined. Traits associated with this factor include imagination, culture, curiosity, originality, broad-mindedness, intelligence, and artisticness (Barrick and Mount 1991).

The personnel selection literature proposes that the factor "Openness to Experience" is predictive of a person's training proficiency (Barrick and Mount 1991), however, it was not found to be predictive of job performance.

It is not clear whether the "Openness to Experience" displayed by the team members has any relationship to team performance. The relationship between "Openness to Experience" and team performance will be investigated in an exploratory manner.

Heterogeneity of personalities

Hypothesizing relationships between the "team level" (composite score, or sum of all team member scores) of a personality construct and team performance implicitly assumes that there is a compensatory relationship between the personality factor being tested and subsequent team performance. That is, if a factor is positively correlated with the task demands, that low scores of some individuals on the factor can be compensated for by high scores on the same factor by other team members. This may prove to be an extremely limited and simplified view of personalities. In a team, compatibility in personality between members is an important contributory factor in the productivity of such groups (Moos and Speisman 1962). The Fundamental Interpersonal Relations Orientation (FIRO-B) scale (Schutz 1958) was an early attempt to measure the compatibility of dyads on three dimensions (affection, inclusion, and control). The scale itself has received mixed support over the years with the most recent research indicating that there are only two real factors instead of six (Dolliver 1984). However, the major contribution of the scale was the recognition that differences in some personality dimensions are beneficial to the functioning of a team. Thus, this study will investigate the relationship between personality differences among team members and the effect that these differences have on the subsequent performance of the team.

The studies that have considered heterogeneity of team member personalities in terms of subsequent team performance have produced conflicting results.

One line of thinking is that a mix of personality types is necessary for optimal team performance (Pitcher 1993) especially when the task characteristics are diverse (Bass 1980; Nieva, Fleishman and Rieck's study as cited by Goodman, Ravlin, and Argote 1986; Pearce and Ravlin 1987). A few studies have looked at the interaction of team member personalities in relation to team performance. Teams (tetrads) composed of members with heterogeneous personality profiles (pairs of team members had both high positive and high negative Kendall's taus or near-zero Kendall's taus in terms of the ten-score profiles of the Guilford-Zimmerman Temperament Survey) outperformed those with members who had homogeneous personalities (the Kendall's taus of each pair on the team was highly positive) on several optimizing tasks (Hoffman 1958; Hoffman and Maier 1961).

In the alternative, heterogeneity of individual characteristics offers breeding grounds for interpersonal conflict detrimental to team performance (Bass 1954; Hoffman and Maier 1961). Similarity theory supports this stance. Similarity theory argues that homogeneity of group members is desirable since it evokes positive forms of mutual attraction while heterogeneity introduces divisive tensions (Tziner 1985). The implications of such an outlook is that workers placed in dissimilar groups in terms of members' personality orientations may have shorter tenure in the group and may ask to be transferred to a more compatible group (George 1990) thus interrupting the productivity of the group.

The fact that the completely opposite views have been generated with respect to the relationship between heterogeneity and team performance may be explained by the team's task and the personality factors studied. That is, heterogeneity may be beneficial for some tasks and not others. In the Hoffman (1958) and the Hoffman and Maier (1961) studies, the task used was an optimizing task. This seems to suggest that heterogeneity of group member personality may be beneficial to optimizing tasks. It is incorrect to generalize these findings to other types of tasks. Driskell, Hogan, and Salas (1987) make it very clear that different personality factors are important for different task types. The benefit or detriment derived from team member heterogeneity on these personality factors is therefore also likely to differ with the type of task undertaken (Collins and Guetzkow 1964; Williams and Sternberg 1988). The two studies in question also did not consider heterogeneity on specific personality factors, rather, it defined heterogeneity as differences among personality profiles as a whole. This, in effect, treated all differences in personality as equal in their contribution to team performance. Although in the aggregate, heterogeneity was shown to be beneficial in this case, it is more likely that heterogeneity on some factors may be beneficial, while homogeneity on other factors may be necessary to ensure team harmony and productivity (Belbin 1981). This was found to be the case in an exploratory study by Kichuk (1996). Heterogeneity of member scores on the factor of "Extraversion" was found to be negatively related to the team's performance while heterogeneity on the factor of "Emotional Stability" was found to be positively related to

subsequent team performance. Although a significant relationship between the heterogeneity of member scores on these two factors in relation to team performance was found, the sample size in the Kichuk study for this relationship was small. Since this evidence does not provide enough support by itself to propose hypotheses, the relationship between the heterogeneity of team member scores on the personality dimensions (operationally defined as the coefficient of variation) and the team's performance will be investigated in an exploratory manner.

Other Independent Variables

Attitudes towards teamwork

The attitudes one holds towards teamwork and the preference one has for either working alone or in a group may affect the person's motivation to cooperate in a team environment (Davis 1969). This, in turn, should be reflected in the team's performance. Determinants of this attitude may include such factors as ethnicity (collectivist versus individualistic cultures; Hofstede 1991), personality (Glazer, Steckel, and Winer 1987), and previous experience working in groups. However, instead of trying to ascertain group members' attitudes indirectly through measures of these possible determinants, the participants in the study will be asked their attitudes towards and preferences for group work. Although attitudes and preferences are very closely related, they are not the same. For example, one could have an equally positive attitude towards working in a group and working individually, but may prefer working alone when given a choice. Alternatively, a

person may have a negative attitude towards both working in a group and working alone, but may prefer working in a group when given a choice. Since these variables are not necessarily the same, the measurement of both preferences and attitudes may provide unique information when measured as separate entities. Therefore, two hypotheses are proposed:

H5: The team's positive attitude towards teamwork (operationalized as the sum of the scores received by each individual on the team on the Teamwork attitude scale) will be positively related to the team's performance. (Glazer, Steckel and Winer 1987).

H6: The team's preference for teamwork (operationalized as the sum of the scores received by each individual on the team on the Preference for Teamwork scale) will be positively related to the team's performance.

These hypotheses may seem in contrast with the argument made previously in this paper claiming that the relationship between team member satisfaction (which may be construed as an attitude towards teamwork) and team performance is weak at best. However, these hypotheses do not refute the point of the previous argument. The argument with regard to the weak relationship between satisfaction and performance (under the discussion of the dependent variable) was made to alert the reader to the inappropriateness of using team member satisfaction as a proxy for performance (e.g.

using satisfaction as the dependent variable). However, if the correlation between attitudes (such as satisfaction) and performance is in the order of 0.17 (which is that suggested in the meta-analysis by Iaffaldano and Muchinsky 1985), attitudes may be an acceptable predictor variable for subsequent team performance (e.g. using attitude as an independent variable).

Gender

In a meta-analysis investigating the impact of team member gender composition on team performance as measured by evaluation of the team's product, Wood (1987) found that all male teams were found to outperform all female teams. However, the superiority of the male teams appeared to be somewhat attributable to the fact that the tasks and settings used in many of the studies reviewed favored men's interests and abilities over women's. Female group members' interaction facilitated performance on tasks requiring positive social activities while men's interaction style facilitated performance on tasks requiring task-oriented behaviour. Wood (1987) also identified a tendency for heterogeneous teams in terms of gender to outperform homogeneous teams, however, the sample size of heterogeneous teams was small and significance was not attained. In the period of 1986-1991, most of the group literature investigating the effect of gender on the group has focused on two broad themes: 1. How do specific behaviours differ depending on whether they are directed toward male or female group members? 2. Might gender differences be better explained by examining a person's gender preferences

rather than gender itself? (Bettenhausen 1991). There has been little research in this period investigating the effect of gender composition on team performance.

In the current investigation, the task at hand is one that Wood would classify as being advantageous to men's interests and abilities. Although this classification may have been true when many of the studies Woods reviewed were done (the median publication date = 1969), this classification may be outdated. Until recently, the proportion of women in the maths and sciences was extremely low, thus tasks which required these types of abilities would favor the performance of men. However, both the female and male portions of the sample used in this study had the same training in the maths and sciences, and both have demonstrated some interest in the type of task they will be asked to perform (e.g. by enrolling in the Engineering program). Thus, it is not expected that the males participants will have a performance advantage over the female participants.

H7: There will be no difference in performance between male and female gender-homogeneous teams.

The tendency for gender heterogeneous teams to outperform gender homogeneous teams as reported by Woods (1987) was not statistically significant. In addition, the explanation offered to justify the propensity of heterogeneous teams to outperform homogeneous team was based on the reasoning that men and women had different interaction styles (which varied as a function of social expectations) when around team

members of the opposite sex. Although it is expected that the "social expectations" of certain gender-related behaviours previously attributed to differences in team performance may be outdated, there is not enough evidence to propose a hypothesis comparing homogeneous and heterogeneous teams. The effect of gender homogeneity and heterogeneity within the teams on team performance will be investigated in an exploratory manner.

CHAPTER 3

METHOD

This experimental study required the subjects to complete an Engineering Design task in a laboratory setting within a specified time limit. The subjects were administered a standardized general ability test, a personality test, a satisfaction questionnaire and a demographic profile (gender and age only). A laboratory setting was used to control for extraneous factors (e.g. organizational politics, status differences) so that effects attributable to the personality variables under investigation would be more obvious (Driskell and Salas 1992).

Subjects

The subjects were 419 first year undergraduate Engineering Students enrolled in a problem-solving course. Twenty percent of the subjects were female. The subjects ranged in age from 16 to 32 years of age with the median age being 19 years.

The students were assigned to one of eight sections consisting of approximately fifty to sixty students each based on scheduling constraints. Within these sections, students were randomly assigned to teams of three for the design exercise. Completion of

the design exercise and the self-analysis measures were a mandatory part of the course. However, participation in the study was contingent on the students voluntarily providing the researcher with demographic information. Of the 139 groups theoretically possible, the number of usable groups (depending on the dependent variable being investigated) ranged from 99 to 116.

Engineering Product Design Task

The task which the teams were asked to perform was to design and build a bridge from a limited amount of newspaper and tape which were provided. This task required the subjects to design and build a product using only the materials provided, in accordance with competing constraints, and within a specified time limit. This task was chosen principally because of its parallel to many industry design problems and its similarity to design problems that an "Engineer in training" may be required to perform. That is, there are often many competing interests in the design of a product which require trade-offs, there is a limitation on the resources available to build the product (e.g. cost containment) and there is usually a time constraint (e.g. race to market).

The bridge was required to span the space between two chairs or tables (standing upright) which had to be at least two feet apart. The bridge could not be affixed in any way to the tables or chairs. It was to rest on top of these surfaces only. The students had 45 minutes to complete the task. Points were awarded based on the bridge's span, uniform width, height (as measured from two points on the base of the bridge) and

strength. Bonus points were awarded for teams who finished under the time limit. Scores for the bridge's dimensions were determined prior to the strength test. The strength of the bridge was determined by its ability to support a two pound book being placed on it and dropped from various heights. Once strength testing commenced, the team was not allowed to touch the bridge. Points were awarded for each drop the bridge withstood. Each team was given the scoring key before the task began. The overall objective of the task was to attempt to maximize the points obtained. Each team received an identical amount of resources with which to build the bridge.

Procedure

The students were randomly assigned to teams of three within classes whose composition was based on scheduling constraints. This was done in the first week of the semester of the first year. It is therefore unlikely that any of the students knew their team-mates well or had any experience working in a team with the other students (thus mitigating the effect of previous social relationships on the teams' process and performance).

Teams consisted of three members for this exercise because of the difficulty of the task and the time allotted. Many authors have claimed that groups need to be large enough to accomplish the work assigned to them, but when too large, groups may be dysfunctional due to heightened coordination rules (Gladstein 1984; O'Reilly and Roberts 1977; Steiner 1972; Campion, Medsker and Higgs 1993). A previous study (Kichuk

1996) determined that teams of three would be able to accomplish the task in the 45 minutes allotted.

The students were administered the personality test, the satisfaction/self-reported performance questionnaire and the demographic profile during class time.

At the beginning of the period, each team was given a description of the task, the material required to construct the bridge, and the scoring key. The students had 45 minutes from this point to construct the bridge. The scoring key was designed so that there were competing constraints on the bridge. The team-mates had to strategize how to build the bridge in order to obtain the most points. There was no one superior strategy. However, significant planning was required in order to obtain points. After the time was up, or, the team had finished the bridge, their bridge was scored by specially trained research assistants, and the members were asked to complete a satisfaction questionnaire about their product and the process employed.

Although measures of inter-rater reliabilities are traditionally provided when products are evaluated by external "experts", the nature of this task did not require such a precaution for several reasons. First, the bridge was evaluated in terms of a pre-set scoring guide that assigns points as a function of the length, width, height, and strength of the bridge. These dimension measures (e.g. length, width, and height) were taken with measuring tapes that are accurate to within 1/16th of an inch. Points were assigned in 1-foot increments. Thus, there were no "judgment calls" in assigning points to the measures

taken. Second, there were two people on each measuring team. One person measured while the other watched and recorded the measurements. Thus, any mistakes in the measurements made by the Measurer were likely to be caught by the Recorder. In addition to the watchful eye of the Recorder, spectators from both the team whose bridge was being measured and from rival teams were likely to catch any mistakes made by the Measurer. The most subjective part of the point assignment was the strength test. The multiple spectators were likely to catch any inconsistencies made by the Measurer, however, in this case, multiple tests (as would be required for inter-rater reliabilities to be calculated) were not possible since the bridge's integrity was diminished with each weight dropped on it.

Measures

The Dependent Variable

Team Performance

Team performance was measured by the team's actual score obtained on their bridge in accordance with the scoring scheme shared with the teams prior to the task.

The Independent Variables

The overall team level of a variable, or "composite", was determined by the simple addition of the team members' scores on the measure of interest (James 1982;

Keller 1986). The heterogeneity of the scores received by each team on each of the independent variables was determined by the coefficient of variation (Allison 1978).

Initial Ability

General Cognitive ability. General ability was measured using Form IV of the Wonderlic Personnel Test. This short (12 minute), test of general cognitive ability includes items in vocabulary, "commonsense" reasoning, formal syllogisms, arithmetic reasoning and computation, analogies, perceptual skill, spatial relations, numerical series, scrambled sentences and knowledge of proverbs. The primary factors measured are verbal comprehension, deduction, and numerical fluency (Foley 1972; Gatewood and Feild 1994; Wonderlic Personnel Test Inc. 1992). The advantage of using the Wonderlic Personnel test is that it is short and has been normed on various populations over a long period of time (since 1938) and has been extensively tested in terms of validity and reliability.

Personality

Team member personality was measured using the NEO-FFI (which is a shortened version of the NEO-PI) personality test (Costa and McCrae 1992) consisting of 60 5-point scale items (ranging from (1) strongly disagree to (5) strongly agree). The NEO-PI test has been recommended by Hogan (1991) as a good measure of the Big Five personality dimensions. In a review of this test for the Eleventh Annual Measurements Yearbook, Widiger concluded that "any study that purports to be addressing fundamental dimensions

of personality should include the NEO-PI as a measure" (Widiger 1992 , 606). The NEO-PI has reported alpha coefficients across the facets measured ranging from 0.61 to 0.79 for men and 0.60 to 0.82 for women (Hess 1992). Both Hess (1992) and Widiger (1992) both refer to the NEO-PI as having "impressive" validity. The NEO-FFI was developed by taking the 12 items with the highest absolute factor loadings on each of the five factors (Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness) from the NEO-PI (McCrae and Costa 1992; Schmit and Ryan 1993). Although the NEO-FFI provides less detail than the NEO-PI, it is still recommended for assessing the "Big Five" personality factors (Briggs 1992). Correlations between the NEO-FFI scales and the NEO-PI factors range 0.75 to 0.89 (Costa and McCrae 1992; Schmit and Ryan 1993). Alpha coefficients in this sample for each of the 12 item scales were found to be 0.85 (N), 0.78(E), 0.75(E), 0.76 (A), and 0.83 (C) which was in accordance with previous reports (0.89, 0.79, 0.76, 0.74, and 0.84 respectively; Costa and McCrae 1992; Schmit and Ryan 1993).

Gender was measured at the individual level using a dichotomous scale (M/F). At the group level, the gender type of the group was coded as the number of females in the group. There were four possible gender combinations: zero females, 1 female, 2 females, and 3 females.

Hypotheses made with regard to the effect of the team's level of initial ability (H1), personality (H2, H3), and both attitudes towards and preference for teamwork (H4, H5)

on performance used the composite score of the team on the appropriate measure described above. Post hoc analyses which proposed a relationship between the heterogeneity of a variable and the performance of the team were measured using the coefficient of variation of the team members' scores. The coefficient of variation (calculated as the standard deviation divided by the mean) is the appropriate measure of heterogeneity when looking at continuous data (Allison 1978)

Analyses

The frequency distribution of the group performance scores indicated that two distinct subsamples could be derived from the overall sample distribution. The first subsample (N = 17) was a cluster of "zero scores" (ZS). The teams that received a score of zero (ZS) on their product did so because they violated fundamental constraints that were clearly stated in the problem. That is, ZS teams failed in the design task - they were not able to produce a minimally acceptable product that could be evaluated. The second subsample (N = 100) consisted of a normally distributed curve of non-zero scores (NZS) (see Appendix 1). The fundamental difference between these two sample subsets was that the NZS teams could function as a team at some minimal level whereas the ZS teams were total failures on the design task.

The existence of two such distinct subgroups within the sample indicated that the relationships between the independent variables and the performance measure should be analyzed in two stages.

Analysis A : Differences Between
Successful and Unsuccessful Teams

In the first analysis, comparisons were made between the teams in the NZS subset and the teams in the ZS subset for each independent variable (e.g. group gender type, and the composites and coefficients of variation for: ability, Teamwork KSA, personality, and attitude) using a combination of MANOVAs and univariate ANOVAs (if warranted from the results of the MANOVA). These comparisons were made in order to determine if there were characteristics that distinguished successful teams (e.g. those in the NZS subset) from unsuccessful teams (e.g. those in the ZS subset). In addition, because of the high inter-correlations among the independent variables, both a stepwise logistic regression (via SPSS software; Norusis 1990a,b,c) and a decision tree analysis (via CART; Classification and Regression Tree software; Breiman et al. 1984; Steinberg and Phillip 1995)[5] were employed in order to ascertain the primary differentiating variables and the incremental value of other independent variables in predicting the success of the teams.

Analysis B : The Relationship Among the Independent
Variables and Team Performance for Successful Teams

Once the characteristics that differentiated the successful teams from the unsuccessful teams were established from the first analysis, the hypothesized relationships and the exploratory analyses proposed earlier between the independent variables (e.g.

[5] CART uses binary recursive partitioning methodology to generate decision trees that may be used to facilitate decision-making. CART is used as an alternative to regression analysis. The authors of CART contend that the results one generates from CART are 10-15% more accurate than those derived from traditional regression techniques.

ability, personality, attitude, and gender) and the team's performance were investigated for the successful teams.

Hypotheses 1-6 proposed the effect of a continuous independent variable (e.g. ability, personality, attitude towards group work) on the continuous dependent variable (e.g. team performance). These hypotheses were tested using multiple regression.

Hypothesis 7 proposed that there would be no difference in team performance between male and female gender-homogeneous teams. Unfortunately, the low percentage of females in the sample (20%) coupled with the randomization of team composition within sections, did not create enough female-homogeneous teams (N = 2) for this hypothesis to be tested.

Given the relatively new focus on selection criteria for team performance, a variety of exploratory correlation analyses were done investigating the relationships between the independent variables for which hypotheses were not offered (e.g. the heterogeneity of the team's general ability level; the personality factors of Agreeableness, Openness to Experience, and Neuroticism; and the heterogeneity of each of the "Big Five" personality factors) and team performance.

CHAPTER 4

RESULTS AND DISCUSSION OF THE PRIMARY ANALYSIS

Results

The distributions of the composite independent variables and the team performance variable is given in Appendix 1. The means, standard deviations, and inter-correlations for the independent variable composites and coefficients of variation are given in Table 1. Most of the personality composites are significantly inter-correlated (r's up to 0.39). The Teamwork KSA test is significantly correlated with general cognitive ability and all of the personality variables. General cognitive ability is significantly correlated with three of the five personality factors (i.e. Neuroticism, Agreeableness, and Openness to Experience). Attitude towards teamwork is significantly correlated only with Extraversion.

Analysis A : Differences Between Successful and Unsuccessful Teams

The differences between successful and unsuccessful teams on the independent variables are displayed in Table 2.

There was no significant difference between successful and unsuccessful teams with respect to the number of females on the team ($F(1, 114) = 1.74$, $p>.05$).

Table 1. Descriptives and Inter-correlations for the Independent Variables

	N	Mean	Coefficient of Variation	1	2	3	4	5	6	7	8	9
1. Conscientiousness	88	101.7	.19	--	.06	.32**	-.02	-.07	.11	.03	-.17	-.29**
2. Extraversion	88	94.3	.15	.22*	--	.10	.40**	-.10	.08	.07	.13	.13
3. Neuroticism	88	55.7	.33	-.24*	-.39**	--	.15	.06	-.08	-.14	.12	-.14
4. Agreeableness	88	98.4	.14	.37**	.44**	-.37**	--	-.00	.11	.03	.03	.14
5. Openness to Experience	88	85.5	.17	.13	.29**	-.24**	.19	--	.05	-.02	.09	.10
6. Teamwork KSA	91	67.4	.18	.31**	.18	-.45**	.43**	.36**	--	.22*	-.04	-.10
7. Cognitive Ability	87	67.7	.13	.13	.12	-.26**	.25*	.25*	.56**	--	-.06	-.11
8. Attitude	100	103.2	.10	-.02	.30**	-.10	.08	.09	-.04	-.04	--	.05
9. Gender[a]	99	0.62	--	.24*	-.13	.17	.13	.18	.25*	.11	-.17	--

Notes: Data are provided for teams in the NZS subset only. Inter-correlations among the independent variables' composites are presented in the lower triangle. Inter-correlations among the independent variables' coefficients of variation are presented in the upper triangle.

[a] Gender is operationalized as the number of females on the team; $N_{x\ females}$ = number of teams with x females on the team; $N_{0\ females}$ =52, $N_{1\ female}$ = 34, $N_{2\ females}$ = 12, $N_{3\ females}$ = 1

* p<.05 **p<.01

Table 2. Descriptives for the Independent Variables

	Mean		Mean Coefficient of Variation	
	NZS Subset	ZS Subset	NZS Subset	ZS Subset
Conscientiousness	101.7	96.5	0.14	0.18
Extraversion	94.3* [a]	86.5* [a]	0.14	0.16
Neuroticism	55.8** [b]	68.6** [b]	0.34	0.27
Agreeableness	98.4** [c]	89.7** [c]	0.13	0.13
Openness to Experience	85.5	82.6	0.17	0.15
Teamwork KSA	67.4**	57.9**	0.18	0.21
Cognitive Ability	67.7**	57.2**	0.19	0.22
Attitude	103.2	103.5	0.10	0.10

Notes: Variables for which the means differ between the NZS and ZS subsets are marked with the appropriate level of significance. NZS Subset = Non-zero scoring subset (e.g. successful subset). ZS subset = Zero scoring subset (e.g. failing subset). Mean Coefficient of Variation = mean of the coefficients of variation in the corresponding subset. N_{NZS} = 88-100 and N_{ZS} = 13-17. The range of "N's" occurred because the variables differed in the number of missing values.

[a] The difference between the means of the NZS and ZS subsets are significant at the $p<.05$ level when general cognitive ability is controlled

[b] The difference between the means of the NZS and ZS subsets are significant at the $p<.01$ level when general cognitive ability is controlled

[c] The difference between the means of the NZS and ZS subsets are significant at the $p<.10$ level when general cognitive ability is controlled

*$p<.05$ **$p<.01$

The results from a MANOVA ($F(8, 89) = 2.93$, $p<.01$) entering all of the independent variable composites suggested that there were significant differences between the NZS and ZS subgroups. More specifically, successful teams were characterized by higher composite levels of cognitive ability ($M_S = 67.7$ versus $M_U = 57.2$, $F(1,96) = 12.9$, $p<.01$), higher Teamwork KSA test scores ($M_S = 67.4$ versus $M_U = 57.9$, $F(1,96) = 12.1$, $p<.01$), higher Extraversion scores ($M_S = 94.3$ versus $M_U = 86.5$, $F(1,96) = 6.2$, $p<.05$), higher Agreeableness scores ($M_S = 98.4$ versus $M_U = 89.7$, $F(1,96) = 7.4$, $p<.01$), and lower Neuroticism scores ($M_S = 55.8$ versus $M_U = 68.6$, $F(1,96) = 12.2$, $p<.01$) than their unsuccessful counterparts.

Upon first glance, it seems as if there are many differences between the two subsets. However, these differences must be interpreted with caution because many of these variables are inter-correlated (Table 1). Given the high degree of inter-correlation (r's up to 0.56) among the variables cited above (e.g. general cognitive ability, Teamwork KSA scores, Agreeableness, Extraversion, and Neuroticism), a logistic regression was done in order to determine if there was a smaller subset of predictor variables that distinguished the successful from the unsuccessful teams. The composites and coefficients of variation of the independent variables were entered into a forward-stepwise logistic regression equation. After the stepwise regression, two variables were found to be the primary differentiating variables between successful and unsuccessful teams: the composite of general cognitive ability ($\chi^2 = 11.7$, $p<.01$), and the composite of

Neuroticism ($\chi^2 = 7.3$, $p<.01$). A CART analysis supported the initial differentiation of the sample into successful teams and unsuccessful teams with the composite of general cognitive ability (improvement = 0.17). However, incremental differentiation of the sample differed slightly from the results obtained by a regression analysis. For the subset with the higher scores on the composite of general cognitive ability (i.e. teams with composites of general cognitive ability higher than 61.5[6]), Neuroticism was still the primary differentiating factor (improvement = 0.10). However, for the subset of lower general cognitive ability scores (e.g. scores lower than or equal to 61.5), the composite of Extraversion (improvement = 0.07) was found to slightly improve the differentiation of the sample into successful and unsuccessful teams.

The MANOVA results for the heterogeneity measures of the independent variables were not significant. Therefore, these variables did not warrant further investigation in this analysis.

Analysis B: The Relationships Among the Independent Variables and Team Performance for Successful Teams

The bivariate correlations between the independent variables and the performance criterion are given in Table 3.

[6]A composite score of 61.5 implies that the "average member" of the team obtained a score of 20.5. A score of 20.5 falls in the 46th - 52nd percentile range of the normal adult population (Wonderlic, 1992).

Table 3. Correlations Between the Independent Variables and Performance for the NZS Subset

Composites	Group Score	Coefficient of Variation	Group Score
Conscientiousness	0.07	Conscientiousness	-0.22*
Extraversion	0.07	Extraversion	-0.06
Neuroticism	0.01	Neuroticism	-0.12
Agreeableness	-0.02	Agreeableness	-0.02
Openness to Experience	0.03	Openness to Experience	-0.01
Teamwork KSA	0.01	Teamwork KSA	0.00
Cognitive Ability	-0.07	Cognitive Ability	-0.11
Attitude	0.00	Attitude	-0.01

Notes: N ranged from 81- 95 teams for the correlations with group performance. There was a range of N's because the independent variables differed in the number of missing values.

*p<.05 **p<.01

Hypothesis 1 proposed that there would be a positive relationship between the team's composite score on the factor of initial cognitive ability ("g") and the team's subsequent performance. Contrary to expectations, this hypothesis was not supported ($\Delta R^2 = 0.02$, $p>.05$). Furthermore, no significant relationship was found between the teams' heterogeneity of ability scores and the team's subsequent performance ($r = -0.11$, $p>.05$). There was also no significant relationship between the teams' ability characteristics and the teams' performance when both the composite and the heterogeneity scores were considered together (e.g. simultaneously) in a regression equation.

Hypothesis 2, which postulated that the team's composite level of Conscientiousness would be positively related to the team's performance was not supported ($\Delta R^2 = 0.02$, $p>.05$). However, in the exploratory analysis, the heterogeneity of Conscientiousness was found to be negatively and significantly correlated with the team's performance ($r = -0.22$, $p<.05$)[7]. Furthermore, when all of the independent variables (e.g. both the composites and the coefficients of variation for all of the ability, personality, and attitude variables) were entered into a stepwise regression equation with the group's performance score as the dependent variable, the heterogeneity of Conscientiousness was the only variable to share significant variance with the performance scores ($\Delta R^2 = 0.05$, $p<.05$). However, a post-hoc regression analysis entering both the

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[7] Previous arguments suggested that bivariate correlations should be interpreted with caution due to the high inter-correlations among the composites of the independent variables. However, the inter-correlations among the coefficients of variation (e.g. the heterogeneity measures) were not as strong as those found among the composites (see Table 1).

composite and the level of heterogeneity of Conscientiousness simultaneously as independent variables did not produce significant shared variance with performance ($\Delta R^2 = 0.05$, $p>.05$)

Hypothesis 3, which postulated that the composite level of Extraversion would be positively related to the actual performance of the team was not supported ($\Delta R^2 = 0.01$, $p>.05$). The heterogeneity of the team on the factor of Extraversion was also not significantly related to the team's subsequent performance ($r = -0.06$, $p>.05$). A post-hoc regression investigating the potential effect of the composite and heterogeneity measure of Extraversion on performance did not produce significant results.

Hypothesis 4, which predicted that the team's composite of Neuroticism would be negatively related to the team's performance was not supported ($\Delta R^2 = 0.00$, $p>.05$). In addition, the heterogeneity of team member scores on the factor of Neuroticism was not significantly related to performance ($r = -0.12$, $p>.05$). There was also no significant result obtained when both the composite and heterogeneity of Neuroticism were entered as independent variables.

Hypothesis 5, which proposed that the team's level of positive attitudes would positively impact performance, and **Hypothesis 6**, which proposed that the team's preference for group work would impact positively on group performance were combined into one hypothesis. This was because, as discussed previously, the questions used to

measure "attitude towards group work" and "preference for group work" could not be statistically discerned (e.g. they both loaded very heavily and decisively on one factor). Neither the group's composite level of attitude towards group work ($\Delta R^2 = 0.00$, $p>.05$), nor the group's heterogeneity level of attitude towards group work ($r = -0.01$, $p>.05$) were significantly related to actual team performance. Likewise, when the composite and heterogeneity measures were combined in a regression equation, no significant relationship emerged.

For the NZS sample, neither the composite nor the heterogeneity of the individual team members' Teamwork KSA scores were significantly correlated with the team's subsequent performance. There were no significant relationships found between any measure of Agreeableness (e.g. the composite or the heterogeneity measure) and actual performance. The team members' levels of Openness to Experience was not found to relate to the actual performance of the team in any way.

Discussion

Cognitive Ability

As argued previously, general cognitive ability, rather than specific facets of ability, was chosen as the predictor in this study for two reasons. First, there is evidence from the personnel selection literature which suggests that general cognitive ability accounts for most of the variance in job performance and that specific facets of ability add little incremental variance to performance. Second, a good approximation of a person's general

cognitive ability can be assessed in a minimal amount of time (e.g. the Wonderlic personnel test takes 12 minutes to administer) while a more resource-intensive test would be necessary to assess a person on all of the possible facets of ability. General cognitive ability was therefore seen as a potentially efficient selection measure (e.g. maximum impact for minimal resources) for Engineering Design teams.

The composite of general cognitive ability appeared to have a "threshold" relationship with team performance. That is, some minimum level of general cognitive ability was necessary in order for a team to be minimally successful (e.g. satisfy the basic constraints of the task), however, once a team had the composite ability necessary to achieve success, general cognitive ability was not related to increments in the team's performance. It was not surprising that unsuccessful teams tended to have low composite scores on the cognitive ability variable. The Wonderlic personnel test, which is the test that was used to estimate "g", measures verbal comprehension, deduction, and numerical fluency. All of these factors would be necessary for a person to be able to read and understand the bridge building task. For example, one must be able to read and understand the instructions, deduce that the object of the exercise is to gain the most points possible, and be able to understand the scoring scheme. It therefore makes sense that teams which were comprised of members scoring low on the Wonderlic were not able to perform even at a minimally acceptable level.

The lack of relationship between general cognitive ability and performance in successful teams was not expected and did not seem to be in accordance with the evidence presented earlier. However, there is a possible explanation which aligns the results attained in this study with the evidence presented in the literature. According to Jensen (1993), the substantial variance in performance accounted for by general cognitive ability in higher level occupations may manifest itself in terms of a threshold variable for entry. In other words, if the design task used in this study was a "higher level task" (e.g. representative of higher level occupations), a threshold relationship, instead of a linear relationship between general cognitive ability and team performance should have been expected. The classification of the Bridge building exercise as a "higher level task" receives some support from the data in this study. The mean score of the successful teams' average level of ability (e.g. composite ability divided by the number of members) was higher than the population average on the factor of general cognitive ability[8] . It could therefore be argued that the bridge building exercise was a complex task requiring above average ability levels to complete, and as such, the threshold relationship found in this study between cognitive ability and performance is exactly what should have been expected.[9]

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[8] In order to compare the "level" of cognitive ability that successful and unsuccessful teams exhibited with the population norms provided in the Wonderlic manual (1992), the teams' average scores were used (e.g. the team's composite of cognitive ability divided by the number of team members). The mean of the teams' scores for the successful team subset was 22.6. The population average score on the factor of general cognitive ability was 21.

[9] The composite of general cognitive ability accounted for approximately 11% of the variance in the classification of teams into "successful" and "unsuccessful" status.

If the threshold relationship between cognitive ability and team success is what should be expected when considering design tasks, one must question the usefulness of using general cognitive ability tests to select team members in organizational settings. It is likely that product designers have been screened on the factor of general cognitive ability and have had to meet certain standards in order to be hired by the organization. Since there was no relationship between general cognitive ability and team performance once a minimal amount of general cognitive ability was present, it is unlikely that this factor would differentiate team performance in an organization.[10]

The potentially limited usefulness of general cognitive ability as a selection measure for organizational design teams forces us to consider alternative potential prediction variables. Although specific facets of ability were argued to add little incremental validity to the prediction of job performance over that provided by general cognitive ability, there is an argument that for complex tasks where high levels of general cognitive ability are necessary to perform the task, that more specific abilities might be helpful in determining increments in success[11]. If this is the case, the definition of specific

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[10] One might also expect that the students in an Engineering program with competitive admission standards would also have been screened for initial general cognitive ability. However, no significant restriction of range in the general cognitive ability scores of the students was found when compared with the general population (see Appendix 1). This implies that the admission requirements for entry into the Engineering program might not be significantly related to general cognitive ability.

[11] This argument is derived from recent research performed by Evans (1995) who hypothesized that high ability people may be differentiated on specific abilities to a greater degree than lower ability people, and by the "pooling of ability" model presented by Laughlin and various colleagues (e.g. Laughlin & Bitz, 1975; Laughlin & Branch, 1972, Laughlin, Branch & Johnson, 1969; Laughlin & Johnson, 1966; Laughlin, McGlynn, Anderson & Jacobson, 1968) which is predicated on the assumption that high ability people possess the full breadth of abilities that someone of moderate or low ability possesses, however, two

facets of ability that are related to the design process may be necessary in order to predict design team performance.

Teamwork KSA

The composites of the Teamwork KSA scores differed significantly between successful and unsuccessful teams. The authors of the Teamwork KSA test report that their test correlates significantly with cognitive ability measures (e.g. $r = 0.89$) and that their test provides incremental validity over that provided by general cognitive ability in predicting teamwork performance. In this study, the composite of Teamwork KSA scores also correlated significantly with the composite of cognitive ability scores (e.g. $r = 0.56$), however, the Teamwork KSA score did not provide incremental validity over that provided by general cognitive ability in differentiating between successful and unsuccessful teams at the traditional $p<.05$ level. There was also no significant relationship between the combination of scores received by the team members on the Teamwork KSA test and the team's subsequent performance for successful teams.

These results were disappointing because the Teamwork KSA test was developed by Stevens and Campion (1994b) after a systematic and thorough investigation of the literature available addressing effective teamwork. However, one possible reason that this test was not significantly related to the objective performance measures is that many of the

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people displaying high general ability levels do not necessarily have the same breadth of ability - they may differ greatly in specific abilities.

studies in the team literature measures performance in terms of team member self-reports of performance and satisfaction. As suggested earlier, there is some evidence that self-reported measures might not be good proxies for objective performance. If this is the case, the Teamwork KSA test might be related to self-reported measures of performance instead of objective performance. This possibility will be investigated in the supplementary analysis section.

There is a second possible reason why no relationship was found between the scores a team obtained on the Teamwork KSA test and the subsequent performance of the team. The Teamwork KSA test purports to measure the behaviours that are necessary for teamwork. However, knowledge of the behaviours necessary for effective team functioning does not necessarily guarantee performance of those behaviours (McClelland 1993).

The third possible reason that the Teamwork KSA test scores were not related to performance is that the test might not measure what it purported to measure. That is, the researchers might not have been successful in creating a test that was indicative of the effective team behaviours derived from the literature.

Finally, it is also possible that no relationship was found between the Teamwork KSA scores and subsequent team performance because the effective teamwork behaviours, as defined by Stevens and Campion from previous literature, are not related to performance. However, before this conclusion is accepted, further research must be done

on longer term teams. It is possible that the relatively short duration of the exercise in this study did not allow the effect of effective team behaviour to manifest itself in performance differences.

Conscientiousness

The level of Conscientiousness a person possesses (e.g. the degree to which a person is dependable, purposeful, and strong-willed) has been associated with increased task performance in the individual personnel selection literature (Barrick and Mount 1991; Tett et al. 1994). It was therefore expected that the group's level of Conscientiousness would be related to the group's product performance. The lack of relationship between the composite of Conscientiousness and the team's performance was therefore surprising. One possible explanation for the apparent lack of relationship between the Conscientiousness composite and the team's performance may be that the subjects under investigation in this study were new students and that the result of the task was part of each student's mark in the course. The relative novelty of being a university student and the perceived consequences of not performing well may have caused most students to behave in a conscientious manner over the short time period required to perform the task. Studies which follow design teams over a longer period of time need to be done in order to establish the long-term impact of Conscientiousness on performance.

The heterogeneity of Conscientiousness was found to be negatively and significantly related to the actual performance of the team. This finding is not surprising.

People who score high on the Conscientiousness factor tend to be focused and achievement-oriented, while those scoring low on the factor may be more relaxed in applying the work ethic (Costa and McCrae 1992). Thus, the negative relationship between the level of heterogeneity in the Consciousness factor and team performance might be attributable to conflict that arises among the team members with respect to the urgency or importance of the task at hand. For example, team members with a high-achievement orientation may have become frustrated with other team members who were more relaxed in the execution of the exercise. The differences in outlooks could have become apparent in a short time and may have distracted the team members from focusing on the task, or, prevented some members from cooperating with others. These feelings of frustration, or hostility towards other members, might have detracted from the team's ability to perform at an optimal level. This contention has received anecdotal evidence. In one company's experience with teams, the stress level of the team members significantly increased when there were members on the team who were reluctant to accept sufficient responsibility to complete the assigned task to the other team members' satisfaction. This in turn, negatively affected performance (Flynn, McCombs, and Elloy 1990).

Extraversion

Successful teams were found to score higher on the composite of Extraversion than were unsuccessful teams. This provides support for the earlier contention that the team's composite level of Extraversion is positively related to performance (e.g. teams must have some minimum level composite of Extraversion to be successful as a design team). However, in terms of potential predictive value, once the composite of Neuroticism is considered, Extraversion does not add any value in differentiating successful from unsuccessful teams.

The composite of Extraversion was not found to be significantly related to the performance of successful teams. This finding is in direct contravention to the individual personnel selection literature which suggests that a person's level of Extraversion positively impacts performance in jobs where there is a large social component (e.g. Barrick and Mount 1991), and from the small group literature which proposes that the team's level of Extraversion (or some facet of Extraversion such as dominance or sociability) should be positively related to the performance of the team. However, there are several possible reasons why the relationship between Extraversion and team performance was not observed.

First, although the design task in this study closely paralleled many aspects of "real world" design processes, the time frame over which the exercise took place did not. It is therefore possible that the relationship expected between Extraversion and

performance was not found because of the short duration of the exercise. That is, the teams' levels of Extraversion did not have a chance to be manifested in performance differences.

Second, the expectation derived from the individual personnel literature and the small group literature that Extraversion would affect team performance may not have been warranted. The bridge-building exercise used in this study was classified as an "optimizing" task because the mandate of the team was to attempt to maximize the value of their product (e.g. build a bridge that would attain the maximum number of points when evaluated in terms of a pre-defined scoring guide). Although the overall task was to build an optimal bridge, this required the team to engage in a series of different subtasks. First, the team had to define a design strategy that would accomplish their mandate. This initial phase required frequent social interaction in order to evaluate alternate design ideas. The first part of the process was therefore akin to both an "optimizing" task as defined in the small group literature, and a "social" occupation as defined by the personnel selection literature. Similar to a "real life" design process where prototypes are built in order to assess the feasibility of the final design, the design teams in this exercise were required to build the bridge they designed. This prototype building may be thought of as a "mechanical" task (as defined by Driskell, Hogan, and Salas 1987). Thus, although the product of the design process (e.g. the "optimal" product) would suggest that the design process should be classified as an "optimizing" task, the design process is really best

described as an optimizing process which consists of a combination of task types (e.g. optimizing, social, and mechanical). Much of the literature in the small group studies used tasks which could be neatly classified into a single task category (e.g. "optimizing", "social" etc.). Thus, the application of these results to the design process are somewhat problematic. Driskell, Hogan, and Salas (1987) hypothesized that "sociability" (which is part of Extraversion) is positively correlated with team performance on social tasks, negatively correlated with team performance on mechanical tasks, and has no significant relationship with the performance of optimizing tasks in a team setting. Further, they contend that "ambition" (which they also contend to be part of Extraversion) is positively related to team performance on optimizing and mechanical tasks, but has no relationship to social tasks. It becomes apparent that when the design process is artificially factored into the traditional task categories used in the small group literature that the information available relating personality to team performance becomes very confusing and of questionable usefulness. Future research should therefore focus on commonly performed tasks/processes (such as design processes) that occur in the workplace, or realistic approximations of these tasks (such as the one used in this study).

A third possibility is that the relationship between Extraversion and the performance of successful teams is more complex (e.g. not linear) than the one investigated in this study. The effect of Extraversion on performance may also depend on the combination of the team members' levels on this factor, although a regression equation

entering both the composite and standard deviation of the groups' Extraversion scores as a function of actual performance did not show any significant relationships.

Neuroticism

Successful and unsuccessful teams differed substantially on the factor of Neuroticism. The composite of Neuroticism was the only factor to add incremental validity to the prediction of team success (e.g. ZS versus NZS status) over that provided by the composite of general cognitive ability. However, neither the composite nor the heterogeneity measure of Neuroticism was found to be predictive of team performance in teams capable of minimal performance (e.g. the NZS subset).

The above findings are in line with the "threshold" hypothesis proposed by researchers in the individual personnel selection literature (Barrick and Mount 1991). That is, there is a minimal level of Emotional Stability (e.g. low scores on the Neuroticism factor) that is necessary for adequate functioning on the job, however, after this minimum level is attained, there is no relationship between incremental amounts of Emotional Stability over and above this threshold and performance.

The results from this study are also somewhat supportive of the proposition from some early studies in the small group literature that a high level of Neuroticism is associated with poor performance.

Agreeableness

The composite of Agreeableness was found to be significantly higher in the NZS subset than the ZS subset, however, once the effects of Neuroticism and cognitive ability were considered, the significance of this difference disappeared.

The lack of relationship between any measure of Agreeableness and the outcome variables for the groups in the NZS subset is in keeping with the lack of previous substantive evidence in both the small group and individual personnel selection literature linking this variable with task/job performance. Thus, the factor of Agreeableness does not seem to be related to team performance for teams that are capable of adequate performance.

Openness to Experience

No relationship was found between the factor of Openness to Experience and team performance. This lack of relationship may be characteristic of this task which was very focused (e.g. the problem was already identified, and the performance criteria already discerned). Openness to Experience may be more influential on performance if the task requires creativity, or tackling an abstract problem (Driskell, Hogan, and Salas 1987).

Attitude Towards Teamwork

There were no relationships found between the team members' attitudes towards teamwork and the team's subsequent performance. It was argued that the team's level of

attitude towards teamwork would influence the team's performance via the team members' propensity to cooperate with the other team members.

In this study, each individual on the team received the same performance score (e.g. grade) as every other individual on the team, and the performance score received by each individual was based on the quality of the product which the team produced. It was therefore in the best interest of each team member to improve the quality of the team's product by cooperating with the other members on his/her team. It is therefore possible that a person's attitude towards teamwork may have become less important in determining a person's willingness to cooperate than the immediate concern of one's grade on the exercise. Thus, in this case, attitude did not manifest itself in performance differences. However, attitudes towards teamwork may still be important in determining a person's willingness to cooperate in a team environment over a longer period of time. The relationship between attitude and the propensity of a person to continue working on team will be addressed in the supplementary analysis section.

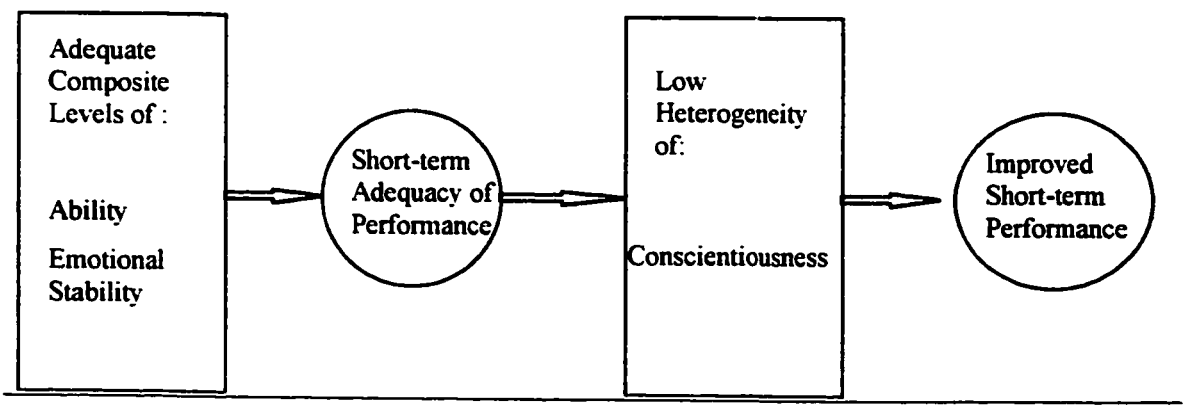
Summary: Groundwork for a Model

The task that the teams were asked to perform was of a very short duration. As mentioned above, some of the relationships that may exist between team member personalities and the performance of the team may not have had a chance to emerge. However, even in this very short time period, it became apparent that some teams were not able to function at a minimally acceptable level (e.g. those teams in the ZS subset).

The differences in personality and ability that were found between the successful and unsuccessful teams may indicate that there are certain characteristics that the team must exhibit in order to surpass a critical period at the beginning of the team's life in which immediate failure is possible.

As diagrammed in Figure 1, it is proposed that the survival of the team depends on the team's ability to overcome short-term obstacles in order to function adequately . In order to attain short-term adequacy, the team members together (e.g. the composite of individual team member scores) must have an adequate level of ability to do the task, and must display adequately low levels of Neuroticism to function as a team. Of course "adequate levels" must be further defined. Once the team has achieved short-term adequacy, the heterogeneity of the team on the factor of Conscientiousness seems to be negatively related to increments in successful performance.

Figure 1. Preliminary Model Relating Group-level Ability, Personality, and Attitude to Team Performance



Future Research Directions

Given the exploratory nature of this study, it is premature to suggest rules for selecting successful teams. However, the findings from this study do suggest that the ability and personality tests currently used in individual personnel selection may have some applicability to the selection of teams. It is possible that a combination of ability and personality factors may be useful in selecting the appropriate combination of team members in order to avert failure. Furthermore, it is possible that some personality characteristics (e.g. heterogeneity of Conscientiousness) may relate to decrements in performance for teams that achieve initial success. Although the current results are promising, future research is required to address some of the limitations of the present study.

First, the variables of ability and personality should be examined as predictors of performance for design teams that are engaged in projects over a longer time period. The short duration of the task used here may not have provided adequate time for some personality combinations to be manifested in performance differences. It is therefore recommended that more involved design projects that require the team to exist over an extended time period be used to verify the results obtained.

The advantage of using of a laboratory design for exploratory team research minimizes the effect of other potentially confounding variables (e.g. status differences, organizational politics) so that any relationship between the independent and dependent

variables may be isolated to a greater degree than is possible in a field environment (Driskell and Salas 1992). However, there are also arguments that may be made with respect to limitations in the generalizability of the results as a result of the simplification of the situation, including the characteristics of the task. The "bridge-building" task that was used in this study, although not as complex as many design problems found in organizational settings, was of sufficient difficulty to differentiate between successful and unsuccessful teams. The design task also had many characteristics similar to a design situation in the workplace. Specifically, in order to be successful at this task, the team had to satisfy many constraints, strategize how to improve performance (in terms of points), allocate resources, and perform under time pressure. Although the results suggest some relationships for future research, in order for these preliminary results to generalize to organizational design teams, studies need to be taken from the laboratory environment into actual organizations where other "real life" variables (e.g. organizational politics, reward systems, status differences, experience differences) impact on the team's ability to succeed in addition to personality. This will allow us to determine if the team's personality combination is still a major factor in determining the team's success when other factors are present.

There are several potential limitations with respect to the generalizability of the results from this research which stem from the fact that a student sample was used. The first concern relates to the suitability of Engineering students as proxies for actual

Engineers. However, this is not thought to be a big limitation. The focus of this research was on Engineering Design teams which were responsible for the design of a product. The use of Engineering students is an acceptable proxy for actual Engineers because these students ARE the future Engineers to which organizations may apply the results found in this and similar studies examining the effect of personal characteristics on the performance of Engineering design teams.

Another concern about using a university student sample is potential restriction of range on the factor of ability. However, surprisingly, the sample used in this study did not differ from the population norms to the extent that might have been expected. The student sample scored slightly higher, on average than the population norm (e.g. Student ability score average = 22.3 versus Population norm = 21.1), however, the distribution of scores in the student sample were not different enough from the population norms (e.g. Student sample: Q1 = 18, Median = 22, Q3 = 26; Population norm: Q1 = 16, Median = 21, Q3 = 26) to warrant much concern with respect to restriction of range (see also Appendix 1).

Another potential problem with using a student sample is that the students may not take the exercise seriously, or may try to influence the results of the experiment. However, neither concern was thought to play a large role in the results obtained. This study took place in the first week of classes in the first year of university. The design exercise was also mandatory as part of the course and worth a substantial (i.e. 10%) part

of their mark. Therefore, it is likely that students were motivated to perform the task to the best of their abilities. Although it is possible that the students did not take the ability and/or personality testing seriously, or tried to influence the results of the experiment, this is not thought to be likely. There was widespread interest in the results from the ability and personality tests - most notably, students were very concerned how they scored on the ability test relative to their classmates and wanted to learn about strategies to improve their scores in the future. There was also widespread interest in the interpretation of the personality test results. As well, participation in writing the ability and personality tests was completely voluntary. If students did not want to "waste their time" they were not required to do so. It is also not likely that the students tried to influence the results of the experiment since they were not privy to the research questions prior to the design exercise.

Although the limitations to the generalizability of the results from the use of a student sample were thought to be minimal, future research should be done using actual Engineers to ensure the applicability of the results.

The applicability of the results obtained in this study may be limited to design tasks or to similar optimizing tasks. As mentioned previously, personality combinations that affect team success may be dependent on the team's task (Driskell, Hogan, and Salas 1987). Therefore, in order to develop a "personality map" for team success, team personality combinations need to be investigated for other types of tasks.

CHAPTER 5

SUPPLEMENTARY ANALYSIS, RESULTS, AND DISCUSSION

Introduction

The purpose of the Supplementary analysis chapter is to explore possible relationships that may increase our understanding of three specific questions that were identified in the course of the primary analysis. The three questions addressed in this section include:

Q1. Are self-reported performance and satisfaction measures appropriate proxies for objective team performance?

Q2. What are the variables which determine the propensity of a team member to continue as part of the team?

Q3. Is the Teamwork KSA test significantly related to self-reported performance (instead of objective performance)?

Each question will be fully addressed in turn.

Q1: Self-reported performance measures as a proxy for objective performance

Introduction

In the primary analysis section of this thesis, a team-level objective performance measure was used as the criterion for each team's success. Although this may seem very straight-forward, it was noted previously that much of the small group literature did not use objective criteria in the assessment of performance. Instead, either the sum or the average of individual team member reports of performance or satisfaction were used as proxies for performance. Despite some preliminary evidence which suggests that the use of self-reported performance and satisfaction measures are not suitable proxies for objective performance (e.g. Gladstein 1984; Iaffaldano and Muchinsky 1986; Kichuk 1996; Mabe and West 1982), the use of such measures in group-level investigations continues (e.g. Campion, Papper, and Medsker 1996). In this section, the relationship between self-reported measures (i.e. perceived performance and satisfaction), and the objective performance of the team is investigated in order to ascertain how self-reported and objective performance measures are related, and the suitability of using self-reported measures as a proxy for actual team performance.

In order to maintain consistency with previous small group literature, the appropriateness of satisfaction or self-reported performance as a proxy for objective performance is examined at the group level (e.g. in terms of composites). In addition to the group level of analysis, the relationships among these variables will also be examined

at the individual level in order to relate the findings in this study to those established in the individual performance literature.

Method

Measures. Objective performance at the group level of analysis was measured by the product performance of the group. For the individual level of analysis, objective performance was measured by assigning each subject the score which his/her team received on the product. It should be noted that although the team's product score ("Score") is a group-level variable (e.g. the team's score on the product is a result of the combined effort of all the team members together), when the "Score" variable is disaggregated from the group level to the individual level (e.g. the group's score is assigned individually to each team member as his/her own score), this information may be used to understand how the product information available to each group member was processed and incorporated into his/her self-reported performance and satisfaction scores.

Team member satisfaction was measured by six questions using a Likert 5 point scale tapping into the team members' satisfaction with their product, process, and people. Questions included: "I am satisfied with the quality of the product our group produced"; "I am satisfied with the degree to which our product matched the requirements of the exercise"; "I am satisfied with the process our team employed in creating our product"; "I am satisfied with the contributions of the other team members toward our team's product"; "Overall, I am satisfied with the performance of our team". This scale had an

internal consistency reliability of 0.86. Factor analysis provided support for these items to be combined into an overall Satisfaction composite.

Self-reported performance was determined by two statements using a 5-point Likert scale asking the subjects to rate their performance in terms of the product produced: "I do not think that our team performed well" (reverse scored) (SRP1) and "The product that our team produced was of high quality" (SRP2). The internal consistency reliability of these two items was 0.62 which suggested that these items were significantly related. The responses for these two questions were combined into a composite self-reported performance score (SRPTOT). In Appendix 2 the analysis is redone keeping the responses from the two performance statements (e.g. SRP1 and SRP2) separate.

Analysis. The analyses for the supplementary section were done on successful teams (for the group level of analysis) and on the individuals who were members of successful teams (for the individual level of analysis). The subjects who were not members of a successful team were excluded from the analysis for two reasons. First, the relatively large "clump" of zero scores (approximately 13% of the entire sample) posed some problems with respect to the assumptions necessary for regression and correlation analyses. Second, both questions addressed in the supplementary analysis section are only of interest if the team is successful. That is, if the team cannot perform at a minimally acceptable level, it is of little interest to see if the team members' self-reported measures

are good proxies for performance, or, the team members' propensity to continue as a group in the future (even if the team members wanted to, it probably would not be in the best interest of the organization to allow them to do so!).

The relationships among the self-reported measures (i.e. performance and satisfaction) and objective performance scores were first examined via a correlation analysis. Post hoc relationships were explored both via traditional regression analyses using the SPSS/PC software and via statistical decision trees using CART (Classification and Regression Trees) software (Breiman et al. 1984; Steinberg and Phillip 1995).

Results and Discussion

The correlations among the self-reported measures and objective performance are displayed in Tables 4 and 5. In order for one variable to serve as an acceptable proxy for another, the two variables must be highly correlated. At the group level, the moderate correlations found between self-reported performance and actual performance ($r = 0.34$, $p<.01$), and between Satisfaction and actual performance ($r = 0.37$, $p<.01$) do not support the use of these self-reported measures as proxies for actual performance in a team setting. A post-hoc regression analysis was done in order to determine if the combination of the Satisfaction and self-reported performance scores together formed a better proxy for actual performance. It was found that together, Satisfaction and self-reported performance shared only 14% of the variance with Score, which did not support the use of such measures as proxies for performance.

Table 4. Self-Reported Outcome Measures and Performance - Group Level

Composites	Mean (SD)	SRP1	SRP2	SRPTOT	Satisfaction	Longevity
SRP1	11.0 (2.1)	--				
SRP2	9.1 (2.6)	.55** (97)	--			
SRPTOT	20.1 (4.1)	.85** (97)	.91** (97)	--		
Satisfaction	67.0 (8.7)	.69** (99)	.81** (97)	.86** (97)	--	
Longevity	23.3 (2.5)	.57** (97)	.49** (95)	.59** (95)	.72** (97)	--
Group Score	7.9 (4.0)	.18* (99)	.39** (97)	.34** (97)	.37** (99)	.16 (97)
Gender	0.6 (0.7)	.00 (98)	-.11 (96)	-.08 (96)	-.09 (98)	-.04 (96)

Notes: Data are provided for the NZS (Non-zero scoring) subset only. The standard deviation (SD) for each variable's distribution is given in parentheses below the mean. SRP1 = self-reported overall group performance. SRP2 = self-reported product performance. SRPTOT = combined responses to SRP1 and SRP2. The number of cases used in the calculation of the correlations are given in parentheses below the corresponding correlation.

[a] Gender is operationalized as the number of females on the team; $N_{x\ females}$ = Number of teams with x females on the team; $N_{0\ females} = 52$, $N_{1\ female} = 34$, $N_{2\ females} = 12$, $N_{3\ females} = 1$

*p<.05 **p<.01

Table 5. Individual Level Dependent Variables for the NZS Subset

	SRP1	SRP2	SRPTOT	SAT	LONG	M_F (SD)	M_M (SD)	M_T (SD)
SRP1	--					3.7 (0.9)	3.7 (1.0)	3.7 (1.0)
SRP2	.47**	--				2.7[a] (1.0)	3.2[a] (1.1)	3.1 (1.1)
SRPTOT	.84**	.87**	--			6.4[b] (1.6)	6.9[b] (1.8)	6.8 (1.8)
SAT	.59**	.74**	.79**	--		21.6[c] (3.9)	22.7[c] (3.8)	22.5 (3.8)
LONG	.43**	.47**	.52**	.71**	--	7.5[b] (1.4)	7.9[b] (1.2)	7.8 (1.3)
Group Score	.16**	.34**	.30**	.31**	.13*	7.9 (3.4)	8.0 (4.0)	8.0 (3.9)

Notes: Data are provided for the NZS (non-zero scoring) subset only. SRP1 = self-reported overall group performance. SRP2 = self-reported product performance. SRPTOT = combined responses to SRP1 and SRP2. SAT = self-reported satisfaction with the team. LONG = propensity of the individual to remain part of the team. M_F = Mean on each variable for the females in the NZS subset, M_M = Mean for the males in the NZS subset. M_T = Mean for the entire NZS subset. The standard deviation (SD) is shown in parenthesis below each mean. Total number of females in the NZS subset is 61. Total number of males in the NZS subset is 257. The sample size used in the calculation of the correlations ranges from 315-319. Differences in the N's used for the correlations occurred because the variables differed in the number of missing values.

[a] The means for the male and female subsets of the NZS population differed at $p<.01$.
[b] The means for the male and female subsets of the NZS population differed at $p<.10$.
[c] The means for the male and female subsets of the NZS population differed at $p<.05$.

*p<.05 **p<.01

At the individual level, the findings were much the same as they were at the group level. The correlation found in this study at the individual level between self-reported performance and actual performance ($r = 0.30$, $p<.01$) was not much different than that reported at the group level ($r = 0.34$, $p<.01$) and is in accordance with the correlation found between self-reported performance and actual performance in the Mabe and West (1982) meta-analysis (e.g. $r = 0.29$) using individual-level performance measures. This would suggest that the relationship between self-reports of performance and actual performance is similar for both individual and team performance. If this is true, then much of what we know about individual self-performance ratings would also apply to teams. That is, self-evaluations are notoriously subject to various forms of bias, the most pervasive being positive leniency as most people have unrealistically high perceptions of their own performance (Latham 1986). It is for this reason that self-evaluations of performance are not usually recommended as being the primary source of performance information from individuals. Similarly, it may be concluded that self-reports should not be the primary criteria used for the evaluation of teams. However, if self-evaluations are the only option available to gauge the performance of teams, according to the individual performance literature, self-evaluations have been shown to increase in validity to the degree that the rater expects that his/her self-evaluation will be compared with actual criterion (preferably objective) measures (Lane and Herriot 1990; Latham 1986; Latham et al. 1993; Mabe and West 1982), that the rater is guaranteed anonymity (obviously only

possible in experimental conditions) (Latham 1986; Mabe and West 1982), that there are established self-rating procedures (Mabe and West 1982) such as documentation requirements (Farh and Dobbins 1989), that the rater has experience in rating him/herself (Mabe and West 1982; Somers and Birnbaum 1991), and that comparative performance information is available (Farh and Dobbins 1989; Mabe and West 1982). If all of these factors are incorporated into the self-evaluation procedure, the validity coefficient between self-reported and actual performance may substantially increase (coefficients of 0.63 reported; Mabe and West 1982).

Satisfaction is still used in the group literature as a proxy for performance even though in the individual job performance and satisfaction literature, the old adage " a happy employee is a productive employee" has not received statistical support. In a meta-analysis performed by Iaffaldano and Muchinsky (1985) investigating the relationship between satisfaction and performance, an overall effect size of only 0.17 was reported between the two variables. Although the correlation in this study at the individual level ($r = 0.31$, $p<.01$) between Satisfaction and performance was higher than the overall effect size found by Iaffaldano and Muchinsky, it is not of sufficient magnitude to suggest that Satisfaction is a good proxy for objective performance.

Q2: Possible determinants of team longevity

Introduction

The design task used to derive the model proposed in Figure 1 occurred over a very short period of time. Although many project teams are temporary, it is likely that the majority of teams will meet more than once. One could therefore argue that a successful team is not only one which produces an acceptable product, but also one in which the team members are willing to continue as members of the team after the first session. In this experiment, team members were asked to report their propensity to remain part of the team after the initial design task was completed. This question had particular relevance for these students because the teams used in the design exercise continued on as teams for the remainder of the term. Variables which were related to a person's propensity to remain part of a team were identified in an effort to extend the team performance model proposed in Figure 1.

Method

Measures. Both the independent (e.g. personality, general ability, Teamwork KSA, and attitude) and dependent (e.g. Satisfaction, SRPTOT, and "Score") variables were measured as previously discussed.

Team member propensity to work together in the future was measured using a Likert 5 point scale (Strongly agree to strongly disagree) on two statements: "I would like to continue working with this group in the future"; "I work well with this group" . The

internal consistency reliability for these two items was found to be 0.74. Thus, these items were combined into a composite of "longevity", or propensity to work together in the future for each individual.

It is conceivable that the propensity of a person to remain part of the team would vary not only as a function of one's scores on the independent variables, but also as a function of how much a person differed from his/her teammates on those variables. This difference may be captured by calculating the attribute dissimilarity for each person on each independent variable. The attribute dissimilarity measure may be operationalized as the Euclidean distance between each individual's score on a given variable and the scores received by his/her teammates[12] (Jackson et al. 1991). The attribute dissimilarity measure for each individual was calculated for each of the independent variables.

Analysis. The relationships among the variables in the model and the "Longevity" variable were analyzed with a combination of stepwise regression techniques and statistical decision trees (e.g. CART). Gender was controlled in this analysis because Longevity was correlated with gender at the $p = 0.06$ level and many of the independent variables being examined were also significantly correlated with gender (Table 6).

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[12] For each variable, the attribute dissimilarity was calculated as:

$$\Sigma_{j=1 \text{ to } j=n} [(s_i - s_j)^2 / (n-1)]^{1/2}$$

where: s_i = individual's value on the attribute

s_j = jth member's value on the attribute

Table 6 - Correlations Among the Independent Variables at the Individual Level

	1	2	3	4	5	6	7	8	M_F (SD)	M_M (SD)	M_T (SD)
1. Consc.	--	.08	.29**	.01	-.03	.07	.02	-.11	36.5[a] (5.5)	33.1[a] (6.4)	33.8 (6.4)
2. Extra.	.34**	--	.21**	.35**	.13*	.05	.01	.07	31.5 (6.6)	31.4 (5.9)	31.4 (6.0)
3. Neuro.	-.39**	-.43**	--	-.27**	.07	.09	-.03	.04	20.4[b] (7.8)	17.9[b] (7.9)	18.4 (7.9)
4. Agree.	.32**	.50**	-.43**	--	-.02	.13*	.00	.04	34.8[a] (6.1)	32.2[a] (6.0)	32.7 (6.1)
5. Open.	.14*	.31**	-.29**	.18**	--	.07	.03	.05	28.2[a] (6.4)	30.8[a] (6.0)	28.7 (6.4)
6. KSA	.15**	.28**	-.42**	.41**	.31**	--	.21**	-.04	24.5[a] (4.9)	21.8[a] (5.4)	22.3 (5.4)
7. Ability	.05	.21**	-.31**	.24**	.26**	.64**	--	-.03	24.0 (5.4)	22.4 (5.9)	22.7 (5.9)
8.Att.	-.01	.24**	-.09	.22**	.04	.09	-.01	--	33.6 (4.8)	34.4 (4.8)	34.2 (4.8)

Notes: Inter-correlations of attribute dissimilarity measures are shown in the upper triangle. Inter-correlations for the scores received on each measure are shown in the lower triangle. Correlations were calculated controlling for gender. M_F = Mean for the female NZS subset. M_M =Mean for the male NZS subset. M_T = Mean for the entire NZS subset. The sample size from which the correlations were derived ranged from 277-307; variations in the sample size occurred because the variables differed in the number of missing values. Standard deviations (SD) for the variables are given in parentheses below the mean.

[a] The means for the male and female subsets of the NZS population differed at $p<.01$.
[b] The means for the male and female subsets of the NZS population differed at $p<.05$.

* $p<.05$ **$p<.01$

Although the p= 0.06 level does not represent statistical significance at the traditional p<.05 level, it is close enough to be a concern. Since the gender composition of the sample in this study is very different than the population as a whole (e.g. 80% male versus 50% male), gender was controlled so that the results would be more generalizable.

Results and Discussion

The propensity of an individual to continue working as part of the group was found to be significantly correlated with Satisfaction, Self-reported performance, prior attitude towards group work, Extraversion, general cognitive ability, attribute dissimilarity of Satisfaction, and the performance score received by the individual's team (Table 7). Both a stepwise regression and a CART analysis were performed on the variable of Longevity. In both cases, it was found that once Satisfaction was considered ($\Delta R^2 = 0.51$, $p<.01$), the other variables were of little or no significance in determining the Longevity scores (the attribute of dissimilarity on the factor of Satisfaction shared an incremental 1% of the variance with Longevity over that shared between Satisfaction and Longevity).

Two additional analyses were performed. First, it was of interest to see what independent-level variables affected Longevity so that in the absence of Satisfaction measures (e.g. before the team has been formed), it would still be possible to identify those people who would be more likely to continue as part of a team. All of the individual level independent variables (e.g. personality, ability, and attitude) as well as the person's

Table 7 - Correlations Between the Independent and Dependent Variables

	Satisfaction	Longevity	Attribute Dissimilarity	Satisfaction	Longevity
Cons.	0.06	0.05	Cons.	-0.06	-0.11
Extra.	0.19**	0.14*	Extra.	0.00	-0.02
Neuro.	-0.09	-0.06	Neuro.	0.01	-0.06
Agree.	0.12*	0.08	Agree.	-0.08	-0.09
Open.	0.03	0.05	Open.	0.04	-0.02
KSA	0.01	-0.05	KSA	0.05	-0.03
Ability	-0.07	-0.12*	Ability	0.03	-0.03
Attitude	0.15**	0.19**	Attitude	-0.07	-0.05
Satis.	1.00	0.71**	Satis.	-0.24**	-0.25**

Notes: Correlations were calculated controlling for gender. The sample size from which the correlations were calculated are given in parentheses below the corresponding correlation.

*p<.05 **p<.01

attribute dissimilarity (e.g. the degree to which the person differs on that attribute from his/her teammates) on each variable were entered as independent variables in a series of step-wise regression analyses (Table 8). Attitude towards teamwork was identified as being the primary variable influencing Longevity. General cognitive ability, Extraversion, and the degree to which one differed from his/her team-mates on the factor of Conscientiousness contributed significant incremental variance to the Longevity score. Since Extraversion is highly correlated with Attitude towards teamwork (Table 6), and Attitude towards teamwork could be argued to be a function of one's personality, perhaps Extraversion, in addition to sharing variance directly with Longevity, also influences Longevity indirectly as a function of Attitude. This proposition received support from an additional regression analysis (Table 8). Attitude towards teamwork shared incremental variance with Longevity over that shared between Extraversion and Longevity. Furthermore, the magnitude of variance shared between Extraversion and Longevity decreased when Attitude was entered first into the regression equation. Therefore, some of the variance shared between Extraversion and Longevity is common with that shared between Attitude and Longevity. Thus, it is possible that Extraversion influences Longevity both directly, and indirectly as a function of Attitude. Both cognitive ability and the attribute of dissimilarity on the factor of Conscientiousness shared significant incremental variance with Longevity over that accounted for by Extraversion

Table 8 - Possible Determinants of Longevity

Regression Analyses	ΔR^2	B	SE B	β
Stepwise (including attitude measures)				
Step 1: (Entered) Gender	0.01[a]	-0.29	0.19	-0.09
Step 2: Attitude towards teamwork	0.04**	0.05	0.02	0.17
Step 3: Attribute Diss. Conscientiousness	0.02*	-0.04	0.02	-0.13
Step 4: General Cognitive Ability	0.01*	-0.03	0.01	-0.15
Step 5: Extraversion	0.02*	0.03	0.01	0.13
Step 1: (Entered) Gender	0.01[a]	-0.29	0.19	-0.09
Step 2: (Entered) Extraversion	0.02*	0.03	0.01	0.13
All Independent Variables(Stepwise):				
Step 3: Attitude towards teamwork	0.02**	0.02	0.02	0.17
Step 4: General Cognitive Ability	0.02*	0.01	0.01	-0.15
Step 5: Attribute Diss. Conscientiousness	0.02*	0.02	0.02	-0.13

*p<.05 **p<.01

and Attitude towards teamwork. Given the lack of relationship between general cognitive ability, the attribute of dissimilarity of Conscientiousness, and attitude towards group work, it is proposed that general cognitive ability influences Longevity directly (Figure 2). From a logical standpoint this also makes sense. Both cognitive ability and the degree to which one differs from his/her teammates on the factor of Conscientiousness are negatively related to his/her propensity to remain as part of the team. Those individuals who scored high on the cognitive ability test may have felt that they could have done better on the task alone; that is, they may have felt encumbered by the other teammates who were not as "smart" as the high scorer. The difference in Conscientiousness may also be logically surmised to affect one's propensity to remain part of the team. As discussed previously, if a very Conscientious person is matched with less Conscientiousness teammates (or vice versa) the differences displayed by the team members with respect to their focus on the task at hand may cause friction among the team members. This friction may negatively influence one's willingness to work with the same people in the future.

The second post-hoc analysis involved exploring the relationship between Satisfaction and the independent variables since Satisfaction was the primary determinant of Longevity[13]. Satisfaction was also significantly correlated with Extraversion,

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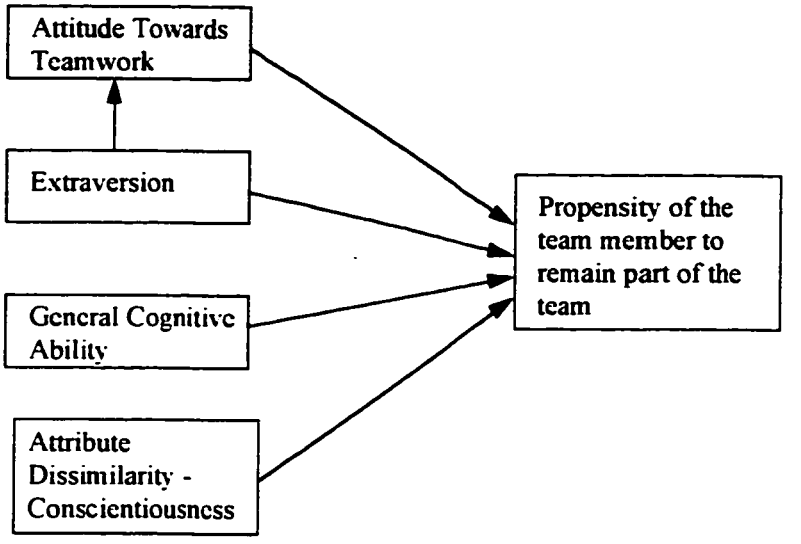
[13] It should be noted that for these analyses gender is also controlled because both the dependent variable (e.g. Satisfaction) and several of the independent variables (e.g. some of the personality variables and the KSA test) are significantly influenced by gender ($p<.05$).

Figure 2 - Preliminary Model Relating Individual-level Ability, Personality, and Attitude to the Propensity to Remain Part of the Team



Agreeableness, and Attitude towards teamwork (Table 7). The finding that Extraversion was positively related to a person's level of satisfaction was in accordance with the findings from a previous study (Kichuk 1996). Given the high inter-correlation of the independent variables, a series of stepwise regression analyses were performed in order to ascertain the independent contribution of each significant variable (Table 9). As expected, Extraversion was found to be the primary variable influencing Satisfaction (both directly and indirectly via attitude towards teamwork). Further analysis with CART supported the

Table 9. Possible Determinants of Satisfaction

Regression Analyses	ΔR^2	B	SE B	b
Step 1: Gender (Entered)	0.01*	-1.14	0.57	-0.12
Stepwise (all independent variables)				
Step 2: Extraversion	0.05**	0.12	0.04	0.18
Step 1: (Entered)Gender	0.01*	-1.07	0.57	-0.11
Step 2: (Entered)Attitude Towards Teamwork	0.04**	0.09	0.05	0.11
All independent variables (Stepwise)				
Step 3: Extraversion	0.02**	0.10	0.04	0.16
Step 1 : Gender (Entered)	0.01*	-1.20	0.58	-0.12
Step 2: Agreeableness (Entered)	0.01	0.02	0.04	0.03
Stepwise (all independent variables)				
Step 3: Extraversion	0.02*	0.11	0.04	0.17

*p<.05 **p<.01

factor of Extraversion as being a primary differentiating factor on the variable of Satisfaction.

In summary, Satisfaction with the team experience seems to be the primary determinant of the propensity of a person to remain part of the team. However, from a selection standpoint, this is not particularly useful information since the satisfaction level of the team members cannot be ascertained before the team is formed. The results from the analyses above suggest that a person's prior attitude toward teamwork and a person's level of Extraversion may influence a person's satisfaction level with the team and the person's subsequent propensity to remain part of the team. In addition, a person's level of cognitive ability and the degree to which s(he) differs from the other team members on the the factor of Conscientiousness may affect a person's propensity to remain part of team. The proposed relationships are diagrammed in Figure 2. It is recommended that these variables be investigated in future research as potential predictors of team longevity.

Q3: The Relationship Between the Teamwork KSA test and Self-reported performance

Introduction

The Teamwork KSA test was developed from the available literature on effective teamwork and was designed to measure the "KSA's" necessary for effective teamwork behaviour. In the primary analysis section, neither the team's composite level nor the level of heterogeneity of the team members on the Teamwork KSA test was found to be significantly related to the performance of the team. It was hypothesized at that point that

the Teamwork KSA test scores might be related to a person's perceived (e.g. self-reported) performance because many of the studies from which team effectiveness information was derived used self-reported performance as a proxy of objective performance.

Method

Measures. Teamwork KSA scores and self-reported performance scores (SRPTOT) were measured as previously described.

Analysis. A regression analysis was done entering the individual-level self-reported performance as the dependent variable and the individual-level Teamwork KSA score as the independent variable.

Results and Discussion

The Teamwork KSA test was not significantly related to the self-reported performance composite. This suggests that the Teamwork KSA test is not indicative of objective or self-reported performance at the team level. However, as mentioned previously, the composite self-reported measure combined the responses from two statements. One statement was focused on the team's performance of the product (i.e. " The product that our team produced was of high quality."), and one was focused on a more "global" statement of performance (i.e. "I do not think that our team performed well." (Reverse scored)). In accordance with previous discussions, the relationship

between self-reported performance and actual performance tends to become stronger when the self-report is focused on the criteria on which the person is being evaluated. That is, the self-report of product performance would be more indicative of actual performance than the "global" self-report. It might therefore be expected that the relationship between the Teamwork KSA scores and the self-report of product performance might be similar to the relationship between the Teamwork KSA scores and actual product performance. Given that there was no significant relationship found between an individual's score (or attribute dissimilarity) on the Teamwork KSA test and the performance of his/her team, perhaps there is also no relationship between the Teamwork KSA scores and self-reports of product performance. When the self-report of product performance and the self-report of "global" performance were combined into a composite, the lack of relationship between the Teamwork KSA test scores and self-reported product performance might have masked a significant relationship between the Teamwork KSA scores and the reports of "global" performance. This possibility is examined in Appendix 2.

CHAPTER 6

SUMMARY

Potential relationships between team member characteristics (e.g. general cognitive ability, personality, and attitude) and team performance were investigated for Engineering design teams. In the short time period over which this study took place, it became apparent that some teams were able to perform at a minimally acceptable level, and some were not. Successful teams were characterized by higher composite levels of general cognitive ability, Extraversion, Agreeableness, Emotional Stability, and Teamwork KSA scores than their unsuccessful counterparts. However, from a selection standpoint, only general cognitive ability and Neuroticism provided unique variance in differentiating successful from unsuccessful teams. The heterogeneity of Conscientiousness was negatively related to the performance of successful teams.

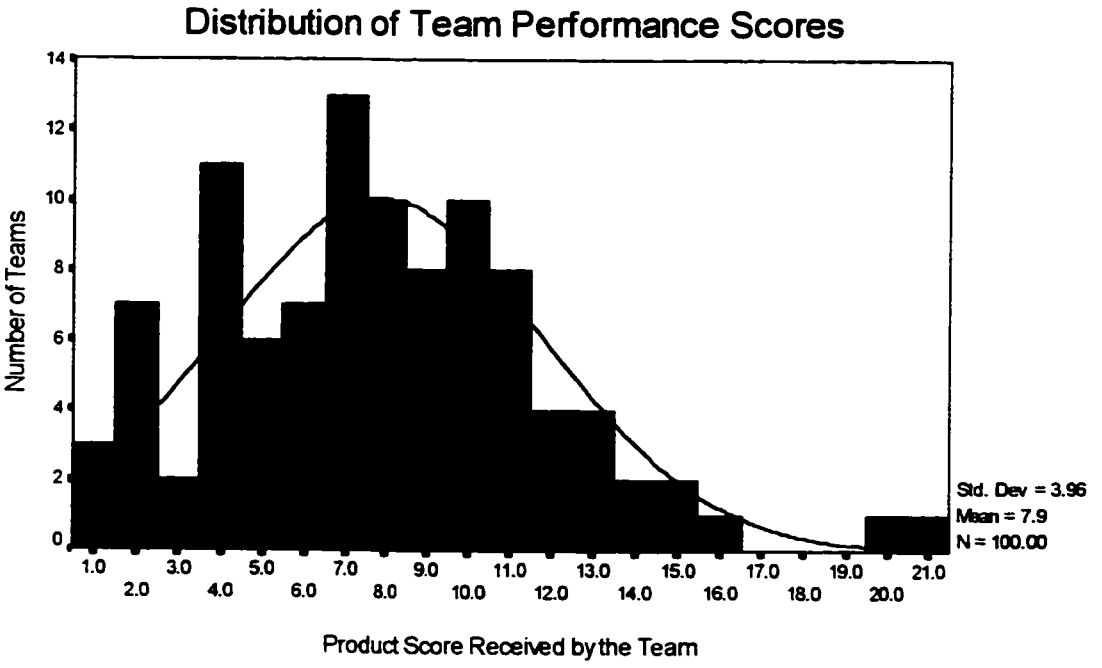
Team member reports of satisfaction and performance were moderately related to the team's product performance, although the relationship was not sufficiently large to suggest that self-reported measures may be used as proxies for team product performance. Satisfaction was, however, the primary determinant of the team members' propensity to remain part of the team in the future. Thus, if the team must meet more than once, the satisfaction of the team members might also be considered another important outcome variable in addition to product performance. A team member's initial attitude towards

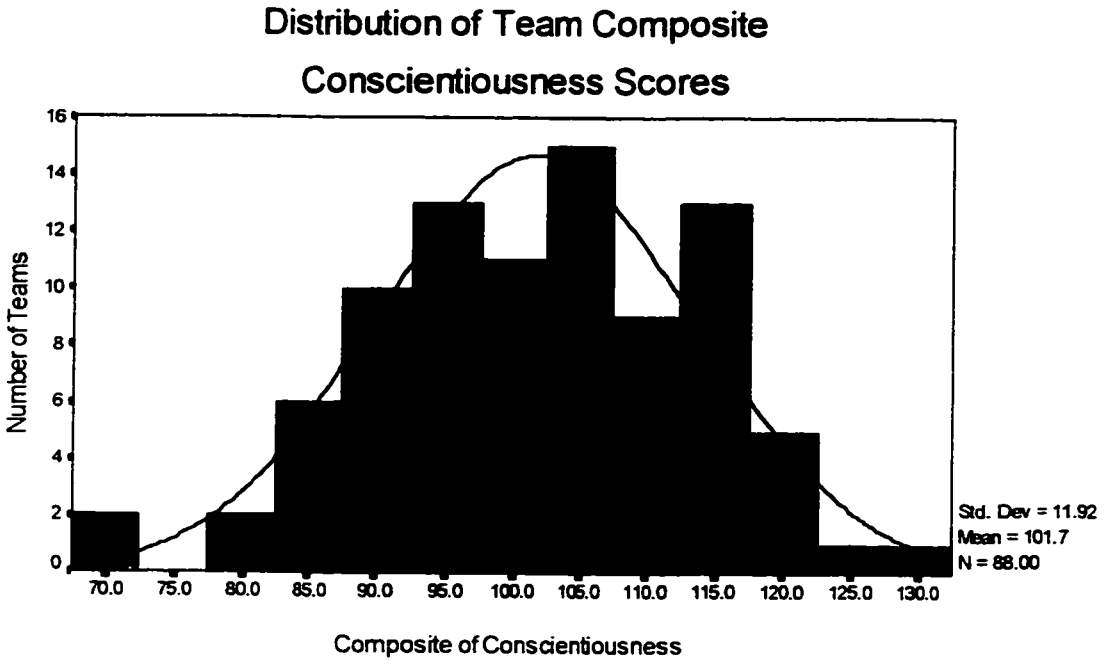
teamwork and level of Extraversion were positively related to the person's level of satisfaction with the team. Given the strong relationship between a person's level of satisfaction and his/her propensity to remain part of the team, these factors were also positively related to the propensity of a person to remain part of the team. The degree to which a person differed from his/her team-mates on the factor of Conscientiousness and the person's level of general cognitive ability were negatively related to the person's propensity to remain part of the team.

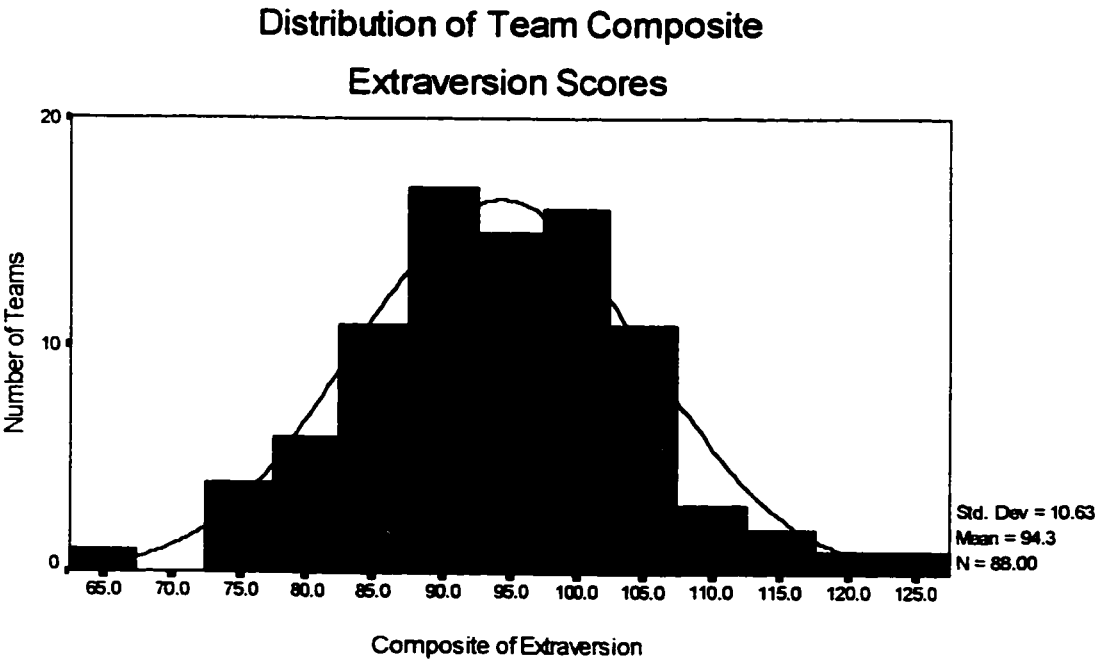
The various limitations of this study make it premature to suggest selection rules for teams. However, the results suggest that team members' levels of general cognitive ability and personality influence team performance and may be useful as potential selection measures. It is therefore recommended that the effect of team member ability, personality, and attitude towards teamwork on team performance be investigated in future research.

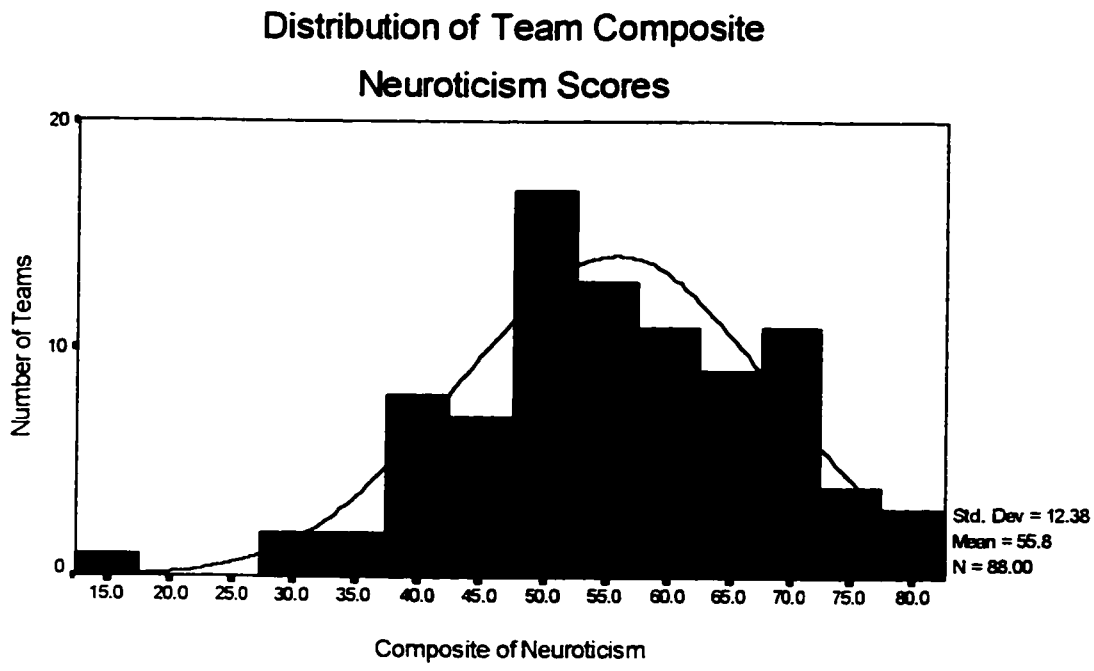
APPENDIX 1

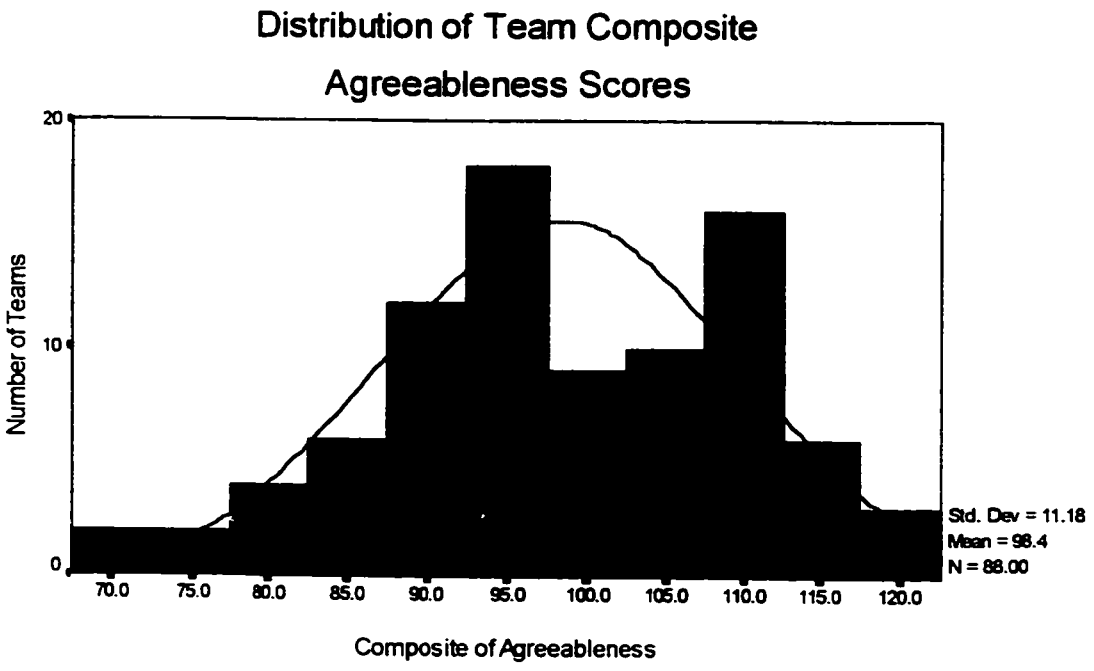
SUPPLEMENTARY ILLUSTRATIONS

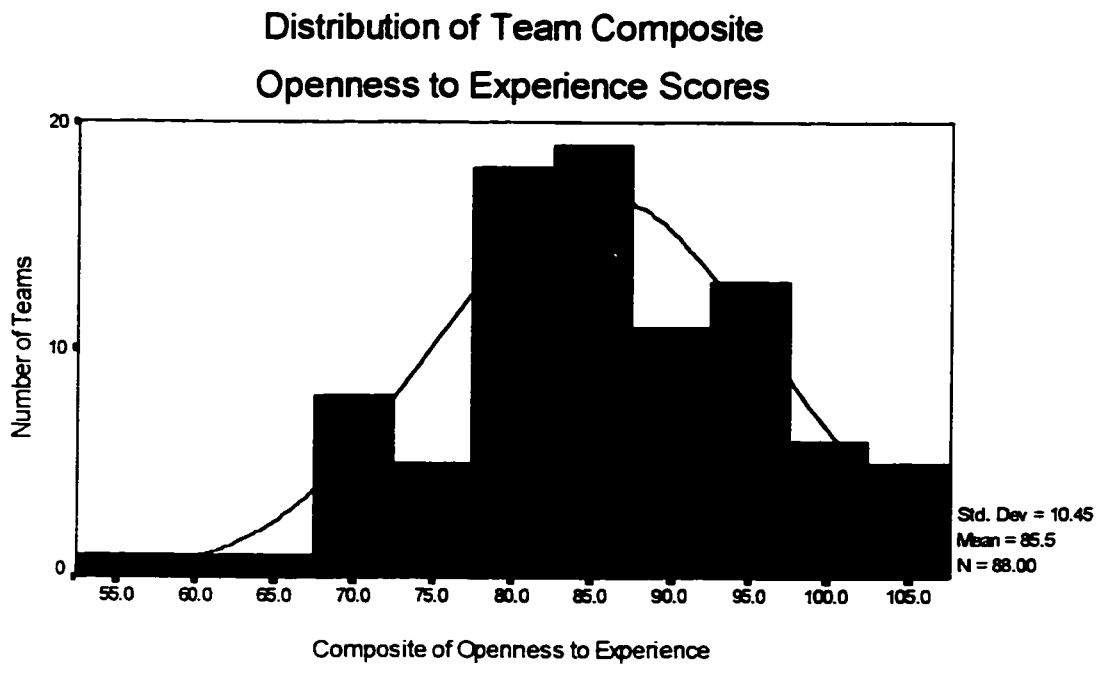


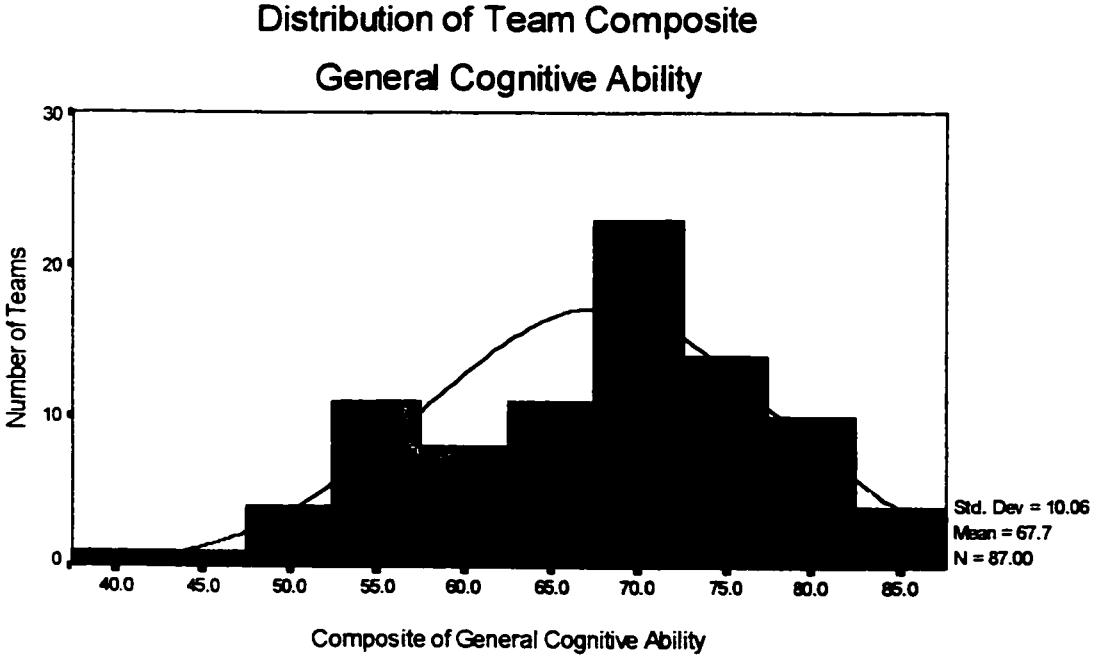

Distribution of Team Composite
Conscientiousness Scores
Number of Teams
16
14
12
10
8
6
4
2
0
70.0
75.0
80.0
85.0
90.0
95.0
100.0
105.0
110.0
115.0
120.0
125.0
130.0
Std. Dev = 11.92
Mean = 101.7
N = 88.00
Composite of Conscientiousness

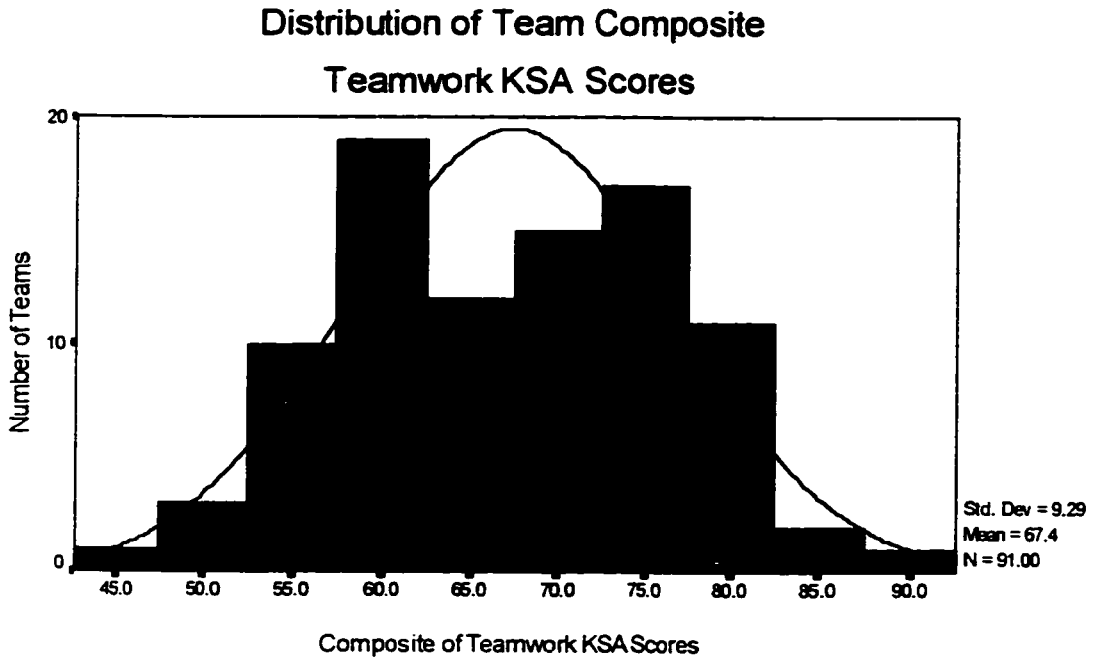

Distribution of Team Composite
Extraversion Scores
Number of Teams
20
10
0
65.0
70.0
75.0
80.0
85.0
90.0
95.0
100.0
105.0
110.0
115.0
120.0
125.0
Std. Dev = 10.63
Mean = 94.3
N = 88.00
Composite of Extraversion

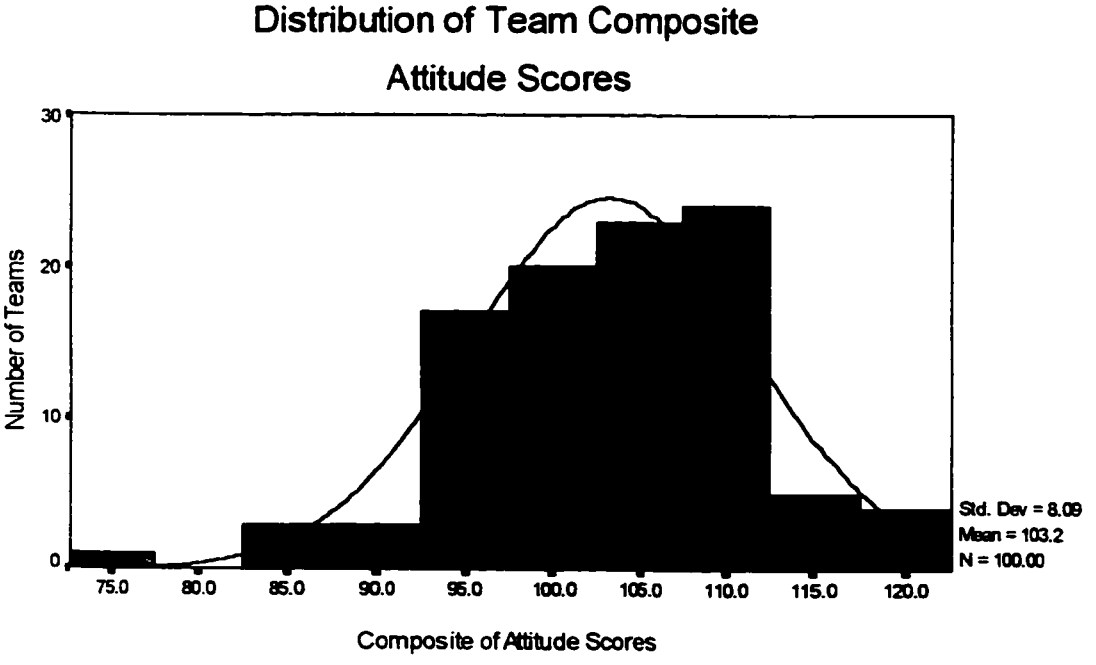

Distribution of Team Composite
Neuroticism Scores
Number of Teams
20
10
0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Std. Dev = 12.38
Mean = 55.8
N = 88.00
Composite of Neuroticism


Distribution of Team Composite
Agreeableness Scores
Number of Teams
20
10
0
70.0
75.0
80.0
85.0
90.0
95.0
100.0
105.0
110.0
115.0
120.0
Std. Dev = 11.18
Mean = 98.4
N = 88.00
Composite of Agreeableness


Distribution of Team Composite
Openness to Experience Scores
Number of Teams
20
10
0
55.0
60.0
65.0
70.0
75.0
80.0
85.0
90.0
95.0
100.0
105.0
Std. Dev = 10.45
Mean = 85.5
N = 88.00
Composite of Openness to Experience


Distribution of Team Composite
General Cognitive Ability
Number of Teams
30
20
10
0
40.0
45.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
85.0
Std. Dev = 10.06
Mean = 67.7
N = 87.00
Composite of General Cognitive Ability


Distribution of Team Composite
Teamwork KSA Scores
Number of Teams
20
10
0
45.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
85.0
90.0
Std. Dev = 9.29
Mean = 67.4
N = 91.00
Composite of Teamwork KSA Scores


Distribution of Team Composite
Attitude Scores
Number of Teams
30
20
10
0
75.0
80.0
85.0
90.0
95.0
100.0
105.0
110.0
115.0
120.0
Std. Dev = 8.09
Mean = 103.2
N = 100.00
Composite of Attitude Scores

APPENDIX 2

SUPPLEMENTARY ANALYSIS

Introduction

In the supplementary analysis section, the variable "Score" was examined in terms of Satisfaction and a composite measure of self-reported performance (SRPTOT). SRPTOT was a combination of the responses to two questions: "I do not think that our team performed well" (reverse scored) (SRP1) and "The product that our team produced was of high quality" (SRP2). The internal reliability coefficient of 0.62 indicated that the responses to these two questions were significantly related, and as a result, the responses were combined into a composite for the previous analysis. However, it may be argued that whenever responses are combined into a composite, information is lost. Furthermore, a reliability coefficient of 0.62 also indicates that there are some differences in the pattern of responses between the two self-reported questions posed. That is, the responses to these two statements may be measuring somewhat different aspects of self-reported performance. Given the exploratory nature of this thesis, the research questions posed in the supplementary analysis section were re-examined keeping the responses to the two self-reported performance questions separate.

Q1: Self-reported measures as a proxy for objective performance

Results and Discussion

Correlations between the self-reported measures and objective performance are presented in Tables 4 and 5.

As in the supplementary section, there was little support for the use of self-reported performance measures as a proxy for actual performance ($r_{SRP1/Score} = 0.18$, $p>.05$. and $r_{SRP2/Score} = 0.39$, $p<.01$). However, it should be noted that when the self-reported performance measures are examined separately, the responses to the performance statement focusing directly on the performance criterion itself (e.g. SRP2 : "The product that our team produced was of high quality") was significantly more indicative of the score that the person's team received than was the less focused performance statement (e.g. SRP1: "I do not think that our team performed well"). Therefore, although self-reported performance measures are not recommended as a "stand-alone" proxy for performance, if self-evaluations must be used, their accuracy may be increased by making these measures directly relate to the criterion being evaluated.

Q2: Potential Determinants of Team longevity

Results and Discussion

Longevity was found to be significantly correlated with both of the self-reported performance measures ($r_{SRP1/Long} = 0.43$, $p<.01$; $r_{SRP2/Long} = 0.46$, $p<.01$). The series of stepwise regression and CART analyses that were done in the supplementary analysis

section examining the self-reported measures and the independent variables as a function of Longevity were re-done with the two separate self-reported performance measures. As established in the supplementary analysis section, once the variable of "Satisfaction" was considered, the other variables examined in the study shared little incremental variance with Longevity ("Score" provided $\Delta R^2 = 0.02$, $p<.001$; and SRP2 provided $\Delta R^2 = 0.01$, $p<.05$) over that shared with Satisfaction ($\Delta R^2 = 0.50$, $p<.01$). Therefore, Satisfaction remained the primary determinant of Longevity even when the self-reported performance measures were examined independently.

Q3: The Relationship Between The Teamwork KSA test and self-reported performance

Results and Discussion

An individual's Teamwork KSA score was found to be significantly correlated with his/her "global" evaluation of his/her team's performance ($r_{KSA/SRP1} = 0.15$, $p<.05$). However, it was not found to be significantly related to reports of product performance ($r_{KSA/SRP2} = -0.02$, $p>.05$). This provides some (although weak) support for the speculation that the Teamwork KSA test may be more indicative of global self-reports of performance than actual performance because the content of the Teamwork KSA test was partially developed using studies which used self-reports of performance as the performance criteria.

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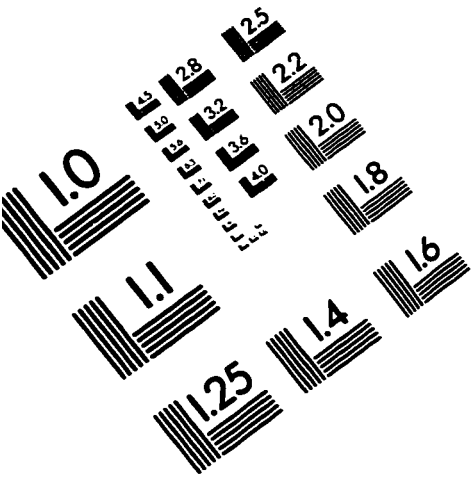
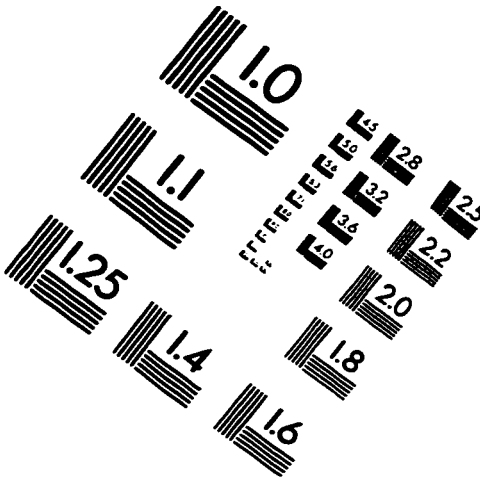
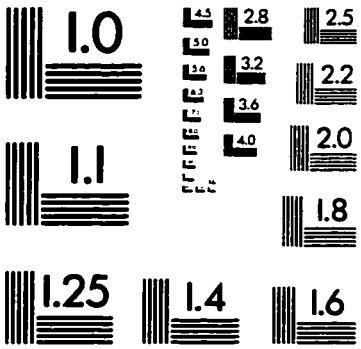
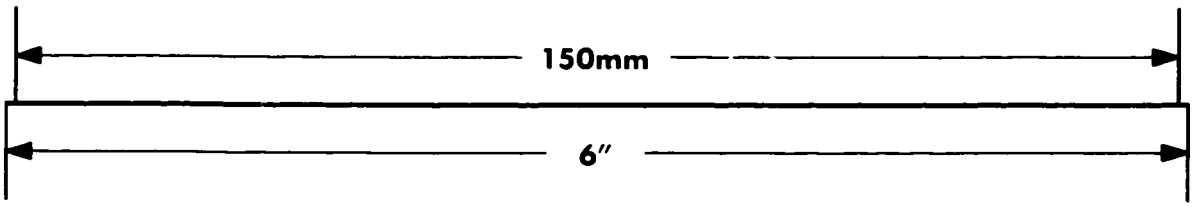
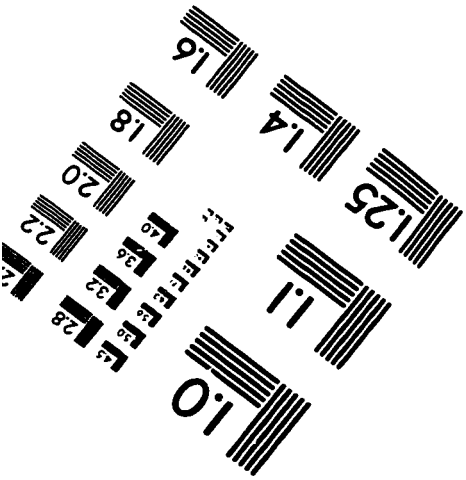
IMAGE EVALUATION TEST TARGET (QA-3)

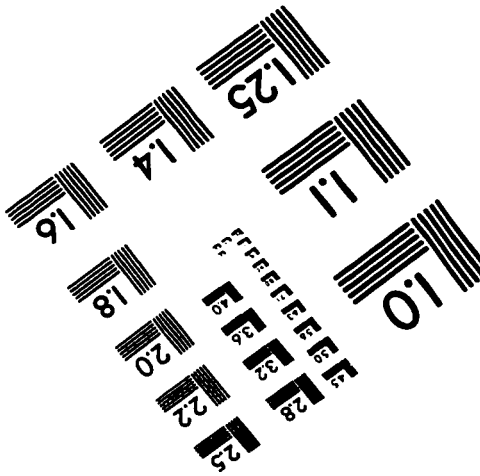












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