

# **The Relationship between Communication and Team Performance: Testing Moderators and Identifying Communication Profiles in Established Work Teams**

**A thesis submitted in total fulfillment of the  
requirements for the degree of**

**Doctor of Philosophy**

**by**

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## Abstract

Communication is one team process factor that has received considerable research attention in the team literature. This literature provides equivocal evidence regarding the role of communication in team performance and yet, does not provide any evidence for *when* communication becomes important for team performance. This research program sought to address this evidence gap by a) testing task complexity and team member diversity (race diversity, gender diversity and work value diversity) as moderators of the team communication — performance relationship; and b) testing a team communication — performance model using established teams across two different task types. The functional perspective was used as the theoretical framework for operationalizing team communication activity. The research program utilised a quasi-experimental research design with participants from a large multinational information technology company whose Head Office was based in Sydney, Australia. Participants voluntarily completed two team building exercises (a decision making and production task), and completed two online questionnaires.

In total, data were collected from 1039 individuals who constituted 203 work teams. Analysis of the data revealed a small number of significant moderation effects, not all in the expected direction. However, an interesting and unexpected finding also emerged from Study One. Large and significant correlations between communication activity ratings were found across tasks, but not within tasks. This finding suggested that teams were displaying very similar profiles of communication on each task, despite the tasks having different communication requirements. Given this finding, Study Two sought to a) determine the relative importance of task versus team effects in explaining variance in team communication measures for established teams; b) determine if established teams had reliable and discernable

team communication profiles and if so, c) investigate whether team communication profiles related to task performance.

Multi-level modeling and repeated measures analysis of variance (ANOVA) revealed that task type did not have an effect on team communication ratings. However, teams accounted for 24% of the total variance in communication measures. Through cluster analysis, five reliable and distinct team communication profiles were identified. Consistent with the findings of the multi-level analysis and repeated measures ANOVA, teams' profiles were virtually identical across the decision making and production tasks. A relationship between communication profile and performance was identified for the production task, although not for the decision making task.

This research responds to calls in the literature for a better understanding of *when* communication becomes important for team performance. The moderators tested in this research were not found to have a substantive or reliable effect on the relationship between communication and performance. However, the consistency in team communication activity suggests that established teams can be characterized by their communication profiles and further, that these communication profiles may have implications for team performance. The findings of this research provide theoretical support for the functional perspective in terms of the communication – performance relationship and further support the team development literature as an explanation for the stability in team communication profiles. This research can also assist organizations to better understand the specific types of communication activity and profiles of communication that could offer teams a performance advantage.

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## **List of Abbreviations**

IPO	Input-Process-Output
SPM	Raven's Standard Progressive Matrices
MOU	Memorandum of Understanding
SPSS	Statistical Package for the Social Sciences
O	Orientation
PD	Problem Definition
CD	Criteria Development
SD	Solution Development
SE	Solution Evaluation
TC	Task Complexity
GD	Gender Diversity
RD	Race Diversity
WVD	Work Value Diversity

## Statement of Authorship

The work contained in this thesis has not been previously submitted for a degree or diploma at any other University. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

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Stacey Lee Hassall

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Date

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# **CHAPTER 1: INTRODUCTION**

## **Thesis Overview**

This thesis explores the relationship between team communication and performance. More specifically, this thesis extends the literature in two specific ways. First, task complexity and team member diversity are tested as moderators of the team communication and performance relationship. Second, the nature of team communication profiles are explored by examining the extent to which team and task effects explain variance in team communication measures; identifying whether reliable team communication profiles exist; and testing whether these communication profiles are related to team performance. In doing so, this research makes clearer, i) the conditions under which communication becomes important for team performance, ii) profiles of communication activity for established teams, and iii) those communication profiles that are related to improved performance for established teams. This Chapter provides the context for the research. A background to each study is first presented followed by the research aims and objectives. A summary of the contributions made by this thesis are then outlined and methodological issues addressed. An overview of the thesis Chapters is finally noted.

## **Background to Study One**

Teams feature prominently on the organisational landscape, being considered one of the most effective and efficient methods for achieving organisational tasks and goals (Sinclair, 1992). It has been noted with some concern, that teams occupy a central and unquestioned place in organisational reform (Sinclair, 1992), but without consistent empirical evidence to support their widespread application (Glassop, 2002). Communication is often assumed to be central to the successful performance of teams. Yet, this assertion is not necessarily supported by the existing literature. Communication is broadly defined as the exchange

of information and the transmission of meaning (Katz & Kahn, 1978). It is central to the way in which teams go about identifying, collecting, discussing, interpreting, and evaluating the information they have at hand in order to reach a decision or complete the task(s) required of them. Irrespective of the type of team and its tasks, all team members need to interact and exchange information in order to achieve their goals.

For decision making teams at least, it has been suggested that the quality of the communication that takes place within the team is one of, if not the most important factor determining decision making success (Collins & Guetzkow, 1964; Gouran & Hirokawa, 1983; Hackman & Morris, 1975; McGrath, 1984; Taylor & Faust, 1952). However, despite this suggestion, for teams more generally, the literature provides little consensus regarding the impact of communication on performance. It has been found that factors such as team size and demography have a more influential role in team performance compared to communicative factors (Steiner, 1972). Alternatively, communication is argued to be integral for teams as it provides the means through which information and critical resources can be pooled (Barnlund, 1959; Marquart, 1955), errors identified and poor suggestions rejected (Shaw & Penrod, 1964; Taylor & Faust, 1952) and collective effort exerted over decision preferences (Reicken, 1958; Shaw & Penrod, 1964). The lack of consensus in the research literature could be due to a range of factors such as inconsistencies in approaches to measuring constructs and the application of different team tasks, etc. But it also implies that the relationship between communication and team performance may be contingent on other factors. Put another way, communication might be important for team performance in some circumstances, but not as important for performance in other circumstances.

## **The Functional Perspective of Team Communication**

The functional perspective is considered to be a key theoretical paradigm in the team decision making literature (Baltes, Dickson,



Sherman, Bauer, & LaGanke, 2002; Hirokawa & Poole, 1996). This theoretical perspective focuses on what *function* communication serves in teams, particularly decision making teams (Hirokawa, 1980, 1982, 1983, 1985, 1987, 1988, 1990; Hirokawa & Pace, 1983; Hirokawa & Poole, 1996; Salazar, Hirokawa, Propp, Julian, & Leatham, 1994). According to the functional perspective, communication is the means through which teams reach decisions and generate solutions to problems encountered. Communication activity is referred to as 'requisite functions' and it is the extent to which a team satisfies these requisite functions that determines quality decision making (Hirokawa, 1980, 1982, 1983, 1985, 1987, 1988, 1990; Hirokawa & Pace, 1983; Hirokawa & Poole, 1996).

Research adopting the functional perspective has offered much insight into the relationship between communication and team decision making performance, but this literature is plagued by inconsistencies in terms of its ability to consistently identify those requisite functions deemed most important for team decision making performance. Recent advances to this theoretical approach have begun to focus on determining the conditions under which communication might be related to team decision making performance. In other words, other factors might be moderating the relationship between communication and team decision making performance. A number of task-based factors, such as the complexity or equivocality of the task, have been proposed as important in moderating the relationship between requisite functions and team performance. However, task complexity has not been extensively investigated empirically within the functional perspective. Of equal importance is the need to investigate the moderating role of team based factors (such as team member diversity) on the relationship between requisite functions and team performance (Orlitzky & Hirokawa, 2001). The functional perspective has only been tested with teams whose primary function is to make decisions. However, all teams irrespective of their intended role require team members to communicate with one another. Investigating the role of requisite functions and team

performance for different type of tasks is an important theoretical advancement that has not yet been explored.

In order to advance our understanding of the relationship between communication and team performance using the functional perspective as the theoretical framework, Study One addressed several important research questions. The research questions addressed in Study One were:

1. Do task complexity and team member diversity moderate the relationship between team communication and team performance?
2. Do the effects of these potential moderators generalize across different types of team tasks?

The next section of this Chapter provides a brief overview of the two moderators investigated in this thesis — task complexity and team member diversity.

## **Task Complexity**

Despite varying definitions of task complexity applied in the literature, it is considered to be an important moderating variable in the relationship between team processes and performance (Bowers, Pharmer, & Salas, 2000; Brown & Miller, 2000; Cohen & Bailey, 1997; Gladstein, 1984; Hirokawa, 1990; Jehn & Mannix, 2001; Orlitzky & Hirokawa, 2001; Segal, 1982). In relation to team communication and performance specifically, it has been shown that communication becomes more important for performance when teams are undertaking a complex task. In contrast, communication has been found to not be significantly related to performance for simple or less complex tasks (Barnlund, 1959; Burleson, Levine, & Samter, 1984; Campbell & Gingrich, 1986; Kanekar & Rosenbaum, 1972; Lamm & Trommsdorff, 1972).

More complex tasks are often non-routine and are said to have higher information and/or cognitive processing requirements (Abdel-Halim, 1983; Campbell & Gingrich, 1986). Such increases in cognitive demand necessitate increased communication which can facilitate potential cognitive enhancements for a team resulting in improved

performance (Campbell & Gingrich, 1986). This increased cognitive demand is not produced for tasks that are more simple and routine in nature. In addition to this, increased cognitive demand is also likely to be responsible for the greater creativity and wider range of thinking processes that teams produce when undertaking a complex task (Higgs, Plewnia, & Ploch, 2005). This creativity and extended thinking processes facilitate better team performance. However, teams undertaking less complex or simple tasks do not experience such improvements and rather, tend to focus more on relationship matters within the team; resulting in poorer performance (Higgs et al., 2005). Consequently, task complexity should strengthen the need for communication and thus the relationship between communication and performance.

## **Team Member Diversity**

The increase in the number of women entering and remaining in the workforce, the ageing population, and other demographic changes has meant organisations and the teams within them have become, and will continue to become, more and more heterogeneous (Triandis, Kurowski, & Gelfand, 1994). Diversity has been used to describe a range of team member differences, but diversity typically refers to the distribution of personal attributes among persons who work together interdependently (Jackson & Joshi, 2004).

While diversity has been and continues to be an often-explored variable in the team literature, any positive benefits of diversity are typically seen under only very narrow conditions. There are a number of reasons why this literature has remained largely equivocal, and one central reason appears to be the ongoing emphasis on testing the main effects of diversity. Research effort needs to move from investigating *how* diversity impacts team processes and performance to investigating *when* diversity impacts team processes and performance, thereby applying diversity as a moderator variable, not predictor variable when investigating its impact on team performance. Although the literature using diversity as a moderator variable is relatively scant, the available

literature does provide evidence for how diversity moderates the relationship between team processes and performance (Jehn, Northcraft, & Neale, 1999; Lee & Farh, 2004; Polzer, Milton, & Swann, 2002; Schippers, Hartog, Koopman, & Wienk, 2003). This thesis is exploring diversity, specifically gender diversity, race diversity and work value diversity, as moderator variables in the relationship between team communication and performance in an effort to better elucidate their effects.

The next section of this Chapter provides an overview of Study Two of this thesis — the identification of communication profiles within established teams; the factors responsible for variance in these communication profiles and their relationship (if any) with team performance.

## **Background to Study Two**

A unique and defining feature of this thesis is the use of established teams to test the communication and team performance relationship. Much of the team literature reflects ad-hoc or zero-history teams and the results of research using these types of teams has often been generalised to established teams. But established teams are inherently different to ad-hoc teams (Hall & Williams, 1966). One of the key differences between ad-hoc and established teams is the team history or team development process that team members of established teams have experienced. The team development literature suggests that in order to understand team effectiveness, issues around team development must be taken account of (Gersick, 1988). It is for this reason that the communication activity or interaction patterns of team members who are used to working together will be different to teams whose members are unfamiliar with one another. There is some research evidence to directly support this notion (Gruenfeld, Mannix, Williams, & Neale, 1996; Katz, 1982), in addition to an evidence base suggesting that established teams use routine processes or habitual ways of dealing with information; handling conflict and team

dissent; and making decisions (Argyris, 1969; Gittleman, Horrigan, & Joyce, 1998; Hackman & Morris, 1975; Janis, 1982; McClelland, 1984).

What is relatively unclear in the literature, for established teams at least, are the factors responsible for different team communication profiles. It is implied, yet not well supported by empirical evidence, that the nature of the task that teams undertake influences communication profiles (English, Griffith, & Steelman, 2004; Hackman & Morris, 1975; McGrath, 1984; Morris, 1966; Poole, 1978; Stewart & Barrick, 2000). However, there might be factors related to the team (e.g. leadership style, team culture, demography, education level, etc) that influence communication profiles also. In order to provide greater clarity to these issues, this thesis was designed to tease out these effects and determine what the relative importance of task and team effects were in explaining variance in team communication measures. If established teams use routine or characteristic ways of interacting with one another, then we are likely to see consistent types of communication profiles emerging for these teams. While routine approaches to communication can offer a range of efficiencies for teams in terms of team management and coordination, greater role confidence, and less task uncertainty (Gersick & Hackman, 1990), it can also create inefficiencies for teams (which largely remain unrecognised) such as failing to harness innovation or recognising changes in familiar situations (Gersick & Hackman, 1990). Study Two extended the literature by addressing the following three questions:

3. What is the relative importance of task versus team factors in explaining the variance in team communication ratings for established teams?
4. Do teams demonstrate consistent team communication profiles? And if so,
5. Are these team communication profiles related to team performance?

## **Research Aims and Objectives**

The aim of the first study in this program of research is to extend the existing literature on team communication and performance by investigating task complexity and team diversity as moderators of the relationship between team communication and performance. The model is tested across two types of tasks in an effort to generalise the findings beyond a decision making task context to a production task context. The second study in the research program seeks to determine whether reliable team communication profiles exist. It does this by exploring whether task differences or team effects explain variance in team communication measures, cluster analyzing team communication data, and then testing whether specific types of communication profiles are related to team performance.

The specific objectives of the research program are to:

- Develop and test a model explicating the relationship between team communication and performance using the functional perspective as the theoretical backdrop.
- Investigate task complexity as a moderator of the relationship between team communication and team performance.
- Investigate team member diversity as a moderator of the relationship between team communication and team performance.
- Determine if the above effects generalise beyond a decision making task context to a production task context.
- Determine the relative importance of task versus team effects in explaining the variance in team communication measures for established teams, and
- Identify whether there are reliable and discernable team communication profiles and whether these communication profiles are related to team performance for established teams.

## Summary of Research Program

Team work is a popular approach to achieving organisational goals. This is despite a lack of clear evidence for the overall effectiveness of teams. While the importance of communication for teams is often implied, the relationship between team communication and performance has not been particularly well explored within the research literature. Understanding the ‘function’ that communication serves within teams is an established theoretical approach that is gaining new research momentum as it attempts to identify moderators of the communication — team performance relationship. However, while a number of moderators of this relationship have been proposed, little empirical investigation of these moderators has been advanced.

Task features are often considered to be important contextual variables for team performance. Task complexity is an often-explored moderator variable in the broader team literature, highlighting how complex tasks can create significant performance improvements for teams. However, task complexity has received little research attention specifically as a moderator in research testing the functional perspective. There is a need to determine if task complexity moderates the communication — performance relationship for all types of team communication activity or if it is only important for some types of communication activity.

Due to workforce changes, teams in organisations have progressively become more heterogeneous and this is likely to continue well into the foreseeable future. Team member diversity has largely been used as a predictor variable in investigations exploring its impact on team performance. This is likely to be one reason explaining the lack of consistency in research findings in this area. There is evidence to suggest that diversity should be used as a moderator variable in investigations of team performance. In doing so, research can better determine when diversity plays a role in the relationship between team communication and performance.

Teams who have a shared work history will communicate with one another in markedly different ways than teams whose members are unfamiliar. The literature to date provides much evidence for how ad-hoc or zero history teams work together including how they communicate, but we know comparatively little about how established teams communicate and the factors that impact or contribute to these communication profiles. If we can understand more about team communication profiles, including their relationship with team performance, then the development of interventions to improve such communication (where necessary) becomes considerably clearer.

## **Methodology**

Various methodological approaches have been applied to the study of teams. This research has adopted a quantitative methodology, applying a quasi-experimental research design within a large Australian-based organisation. The selected organisation was well suited to the planned research program as it used a team-based approach to completing work tasks. A mixed methods approach to data collection was used, including questionnaire, observational, and objective measures of team performance. The strength of this approach rests in its ability to reduce common method variance and balance the advantages and disadvantages of varying data collection approaches. Table 1-1 provides an overview of each research question and the relevant statistical analysis undertaken to answer each research question.



**Table 1-1: Overview of Research Questions and Analyses**

	Research Questions	Analysis
<b>Study One</b>	1. Do task complexity and team member diversity moderate the relationship between team communication and performance?	Moderated Multiple Regression
	2. Do the moderating effects of task complexity and team member diversity generalize from a decision making task to a production task?	Moderated Multiple Regression
<b>Study Two</b>	3. What is the relative importance of task versus team factors in explaining variance in team communication ratings for established teams?	Multi-Level Modeling and Repeated Measures ANOVA
	4. Do teams demonstrate consistent team communication profiles? And if so,	Cluster Analysis
	5. Are these team communication profiles related to team performance?	ANOVA

## Research Significance

This research program contributes to the evidence base by providing new information about the relationship between team communication and performance. In particular, this research program identifies the conditions under which communication becomes important for team performance and the communication profiles associated with improved team performance. This research is significant in that it:

- Uses a large number of established organisational teams. Most if not all of the prior research in this area (particularly investigating the functional perspective) has been undertaken using ad-hoc teams comprising a university student population. It has been argued that the team communication — performance relationship should be examined using real-life teams in real-life contexts (Cragen & Wright, 1993; Frey, 1994). The use of a contrived research setting is often a pragmatic consideration because there can be considerable difficulty gaining access to team settings within an organisation. However, the overall generalisability of findings is improved when using real organisational teams in context.

- Statistically controls for the effects of team member skills and abilities on team communication. It has been argued that when analysing the relationship between communication and team performance, the effects of team member skills and abilities need to be differentiated from process factors (such as communication) (Salazar et al., 1994). This study will differentiate the effect of team communication from the effect of team member skills and abilities, which is referred to as team potential (Salazar, 1997; Salazar et al., 1994) by specifically controlling for it and partitioning out its effects in each analysis undertaken.
- Examines whether the functional perspective can be applied to different types of tasks. To date, all research investigating the functional perspective has dealt with teams carrying out decision making tasks. Given that task type affects team performance (McGrath, 1984), it cannot be assumed that this model will extend to other task types. The research program will test the model for teams carrying out both a decision making task and production task thus testing the generalisability of the functional perspective.
- Identifies the nature of communication profiles for established teams and extends the functional perspective by providing evidence of the types and amounts of requisite functions (or communication activity) engaged in by teams when undertaking different tasks. This research program also shows how certain types of communication profiles are associated with better team performance.

## **Outline of Chapters**

The current Chapter (Chapter One) presents a framework for the research undertaken, providing a background to the key areas explored, and underscoring the importance of the research pursued. In particular, in this Chapter the current research evidence in this area is reviewed; the

need for additional empirical investigation to be undertaken to further advance the literature is noted; and the objectives of the research to be explored and its significance to the broader research literature are detailed.

The theoretical basis for the research program is presented in Chapter Two. This Chapter presents an overview of the literature on teams. This Chapter also explores the literature regarding communication and team performance, providing a detailed overview of the functional perspective — the theoretical perspective used to investigate communication activity in the studies undertaken. Each moderator — task complexity and team member diversity are discussed and justified and then the model to be tested is presented and the proposed hypotheses outlined.

Chapter Three outlines the research questions explored in this thesis and explains the methodology applied in collecting the data. A rationale for selecting the methodological approach adopted to answer the research questions is also provided.

Chapter Four provides a comprehensive overview of the data collection process. The data for this research program were all collected at one point in time. An overview of the organisation, participants, team-based activities, data collection methods and analyses are presented in this Chapter. Chapters Five and Six explore the findings of each Study undertaken.

Chapter Seven concludes with a summary of the research findings and discusses the contribution this thesis has made to the research literature. The practical implications to be drawn out from the findings of this research are discussed. Limitations to the research are outlined and finally recommendations for further research are offered that will further contribute to the understanding of the relationship between communication and team performance.

## Summary

This Chapter has provided a detailed overview of the key objectives of the research program explored in this thesis. It has noted that teams are a regular feature of organisational life and their popularity often belies empirical evidence for their effectiveness. Central to the performance of teams is the communication they engage in to complete specific tasks. While communication can be measured in a variety of different ways, this thesis will explore what function communication serves in teams and the role of these communication functions in achieving improved performance. The literature suggests however, that communication is likely to be more important for teams under certain conditions. What these conditions are requires further elucidation and this thesis will investigate task complexity and team member diversity as moderating variables of the communication — performance relationship. This Chapter has also addressed a number of issues specific to established teams and how the team development literature provides insight into how team normative processes and team habitual routines might impact the way in which established teams communicate. This thesis will examine these specific features of established teams by investigating team communication profiles, in terms of not only what creates differences in communication profiles between teams, but if certain types of communication profiles are related to better team performance.

## **CHAPTER 2: LITERATURE REVIEW**

This Chapter reviews the current literature on team performance, concentrating specifically on findings relating to the relationship between communication and team performance. A number of key factors are identified that are proposed to moderate this relationship. These proposed moderating factors are task complexity and team member diversity. A model representing this relationship is presented and hypotheses to be tested are proposed.

### **The Use of Teams in Organisations**

Teams represent a popular organisational structure. Their implementation is one of the most common changes across organisations over the past 20 years (Osterman, 1994, 2000). The widespread use of teams reflects a highly competitive global economy where large amounts of often complex work needs to be completed in short periods of time. The amount of knowledge and skill required to complete the wide array of tasks in an organization is beyond the capabilities of one individual alone. As such, teams are seen as a key method for organisations to address complex problems, accomplish tasks, and meet changing and demanding goals (Wheelan, 1994).

The input-process-output (IPO) model of team effectiveness establishes those input and process factors considered to have a relationship with team performance (Hackman & Morris, 1975; McGrath, 1964). These factors include task type, team size, individual cognitive ability, task complexity, and other team member characteristics (Abdel-Halim, 1983; Barry & Stewart, 1997; Campion, Medsker, & Higgs, 1993; Cruz, Boster, & Rodriguez, 1997; Devine, 1999; English, Griffith, & Steelman, 2004; Hackman & Morris, 1975; Hill, 1982). Another important process factor impacting the overall performance of teams is

communication. Communication is the cornerstone of team interaction, without which teams would not be able to share information and knowledge, discuss and debate issues or strategies, or develop solutions to problems.

Communication is viewed as functional for team performance in that it allows information and critical resources to be pooled (Barnlund, 1959; Marquart, 1955), errors identified and poor suggestions rejected (Shaw, 1976; Taylor & Faust, 1952), and collective effort exerted over decision preferences (Reicken, 1958; Shaw & Penrod, 1964). Communication and its relationship with team performance represents the key focus of this thesis. As such, the following paragraphs provide a brief review of the literature on the relationship between communication and team performance.

## **The Relationship between Communication and Team Performance**

The literature provides considerable evidence that communication has an impact on team performance, which can be both positive and negative. One line of research has focused on investigating the extent to which the *amount* of communication a team engages in impacts performance. To highlight, when the performance of interacting and non-interacting or free-discussion and limited-discussion teams has been compared, results have been mixed, with higher quality decisions made by both interacting teams and limited-discussion teams (Barnlund, 1959; Campbell, 1968; Lamm & Trommsdorff, 1972; McGrath, 1984; Shaw, 1981; Taylor & Faust, 1952). These results imply that while some teams may need to engage in more communication in order to have better performance, for other teams, the quality of the communication they engage in is more important than how much communication actually takes place.

A more substantial line of research has focused on the *type* of communication or interaction associated with team performance

(Hackman & Morris, 1975; Hirokawa, 1980, 1987, 1988, 1990; Mabry & Attridge, 1990; Sorenson, 1971; Sundstrom, Busby, & Bobrow, 1997; Watson & Michaelson, 1988). For example, research undertaken by Sorenson (1971) showed that the communication activity (based on Bales' (1950) IPA approach) of *structuring*, *generating*, *elaborating* and *evaluating* were positively related to performance quality for a production task. However, only *generating* and *elaborating* communication activity was associated with performance quality for a problem-solving task. While these results are suggestive of there being differences in the types of communication activity important for different types of team tasks, these findings did not replicate to a second type of production or problem-solving task undertaken by different teams.

In contrast to comparing a production and problem-solving task, Mabry (1990) sought to investigate team communication and performance for a structured (ranking task) and unstructured task (case study). Similarly applying Bales' (1950) IPA approach as a measure of communication activity, the results of this study showed no relationship between communication activity and performance on a structured task. Yet a number of significant findings emerged for the unstructured task. Results showed that the communication activity of *agreeing* was significantly related to case studies that were optimistic or had a positive outlook or orientation in expression; the communication activity of *giving opinion* was significantly related to case study answers that expressed a strong belief or opinion about an idea or proposal; and the communication activity of *disagreeing* was significantly related to case studies with originality or novelty in their responses.

Not all researchers investigating the relationship between types of communication activity and performance have found positive relationships. Sundstrom, Busby and Bobrow (1997) sought to test the relationship between communication activity and decision quality for teams performing a desert survival problem solving task. The results of

this study showed no relationship between any communication activity measure and team decision quality.

Overall, the existing literature on the relationship between communication and team performance shows some evidence that communication is positively related to team performance, but this evidence also shows that communication is sometimes not related to team performance. What the current literature is suggestive of, but currently does not provide any evidence for, are the circumstances under which communication becomes important for team performance. This thesis aims to further explore and identify some of these circumstances.

A number of theoretical approaches explicating the relationship between team communication and performance have been advanced (Hackman & Morris, 1975; Hirokawa & Poole, 1996; McGrath, 1964). One of these approaches — the functional perspective, will be adopted for this thesis and as such, a more detailed overview of this theoretical perspective will be outlined in the next section.

## **The Functional Perspective of Team Communication and Performance**

The functional perspective seeks to provide a theoretical explanation for the relationship between team communication and decision making performance specifically. The functional perspective has been described as a key paradigm in the team decision making literature (Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002). A defining feature of the functional perspective is the underlying premise that communication is a social tool that team members can harness in order to satisfy certain prerequisites of effective decision making (Gouran & Hirokawa, 1983, 1986; Janis, 1972, 1982, 1989; Janis & Mann, 1977). While the functional perspective has a relatively long history (beginning with the work of Reicken in 1958), its most substantial development came about through the work of Gouran and Hirokawa (1983, 1986, 1994).



The functional perspective was chosen as the theoretical model to be tested in this thesis for several reasons. First, very few comprehensive theoretical perspectives exist that focus specifically on the relationship between team communication and performance (Hirokawa & Salazar, 1999). The only other alternative and well established theoretical model is the ‘mediational’ model. It is best defined by the work of Hackman (1975) and views communication as playing a mediating role in team decision making; theorising that factors other than team communication (e.g. skills and abilities of team members) account for decision making performance. In contrast, the functional perspective has a central focus on the role of communication in team decision making performance and attempts to identify the characteristics of team communication (referred to as requisite functions) that create effective decision making (Hirokawa & Salazar, 1999; Hirokawa, 1980, 1982, 1983, 1985, 1987, 1988, 1990; Hirokawa & Pace, 1983; Hirokawa & Poole, 1996; Salazar, 1997; Salazar et al., 1994). Further, the functional perspective has more recently advanced to focus on determining the conditions under which communication might be related to team decision making performance. Given its theoretical focus and recent advancements, the functional perspective is considered the most appropriate theoretical framework to examine the questions posed by this thesis.

### ***The Role of Requisite Functions***

It has been suggested (Hirokawa, 1988) that when teams go about making a decision, they focus on three key questions: 1) What is the nature of the problematic situation? 2) What specific objectives and/or values need to be decided upon? and 3) What are the positive and negative qualities of choice alternatives that need to be taken into account? Based on the functional perspective, the answer to these questions necessitates the completion of certain ‘requisite functions’. Requisite functions are achieved through team communication (Hirokawa, 1980, 1982, 1983, 1985, 1988). Effective team decision making

therefore relies on how well team member communication satisfies these requisite functions.

Studies adopting the functional perspective to investigate the relationship between communication and team decision making performance have often varied, albeit marginally, on the number of requisite functions used and the label applied to them, but the definition of each requisite function has for the most part, remained the same. Evidence from more recent work empirically testing the functional perspective suggests the use of five requisite functions (Salazar, 1997). These requisite functions include:

Orientation (O)	Communication concerned with managing the team. Communication that functions to make known team operating procedures and other logistics. Specifies how the team will resolve or approach the problem.
Problem Definition (PD)	Communication that attempts to identify and define the nature of the team's task/problem or the problem's causes, effects and symptoms.
Criteria Development (CD)	Communication concerned with the value(s) to be employed in evaluating decision options or the goals or standards that acceptable choices or solutions must meet in order to become options worthy of consideration.
Solution Development (SD)	Communication concerned with any concrete, particular, specific proposal for action.
Solution Evaluation (SE)	Communication that indicates evaluation of a proposal. Communication for or against a proposal. Includes positive and negative consequences

### ***Findings from Studies Adopting the Functional Perspective***

A considerable literature exists applying the functional perspective to investigate the extent to which team communication activity is associated with decision making performance (Cragen & Wright, 1993; Gouran, 1991; Graham, Papa, & McPherson, 1997; Hirokawa, 1980, 1982, 1983, 1985, 1987, 1988, 1990; Hirokawa & Pace, 1983; Hirokawa & Poole, 1996; Orlitzky & Hirokawa, 2001; Pool & Roth, 1989; Propp & Nelson, 1996; Salazar, 1995, 1996, 1997; Salazar, Hirokawa, Propp, Julian & Leatham, 1994; Wittenbaum et al., 2004). This literature has primarily adopted the use of requisite functions as a measure of communication activity. However, a number of studies have measured communication

activity via other team interaction approaches including Bales' 'Interaction Process Analysis' (IPA) approach (1950). While this lack of consistency reduces the overall generalisability of study findings, some level of comparability between these approaches exists because of the similarity across communication activity types within each approach.

The majority of studies adopting the functional perspective to test the communication and team decision making relationship have used artificial or zero-history teams consisting of mainly three, but up to four team members (typically undergraduate students). To date, only two studies have tested the functional perspective in organisations using real and established work teams (Graham et al., 1997; Propp & Nelson, 1996). In both of these studies using real teams, the number of team members has been significantly higher, with between 6-12 team members participating. Overall, the number of teams in any one study from this literature has varied from 17 to 80 and the team task to be completed has characteristically been a decision-making task (e.g. policy decision task; or winter or desert survival problem) requiring extensive team discussion. These decision making tasks have typically had objective or verifiable choice alternatives from which the quality of team performance has been determined. Finally, most, if not all team tasks have employed the use of at least two raters who have been trained on how to rate team communication activity using requisite functions.

Similar to the broader communication — team performance literature, findings from studies adopting the functional perspective have shown some consistent and inconsistent findings in terms of the requisite functions associated with team decision performance. Hirokawa (1985) found problem definition and solution evaluation (of negative qualities) to account for the largest amount of variance in team decision performance. In replicating this work, Hirokawa (1988) again found problem definition, solution evaluation (of negative qualities) and criteria development to be significantly, positively related to team decision performance. In extending this work further, Hirokawa (1990) established that the

number of utterances or amount of requisite function engaged in had an independent main effect on team decision performance for problem definition, and solution evaluation of i) positive qualities and ii) negative qualities. The findings of both studies undertaken using real, established teams (Graham et al., 1997; Propp & Nelson, 1996) provide support for only some of the above findings. Specifically, Graham et al (1997) found significant differences between effective and ineffective decision making teams on the requisite functions of criteria development and solution evaluation (of positive qualities). Propp and Nelson (1996) found problem definition, orientation and solution evaluation (of positive qualities) to account for the greatest amount of variance in decision performance.

The above evidence suggests that problem definition is one requisite function that is consistently related to team decision performance. While these studies provide varying evidence that certain types of communication activity are important for team decision performance (albeit inconsistently), they are all limited by one key methodological shortcoming. That is, none of the analyses undertaken took into account or statistically controlled for team potential (or team member intelligence, skills or abilities). It has been argued that studies investigating the relationship between communication and team decision performance must simultaneously account for interactive (requisite functions) and non-interactive (team potential) factors (Hewes, 1986; Jarboe, 1988; Salazar et al., 1994). In a study undertaken by Salazar and colleagues (1994) that statistically controlled for team potential when determining the amount of variation requisite functions accounted for in team decision performance, it was found that team potential explained 71% of team decision performance. Requisite functions provided no significant or additional explanatory effects on team decision performance. This finding is important as it calls into question the overall veracity of findings investigating the relationship between requisite functions and team decision performance and highlights that team potential should be considered in future research investigating the role of communication in team performance.

While the functional perspective has advanced our understanding of the relationship between communication and team decision making performance, its main criticism has been the lack of consistency in the relationship between requisite functions and decision making performance across studies and settings (Hirokawa & Salazar, 1999). It is possible that these inconsistencies relate to the methodological shortcoming noted above. However, another issue which may explain the inconsistencies in research findings is the possibility that other factors may be moderating the relationship between communication and performance. The following paragraphs discuss these possible moderating factors.

### **Factors Moderating the Relationship between Communication and Team Performance**

A number of researchers adopting the functional perspective have proposed that the relationship between communication and performance might be affected by moderating factors (Hirokawa, 1990; Orlitzky & Hirokawa, 2001; Pool & Roth, 1989; Salazar, 1996, 1997; Wittenbaum et al., 2004). To date, there has only been one empirical investigation involving one task and one team-specific factor as moderators of the communication — team performance relationship (Salazar, 1997). This study was based on 40 three-person teams who performed the NASA Moon Survival decision task. The two moderators were task tractability (or evaluation demand); a task-specific factor and information homogeneity; a team-specific factor. The results of the analyses were not statistically significant. However, this may be due to two study limitations: i) Salazar did not directly test for the hypothesized moderation effect. That is, he did not test whether a product term (based on the requisite function and either the task or team factor) would explain additional variance in team decision quality; and ii) Salazar only used a small sample size ( $N = 40$  teams) which is likely to have affected the power of the statistical analyses undertaken.

The pattern of results for this study however, was consistent with the proposition that the effect of communication on performance varies according to team and task factors. Specifically, Salazar (1997) found that when information homogeneity and task tractability were both high, team potential accounted for 100% of the variance in team decision performance (NASA deviation score). Alternatively, when information homogeneity and task tractability were both low, team potential accounted for only 1% of the variance in team decision performance and requisite functions (all five entered into the model as a block) accounted for 58% of the variance in team decision performance. When information homogeneity was high and task tractability was low, team potential accounted for 94% of the variance in team decision performance, while requisite functions contributed another 4% to the overall variance explained. Alternatively, when information homogeneity was low and task tractability was high, team potential accounted for 35% of the variance in team decision performance and the contribution of requisite functions added another 30% variance in team decision performance. Thus, Salazar's findings, although not conclusive, are suggestive that the nature of the relationship between communication and team decision performance varies.

More recently, Orlitzky and Hirokawa (2001) undertook a meta-analysis to evaluate the predictive validity of the functional perspective. Specifically, these authors were seeking to investigate the amount of cross-study variance in studies applying the functional perspective that may be attributable to theoretically proposed task-specific moderators or methodological study artifacts. The task-specific moderators proposed to vary the relationship between requisite functions and team decision making performance included: task structure; information requirement; and evaluation demand (Hirokawa, 1990).

The studies included in the meta-analysis were only those that applied similar conceptualisations of the independent and dependent variables that Hirokawa had previously used (1980, 1983, 1985). Based

on this criterion, 11 studies were included in the meta-analysis. Most of these studies were laboratory experiments undertaken with university students in 3-4 person teams. The studies included in the meta-analysis did not all test for the proposed task-specific contingencies. Studies were coded in a binary format (0 = low; 1 = high) according to the proposed moderators; so a study that had no or low task structure, information requirement and evaluation demand was coded (0, 0, 0); and a study with high task structure, information requirement and evaluation demand was coded (1, 1, 1).

Results of the meta-analysis showed that there was only weak support for task structure as a moderator of the relationship between requisite functions and decision making performance. Specifically, of all the requisite functions, task structure had a stronger effect (measured via the estimated true-score correlation) on solution evaluation (of negative consequences). While task structure was predicted to moderate the relationship between problem definition and decision making performance specifically, this relationship failed to reach significance. There was consistently weak support for information requirement as a moderator across all requisite functions in the meta-analysis. Results however did support evaluation demand as a moderator of the effect of solution evaluation (of negative consequences) on decision making performance. The differences in the estimated true-score correlations were significant and in the predicted direction. This however was the only requisite function for which evaluation demand had a significant effect.

Aside from the meta-analytic work of Orlitzky and Hirokawa (2001) which sought to determine the predictive validity of three task-based moderators theoretically proposed by Hirokawa (1990), to date, only two moderators of the relationship between requisite functions and team decision performance have actually been empirically tested (Salazar, 1997). However, neither of these moderating factors was found to moderate the relationship between communication and team performance due to methodological shortcomings. In the literature above, we focused

on moderators of the communication — team performance relationship that have been identified using the functional perspective. The broader team communication — performance literature however also provides evidence that the impact of communication on performance is affected by team and task factors. There are a number of team and task factors that have yet to be explored or need to be more comprehensively explored as potential moderators of the relationship between communication and team performance, particularly within the theoretical model of the functional perspective. In the next section of this thesis, the broader team communication literature is reviewed to explain why this thesis has chosen to further this area of research by investigating task complexity and team member diversity as potential moderators of the communication — team performance relationship.

## **Task Complexity as a Moderator of the Communication — Team Performance Relationship**

Task complexity is an important situational or contextual variable for teams. Varying definitions of task complexity have been applied in the literature (Hackman & Morris, 1975; Hackman & Oldham, 1976; Latham & Yuki, 1975; Locke, Shaw, Saan, & Latham, 1981; March & Simon, 1958; Payne, 1976; Pierce & Dunham, 1976), which has resulted in difficulty finding a standardised definition of the term (Brown & Miller, 2000). Broadly speaking, task complexity has been referred to as the number of different elements of a task and the relationship between these elements (Wood, 1986). It incorporates the number of goals of the task, the number of pathways to achieving these goals (Shaw, 1976), the familiarity of the task (Steinberg, 1983; Volkema, 1988), the lack of information provided about a task or the amount of equivocal information concerning the decision making situation (Driver & Streufert, 1969), and the lack of information regarding how the task will be evaluated (Volkema, 1988).



A varied combination of these factors were used to define the constructs of task evaluation demand and task tractability suggested and tested as moderators by Hirokawa (1990) and Salazar (1996, 1997). Thus, their findings provide partial evidence that the broader construct of task complexity will moderate the relationship between team communication and performance. However, given the lack of standardisation in the definitions used in their research, and the greater amount of prior research associated with the construct of task complexity, we chose to focus on this construct for the current research. Task complexity was defined here as the level of difficulty associated with identifying or verifying the correct answer to a problem.

The broader team literature has, for many decades, highlighted that task complexity is an important variable in the relationship between team processes and performance (Bowers, Pharmer, & Salas, 2000; Brown & Miller, 2000; Cohen & Bailey, 1997; Gladstein, 1984; Hirokawa, 1990; Jehn & Mannix, 2001; Orlitzky & Hirokawa, 2001; Segal, 1982). In terms of team processes such as communication and team interaction, a number of studies have supported the proposition that communication becomes more important for team performance when undertaking a complex task (as opposed to a simple or less difficult task). To highlight, in studies that have compared the performance of interacting and non-interacting teams, communication opportunity was not related to team performance when undertaking simple tasks (Campbell, 1968; Kanekar & Rosenbaum, 1972; Lamm & Trommsdorff, 1972). However, communication opportunity was positively and significantly related to team performance when undertaking complex tasks (Barnlund, 1959; Burleson, Levine, & Samter, 1984).

Task complexity has also been found to necessitate the use of open communication structures, wider team participation, and informal team structures (Abdel-Halim, 1983; Shaw, 1981). Optimal decision making under conditions of high task complexity requires the open exchange of information, opinions, and criticisms (Duncan, 1973; Fry & Slocum, 1984;

Van de Ven, Delbacq, & Koenig, 1976). This decentralised approach to communication is in contrast to the level of interaction required for team decision making on simple tasks. Here, it has been found that centralised communication structures are more appropriate. This is the result of the low information processing requirement and the routine nature of these tasks (Abdel-Halim, 1983).

The above results imply that a complex task increases the cognitive processing requirements of a team which can subsequently improve team performance. In a study designed to test the interactive effects of task complexity and team participation on performance, Campbell and Gingrich (1986) theorized that tasks that are simple in nature are likely to create minimum cognitive demands for a team. As such, teams do not require and therefore cannot take advantage of potential cognitive enhancements that are the result of increased team participation. Complex tasks on the other hand create much greater cognitive demands, which necessitate increased team participation and interaction. This increased level of team interaction should lead to higher task performance. In a study utilising forty employees of a large computer services organisation, Campbell and Gingrich (1986) found performance on a complex task significantly improved as a result of increased team participation. More specifically, a positive and significant relationship was found between team participation and performance under complex task conditions, but not simple task conditions. In a similar vein, Higgs, Plewnia and Ploch (2005) suggested that greater creativity or a wider range of thinking processes was responsible for their finding that teams perform better (in this case by producing more ideas) when undertaking complex tasks compared to teams performing simple tasks.

### ***Task Complexity as a Moderator of Requisite Functions and Team Performance***

The above evidence from the broader communication — team performance literature suggests that task complexity is an important moderating factor in the communication — team performance

relationship. However, task complexity has not yet been extensively tested as a moderator of this relationship in studies adopting the functional perspective. Based on the predictive validity of the moderators tested in Orlitzky's (2001) meta-analysis of the functional perspective, task complexity can be considered as potentially important only in explaining the relationship between solution evaluation and team decision performance. However, based on the findings above from the broader communication literature, it can be argued that a complex task should significantly impact the relationship between some, but perhaps not all requisite functions and team performance.

For example, if complex tasks require the use of open communication structures, wider team participation, and informal team structures (Abdel-Halim, 1983; Shaw, 1981), then orientation communication might not be as important for team decision making performance under complex task conditions, given orientation communication focuses on communication about the teams' operating procedures, and how the team will work together (or structure itself) to approach and resolve a problem. Spending too much time deciphering the logistics of how the team will work together is likely to compromise the amount of time teams spend on other requisite functions which could better help solve the problem.

However, we might expect to see a significant and positive relationship between the other requisite functions and team performance under complex task conditions. If complex tasks facilitate greater creativity or a wider range of thinking processes (Higgs et al., 2005); the open exchange of information, opinions and criticisms (Duncan, 1973; Fry & Slocum, 1984; Van de Ven & Delbacq, 1974), and the generation of a greater number of ideas from teams (Higgs et al., 2005), then a positive relationship should be seen between problem definition, criteria development, solution development and solution evaluation and team performance. Each of these requisite functions involve communication that seeks to define the causes and effects of the problem (PD); the goals

or standards that solutions should meet to solve the problem (CD); ideas about concrete, specific proposals for action (SD); and communication for or against a proposed cause of action (SE). A strong, positive relationship between these requisite functions and team performance should therefore be observed under conditions of high task complexity. Based on this rationale, the following hypotheses were proposed:

*Hypothesis 1:* The positive effect of **orientation** communication on performance will be weaker when **task complexity** is high compared to when **task complexity** is low.

*Hypothesis 2:* The positive effect of **problem definition** communication on performance will be stronger when **task complexity** is high compared to when **task complexity** is low.

*Hypothesis 3:* The positive effect of **criteria development** communication on performance will be stronger when **task complexity** is high compared to when **task complexity** is low.

*Hypothesis 4:* The positive effect of **solution development** communication on performance will be stronger when **task complexity** is high compared to when **task complexity** is low.

*Hypothesis 5:* The positive effect of **solution evaluation** communication on performance will be stronger when **task complexity** is high compared to when **task complexity** is low.

The next section of this thesis justifies why team member diversity, a team-specific factor, is another important moderating factor in the communication — team performance relationship.

## **Team Member Diversity as a Moderator of the Communication — Team Performance Relationship**

Team member diversity is defined in various ways within the literature. One approach defines team member diversity as variation based on any attribute people use to tell themselves that another person

is different (Williams & O'Reilly, 1998), including attributes such as gender, age, religion, education level, and nationality. Other approaches have defined diversity as, "...the distribution of personal attributes among interdependent members of a work unit" (Jackson, Joshi, & Erhardt, 2003, p. 802). While there has been some argument put forth for narrowing the definition of diversity to only include team member variation based on race, gender, and other cultural differences (Cross, Katz, Miller, & Seashore, 1994), the literature generally maintains a much broader view of the term which encompasses the many possible ways in which team members can differ with respect to one another (Mannix & Neale, 2005).

While there are many different definitions of diversity applied within the literature, there are also a range of approaches in which diversity has been classified within the literature. These classifications or taxonomies have included job-related or less job-related diversity (Pelled, 1996); readily detectable or less observable traits (Jehn, Northcraft, & Neale, 1999; Milliken & Martins, 1996; Tsui, Egan, & O'Reilly, 1992), and surface-level or deep-level diversity (Mohammed & Angell, 2004; Riordan, 2000). These classifications have typically been developed and applied in studies testing diversity in an attempt to better understand the effects of different types of diversity on performance or other team outcomes. However, it has been suggested that there is little empirical support for using these classification systems (Christian, Porter, & Moffitt, 2006). Rather, other approaches, beyond testing for simple main effects, should be employed to test for the effects of diversity. One of these approaches is to test for moderators of diversity's effects (Christian et al., 2006; Knippenberg & Schippers, 2007).

However, in this thesis another perspective is explored, namely, the possibility that team diversity might function as a moderator itself. Specifically, this thesis explores team member diversity as a moderator of the relationship between communication and team performance. Given there is very little, if any, research specifically exploring the moderating

effect of diversity on the relationship between communication and team performance, the following section of this Chapter reviews existing evidence for diversity as a moderator of the relationship between team processes and performance.

### ***Interpersonal Congruence and Team Effectiveness***

In one study that examined how team member diversity impacted on interpersonal congruence and team effectiveness, it was found that under conditions of high diversity, increased interpersonal congruence enhanced creative task performance (Polzer, Milton, & Swann, 2002). Interpersonal congruence was defined as, "...the degree to which team members see others in the group as others see themselves" (p.298). Interpersonal congruence was considered important for team interaction because consistency between a team members' self view and the rest of the team's perception of that team member should facilitate feelings of coherence, predictability, and control within the team, which in turn promotes smooth and productive team interaction (Polzer et al., 2002). For homogenous teams (low diversity), interpersonal congruence was hypothesized to have little impact on team effectiveness because the team should already be functioning well due to diversity not having a negative impact on team interaction. For heterogeneous teams (high diversity), interpersonal congruence was hypothesized to make a significant contribution to team effectiveness by offsetting or smoothing over the negative effects of diversity.

In testing these hypothesized relationships, it was found that high interpersonal congruence had a positive, significant effect on creative task performance for heterogeneous (high diversity) teams. High interpersonal congruence did not have a significant effect on creative task performance for homogenous teams (low diversity). In addition to this, a negative effect on creative task performance was found for heterogeneous teams with low interpersonal congruence. Homogeneity (low diversity) facilitated better task performance for teams with low interpersonal congruence.

While this study did not directly test the relationship between communication and team performance, these findings are suggestive. Specifically, this study shows that under conditions of high team diversity, high interpersonal congruence among team members improves team effectiveness. However, this same level of team effectiveness cannot be reached under conditions of low team diversity. The results of this study imply that a team is capable of overcoming the purported negative effects of diversity if its team members are interpersonally congruent.

### ***Team Efficacy and Performance***

Another study that provides evidence in support of the moderating role of diversity on team processes and performance was undertaken by Lee and Farh (2004). Their work sought to determine the moderating effects of gender diversity on team efficacy and performance. Team efficacy or collective efficacy was defined as “a team’s beliefs in their conjoint capabilities to organise and execute the courses of action required to produce given levels of attainment” (Bandura, 1997, p.477). For teams with high collective efficacy, decision making often involves a reluctance to digress from previously chosen courses of action, which can lead to ineffective performance. For teams with low collective efficacy, in circumstances of adversity or negative feedback, decision making often involves reducing commitment to existing courses of action and considering other alternatives.

In terms of the effects of gender diversity on collective efficacy, it was argued that gender diversity may prevent high efficacy teams from committing to a previously chosen and ineffective course of action due to the greater range of values and perspectives this diversity brings to team interaction. Same gender teams are not likely to benefit from different perspectives during team interaction and may therefore commit to a predictable and ineffective course of action. Specifically, it was hypothesized that gender diversity would moderate the relationship between collective efficacy and team outcomes, with a more positive, significant relationship expected for teams with greater gender diversity.

The results of this study supported the hypothesized relationship. That is, gender diversity significantly moderated the relationship between collective efficacy and team performance. Conditions of high gender diversity facilitated a positive and significant relationship between collective efficacy and decision making. However, collective efficacy did not lead to quality team decision making under conditions of low gender diversity.

### ***Outcome Interdependence and Team Performance***

Diversity has also been explored as a moderator in a study examining the relationship between outcome interdependence and team performance (Schippers, Hartog, Koopman, & Wienk, 2003). In this study outcome interdependence was defined as the extent to which team members discuss and strive towards common team goals. Results of this study showed that highly diverse teams performed better when they had high outcome interdependence compared to when they had low outcome interdependence. In contrast, homogenous teams (low diversity) performed better when they had low outcome interdependence compared to when they had high outcome interdependence. These results imply a compensatory relationship between diversity and outcome interdependence. A highly diverse team needs outcome interdependence in order to perform well. However, a team that doesn't have outcome interdependence needs to have greater team homogeneity to perform well.

### ***Interactive Effects of Diversity on Team Performance***

Further evidence for diversity as a moderator of team processes and performance comes from the work of Jehn and colleagues (1999), who explored the influence of three types of diversity (as both process variables and moderator variables) on work outcomes. The types of diversity explored in this study included *informational diversity* or the differences in knowledge and perspectives of team members; *social category diversity* or the explicit differences in team members in race, gender and cultural heritage; and *value diversity* or the understanding team members have about the team task, goal or mission. It was



hypothesized that both value diversity and social category diversity would moderate the relationship between informational diversity and team performance. More specifically, it was proposed that a team would be able to take better advantage of its informational diversity when value diversity and social category diversity were low than when they were high because some commonality in information and perspectives among team members is important to facilitate smooth and productive team interaction.

Using a sample of 92 teams from an industry-based company, results indicated that value diversity and social category diversity both moderated the relationship between informational diversity and team performance. That is, under conditions of low value diversity, informational diversity positively impacted team performance more than under conditions of high value diversity. Similarly, under conditions of low social category diversity, informational diversity had a more positive impact on team performance than under conditions of high social category diversity.

Whilst this study was designed to explore the idea that different forms of diversity would interact in their effects on team performance, they nevertheless, in combination with the other findings reviewed above, suggest that diversity plays an important role in facilitating or impeding the way in which teams use their knowledge and different perspectives to carry out a task.

### ***Team Member Diversity as a Moderator of Requisite Functions and Team Performance***

The above research provides evidence that the effects of diversity go beyond simple main effects. Using diversity as a moderator can provide far greater insight into *when* team processes such as communication become more or less important for team performance. In terms of diversity moderating the relationship between requisite functions and team performance specifically, we could expect the relationship between problem definition, solution development and solution evaluation

communication and team performance to be stronger under conditions of high team member diversity because greater team diversity provides the opportunity for team members to utilise different perspectives (Bowers et al., 2000; Christian et al., 2006), a more diverse skill set, and knowledge (Jackson & Joshi, 2004; Jackson et al., 2003; Jackson, May, & Whitney, 1995) in helping to solve a problem. These requisite functions focus on defining the nature of a team's problem (PD); proposals for actions (SD); and evaluation of proposed courses of action (SE).

However, we might expect diversity to be less important for the relationship between orientation and criteria development communication and team performance. These requisite functions focus on discussing how a team should go about solving a problem and the standards or values team members should employ in reaching an acceptable solution to a problem. Too many diverse viewpoints and values concerning work standards among team members might impede communication specific to each of these requisite functions and subsequently have a negative impact on team performance (Bowers et al., 2000; Jackson et al., 2003). Based on this rationale, the following hypotheses relating to research question 1 were proposed:

*Hypothesis 6:* The positive effect of **orientation** communication on performance will be weaker when **team member diversity** is high compared to when **team member diversity** is low.

*Hypothesis 7:* The positive effect of **problem definition** communication on performance will be stronger when **team member diversity** is high compared to when **team member diversity** is low.

*Hypothesis 8:* The positive effect of **criteria development** communication on performance will be weaker when **team member diversity** is high compared to when **team member diversity** is low.

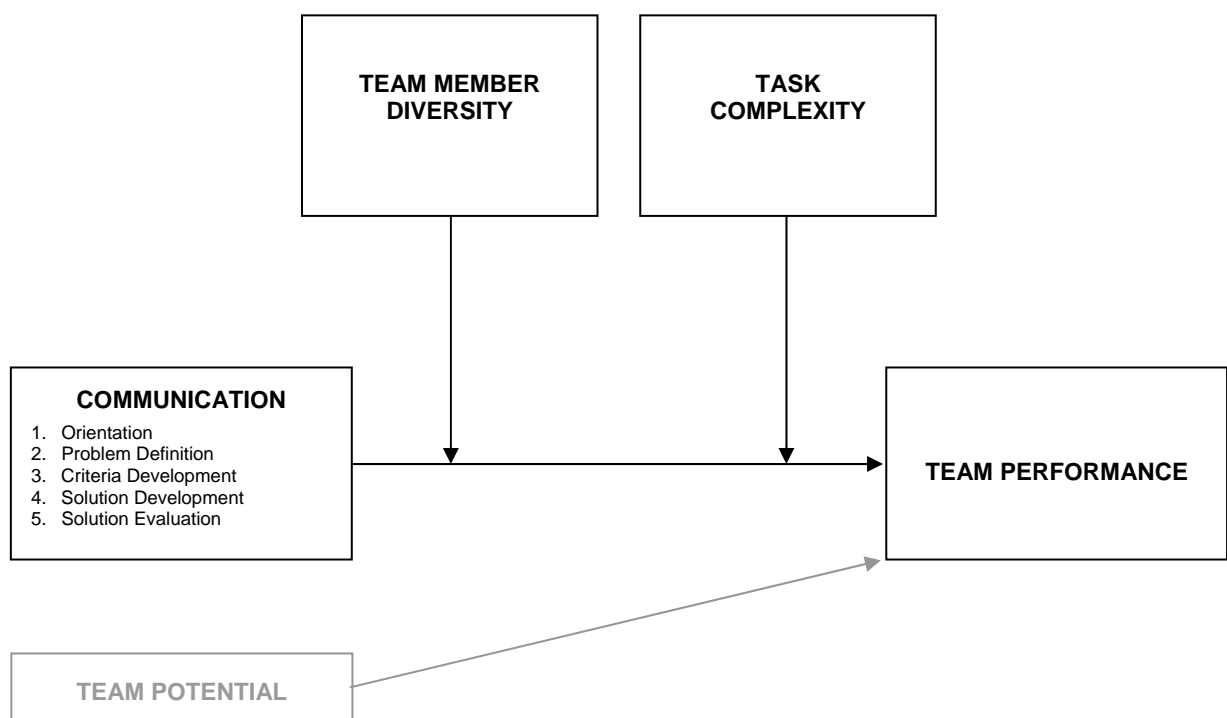
*Hypothesis 9:* The positive effect of **solution development** communication on performance will be stronger when **team member diversity** is high compared to when **team member diversity** is low.

*Hypothesis 10:* The positive effect of **solution evaluation** communication on performance will be stronger when **team member diversity** is high compared to when **team member diversity** is low.

Given the above paragraphs have justified the use of task complexity and team member diversity as moderating variables, the next section of this Chapter proposes the model to be tested in this research program — explicating the moderating role of task complexity and team member diversity on the relationship between team communication and performance.

### **Team Communication — Performance Model with Task Complexity and Team Member Diversity as Moderators**

Figure 2-1 highlights the model to be tested in this research program.



**Figure 2-1: Team communication — performance model**

## **Generalising Moderator Effects Across Task Types**

The functional perspective to date, has only sought to explain the performance of decision making teams (Hirokawa, 1980). However, an important extension of the functional perspective in this thesis is to determine if similar or different relationships between requisite functions and performance are observed across different types of team tasks; namely, a decision making task and a production task. Several established task typologies exist (Hackman & Morris, 1975; McGrath, 1984), and while the range of task types within each typology are different, most include creativity or production tasks; negotiation and discussion tasks; and problem-solving tasks (Hackman & Morris, 1975; McGrath, 1964).

The literature has, for many decades, been unequivocal in the contention that task characteristics play a significant role in team interaction (Carter, Haythorn, Meirowitz, & Lanzetta, 1951; Carter, Haythorn, Shriver, & Lanzetta, 1950; Deutsch, 1951; Hackman & Morris, 1975; McGrath, 1984; Morris, 1966). The characteristics of a task are thought to determine the amount of information that a team must exchange in order to accomplish a task or solve a problem (Poole, 1978). For example, problem solving tasks should require team members to share information in order to solve the problem; however, the extent of communication can be limited because one team member might be able to solve the problem, therefore meaning that the entire team has solved the problem. Negotiation and discussion tasks on the other hand, also require team members to share information in order to reach a decision. However, because the team is seeking a preferred as opposed to correct answer, the extent of the communication undertaken is likely to be considerably more as opinions are discussed and debated (Strauss & McGrath, 1994).

There exists a range of evidence in support of the contention that task features influence team processes and communication in particular.

For example, evidence suggests that teams engage in more communication when discussing and solving emotive and topical issues compared to when they are solving basic problems that have a unique answer (Carter et al., 1951; Carter et al., 1950; Deutsch, 1951). Morris' (1966) study on task effects on team interaction found different levels of interaction for production tasks compared to problem solving and discussion tasks. Teams undertaking production tasks were focused on repetitious communication that involved agreement, disagreement, clarifying, defending and repeating suggestions focused on product completion. Teams undertaking discussion tasks focused more intently on reaching team consensus, elaborating on discussion, clarifying and evaluating decisions.

Katz and Tushman's (1979) study on communication patterns, project performance and task characteristics in a research and development setting also found significant differences in communication activity across different task types. Specifically, problem solving and administrative communication had a positive relationship with performance for research project tasks. However, administrative communication had a negative relationship with performance for technical service project tasks.

Taken together, this evidence is suggestive of task differences in communication patterns and subsequent team performance. However, there also exists equivocal evidence regarding the impact of task characteristics. To highlight, while Katz and Tushman (1979) found some positive relationships between communication and performance, in testing all project types collectively, they found team performance was not positively associated with any communication domains. Further to this, these total communication measures were not consistently and positively related to performance even when examined across specific project task categories (e.g. research, development, and technical service project tasks).

In another study exploring task differences in the relationship between team processes and performance, non significant results for communication were similarly found (Stewart & Barrick, 2000). The team processes measured in this study included communication, conflict, shirking, and flexibility. The types of tasks studied were taken from the work of McGrath (1984) and included generating ideas and plans; choosing between alternatives; negotiating conflicts, and executing work. It was hypothesized that the relationship between communication, conflict, shirking and flexibility and team performance would be positive and significant for conceptual tasks (generating ideas and plans; negotiating conflicts) compared to behavioural tasks (choosing between alternatives; executing work). However, these hypothesized effects were not supported for either communication or flexibility. There was however a strong, negative relationship between conflict and shirking and team performance for conceptual tasks compared to behavioural tasks.

While there is much evidence to suggest that different types of team tasks influence the amount and type of communication a team engages in and their subsequent performance, this evidence is not completely unequivocal. A key limitation of much of this literature is the lack of consistency in the types of tasks investigated and the variation in the measurement of team communication activity. It has also been suggested that it is not task characteristics per se that cause different communication patterns in teams; rather, different types of tasks influence the communication structure of the team, which then in turn impacts team performance (Kabanoff & O'Brien, 1979; Katz & Tushman, 1979). Despite the apparent plethora of evidence regarding task types, the inconsistency in findings makes predicting how the relationship between requisite functions and team performance will vary across two different task types in this thesis difficult. Given this, the approach adopted to answer research question 2 will be exploratory and seek to determine whether the proposed moderation effects generalize across task types (i.e. a decision making and production task).

## Overall Summary

The research literature suggests that task complexity and team member diversity are important moderating factors in the team communication — performance relationship. However, to date, the nature of their moderating effects is either far from consistent or has not been tested specifically within the functional perspective. By testing task complexity and team member diversity as moderators of the relationship between requisite functions and team performance, a better understanding of *when* communication impacts team performance will be determined. This information will be important for knowing when communication becomes more or less important for teams who are charged with making important organisational decisions. With this information at hand, organisations regularly utilising teams will be better positioned to utilise teams for maximum performance advantage.

This thesis contributes to the literature in a number of other important ways. These key contributions include:

- Statistically controlling for team potential in the analyses undertaken to ensure team potential or the effects of skills and abilities of team members are accounted for. In doing so, a more accurate account of the contribution of communication to team performance can be measured.
- Testing the functional perspective across two different task types in an effort to determine if the proposed moderation effects generalize across task types.
- Extending the diversity literature by testing diversity as a moderator variable in order to better understand its effects on the relationship between team communication and performance.
- Testing the functional perspective model using real, established work teams which will improve the external validity and overall generalisability of the model.

This Chapter provides a thorough overview of the communication — team performance literature, focusing specifically on the functional perspective as the theoretical model underpinning the communication — team performance relationship. A clear argument was presented for exploring two moderators of the communication — team performance relationship, across two different types of team tasks. In doing so, this thesis makes a significant contribution to our current understanding of the role of communication in team performance. The next Chapter outlines the research approach adopted for the research program.



## CHAPTER 3: RESEARCH APPROACH

### Introduction

The preceding Chapter outlined the argument for investigating team diversity and task complexity as moderators of the team communication — performance relationship in order to better understand when communication becomes important for team performance. The first questions to be addressed by the research program are:

1. What is the impact of task complexity and team member diversity as moderators of the communication – performance relationship?
2. Do the effects of task complexity and team member diversity generalize from a decision making to a production task?

The key purpose of this Chapter is to present the methodological issues underlying the design of the research program. A brief overview of the paradigmatic foundations underpinning the research approach is presented first. Next, a more detailed overview of the research design is provided. Following this, sampling issues, the nature of the relationship with the organisation, and the research context are discussed.

### Paradigmatic Foundations of the Research Methods

The conduct of research is guided by a number of philosophical positions or paradigms. These paradigms include the *positivist* approach and the *constructionist* approach (Guba & Lincoln, 1994). The positivist approach assumes that knowledge is generated based on observable fact and measured through objective methods (Easterby-Smith, Thorpe, & Lowe, 2002; Tashakkori & Teddlie, 1998). The constructionist approach on the other hand, believes that people determine reality and the role of experience is central to understanding phenomena. In terms of the

corresponding research method each paradigm is associated with, it is said that the positivist paradigm typically applies quantitative methods while the social constructionist paradigm applies qualitative methods (Tashakkori & Teddlie, 1998).

There has been considerable debate generated over the past few decades regarding the choice and use of each paradigm in research. This ‘paradigm war’ as it is termed, holds that each paradigm is irreconcilably different and research must adopt one approach and not attempt mixing the two (Smith & Heshusius, 1986). An end to this ‘war’ however has been urged. The philosophical approach to research now takes a far more pragmatic stance, valuing the contribution of both methods and recognising that research approaches can adopt either paradigm or a multiple or mixed method (Brewer & Hunter, 1989). Taking this change in perspective a step further, pragmatists even question why a particular paradigm must determine the kind of research undertaken (Howe, 1998). Pragmatists consider the research question to be more important than the method or underlying belief system that is supposed to guide the methodological approach adopted. Put simply, a researcher should just do ‘what works’ — applying any available methodological tool that best answers the research question (Cherryholmes, 1994).

The questions to be answered by this research program required the measurement of specific constructs (task complexity, team member diversity, requisite functions or communication activity, and team performance) through valid, reliable, and objective methods. To this end, a positivist approach, using quantitative methodologies was considered the most relevant methodological approach and was therefore adopted as the research method for this thesis. In adopting this approach, specific numerical measures representing the theoretical concepts of interest could be tested.

## **Research Design**

The research program employed a quasi-experimental design. Pure experimental designs are very difficult to conduct in real organisations (Easterby-Smith et al., 2002). The design adopted enabled the researcher to randomly allocate teams to the various conditions of interest. Therefore, team and task complexity were between subjects variables; diversity (gender, race and work value diversity) was a measured between subjects variable and task was a within subjects variable. The benefit of random allocation is to help minimise bias due to individual differences in the selection of participants to conditions (McBurney, 1994). This research design enabled the proposed model to be tested using a large sample of established teams in a real working environment.

The study was based on cross-sectional data, drawing a sample from a specified population at a particular point in time (Babbie, 2000). While this approach to data collection was advantageous in terms of the short amount of time taken to collect the data, cross-sectional data is largely descriptive and inferences about the study results are limited to that group of participants at that point in time (Bowling, 2002). Quantitative data was collected via a questionnaire comprising a number of scales that tested the constructs of interest. A questionnaire is a commonly used research methodology (Neuman, 2003). A questionnaire was the most efficient method for gathering data in the research program undertaken. It enabled data to be collected relatively quickly without imposing significant time demands on team members. The questionnaire needed to consider the context within which the data were being collected. More specifically, it was essential that the scales used would provide a measure of the constructs of interest, but the scales also had to be meaningful within the context of the tasks to be carried out and not be overly burdensome in terms of the amount of time they took participants to complete. It was important to minimize the amount of missing data in the data set, so every attempt was made to ensure that all team members would complete the entire questionnaire.

The questionnaire was developed as an on-line or electronic questionnaire. This method of administration was commonly used by this organisation and therefore was familiar to participants. This approach also facilitated greater efficiencies with data collection and reduced the potential for errors in data entry. The individual scales that comprise the questionnaire will be discussed in greater detail in Chapter Four of this thesis.

## **Sampling**

A key contribution of this thesis is the exploration of the proposed hypotheses within the context of real, established teams. Most research examining the communication — team performance relationship has been carried out in a contrived setting using a university student population. The veracity of any empirical investigation testing the underlying theoretical assumptions of a model is improved when using real teams in context. A number of researchers have noted the need for research evidence on teams to be gathered from teams performing real tasks in real organisational settings (Cohen & Bailey, 1997; McGrath, 1984). The validity of research results can be called into question when they are obtained from ad-hoc as opposed to real teams. The generalizability of the research findings is improved when research questions are examined in a real world context. However, the decision to use established organizational teams for the research meant that logistical considerations arose (e.g. negotiating time demands, approaches to encouraging employee participation, providing feedback, etc) that would not have been as prominent if a sample of university students had been used as participants.

The criteria that were used to identify participants was that team members should be involved in team work on a regular basis and have experience in working in a team with at least two other members (i.e. a team of three members or more). The research literature on performance typically makes a distinction between dyads (two people) and teams with three or more members. Further to this, a team of at least three people

was considered to be more representative of the teams that existed in the participating organisation. Another important feature of this organisation was the diversity of its employees in terms of gender, age and culture, which helped in ensuring an adequate level of diversity could be represented in each team. The final essential feature in the recruitment of teams was ensuring that enough teams could be recruited to ensure adequate statistical power.

To achieve the goal of examining the research questions in the context of real teams, it was necessary to access and gain cooperation from at least one, but potentially several large organisations with a satisfactory number of teams, who were interested in and able to fully participate in the research activity. The researcher did not have the industry contacts to successfully undertake this task. Owing to this, the guidance of an external consultant with industry contacts and experience to facilitate access to the study sample was relied upon. As such, purposive sampling was used for the research program. This approach was considered the most appropriate as it allowed the researcher to benefit from the existing working relationship between the external consultant and organisation and also facilitated more timely access to organisations. Such access would have been quite limited and more difficult to negotiate without support and assistance from the external consultant. The consultant had established relationships with organisations in the information technology, infrastructure, and health industries. However, it is acknowledged that the reliance on the external consultant for recruitment limited possible involvement to only those organisations which the external consultant had a prior working relationship with and whom he considered to be suitable for participation in the research program.

## **Nature of Relationship with Participating Organisation**

The external consultant has undertaken consulting work with a number of Australian and international organisations on a range of

management and employee matters. Through consultation with one client organisation potentially suitable for participation in the research, it was decided that the tasks to be employed would be operationalised as team-based activities undertaken within a team building process that employees engage in as part of their employment.

The external consultant undertook all aspects of liaison with the organisation and was entrusted to monitor the data collection process for the research program. The participating organisation placed considerable emphasis on their team development activities. The organisation was aware that data collected from the team tasks would be used for the purposes of research being carried out by Queensland University of Technology. However, confidentiality was guaranteed at all times and no identifying information regarding the employees or organisation would be made known to the researcher. The researcher only had access to a de-identified data set. All data were aggregated for the purposes of reporting. All other material was retained by the external consultant as part of the broader consulting exercise and the provision of reports and performance feedback was the responsibility of the external consultant.

## **Organisational Context**

A number of factors relating to the context of the organisation that participated in the research program are worthy of being highlighted. First, the participating organisation was an international information technology company whose Australian headquarters was based in Sydney. The organisation had a number of divisions or units that undertook work relating to, for example, product development, technical support, and sales and marketing. Second, the organisation had been experiencing increased competition from similar organisations which was impacting the organisations' overall profitability. The organisations' management believed that team work within and between organisational units was one of the areas in which performance could be improved. It was on this basis that the organisation sought the expertise of an external consultant to develop a team building program that could

improve the communication and team work of employees. The overall validity of the team building program was strengthened by the support and commitment of the organisations' management. They were willing to devote several weeks and considerable expense to undertaking the team building program.

Several factors relating to each team and the team building activities they undertook are important to note. First, the two team building tasks for this research program were undertaken at the beginning of the team building program. The benefit of this is the good variation that should be seen in team communication and performance which might not be as evident if teams had already engaged in a lot of team building work. The disadvantage of this however, is that the 'newness' of the experience may mean that teams did not communicate to the same extent as they might, if they were used to participating in the team building exercises.

Second, the team building tasks were not undertaken in employees' usual work environment, but rather at a large local hotel. This decision was a practical one to ensure that there was enough space to cater for the team building exercises. A change in environment however may have created a sense of artificiality for employees and impacted their ability to relate their experiences back to their normal work environment. Finally, the team building activities undertaken were completely unrelated to employees' normal work tasks. The tasks could have been perceived by employees as 'fun' and considered artificial. While the seriousness of the activities was regularly reiterated to employees and discussion had about how the activities related to usual work tasks and team relationships, the tasks may have been less likely to elicit 'normal' performance. All of the issues identified above help to better illustrate the circumstances and environment in which the research program took place. An understanding of these issues is important particularly in terms of their implications for the generalisability of the study findings.

## **Summary**

This Chapter has provided an overview of the methodology adopted to achieve the research aims. First, the paradigmatic foundations guiding the research programs' methodology was discussed. In this thesis, a pragmatic approach was considered the most appropriate, with the research questions of interest guiding the use of the quantitative methodology employed. An explanation of the research design was then provided, followed by a discussion on sampling issues and the nature of the relationship with the participating organisation. A brief discussion on the research context followed. The next Chapter provides a detailed overview of the method for the research program.



## **CHAPTER 4: METHOD**

### **Introduction**

The data for this research program were collected at one point in time. First, the extent to which task complexity and team member diversity moderate the relationship between team communication and performance for teams undertaking a decision making task will be examined. Second, whether these moderation effects generalise to teams undertaking a production task will be explored.

In this Chapter the study participants are described, followed by a discussion of the team building tasks employed and instruments used to measure the variables of interest. The procedures devised for the recruitment of the sample, the tasks engaged in, and data collection are also presented. Finally, the preparation of the data for statistical analysis is discussed.

### **Sample**

The study participants were all employed within the Australian Head Office of a large multinational organization. The Australian office had decided to engage in a team building process in order to improve the way in which teams interacted across and within departments. Teams in this organisation perform a range of different tasks relating to information technology including product and software development, technical support services, and sales and marketing, providing good variation in the study variables. Further to this, the findings of this research should generalise to teams who perform under a wide range of conditions.

All employees of the organization were members of work teams. Any team of at least three employees who had worked together for more than six months was eligible for participation in the team building activities.

There were a total of 203 work teams who met these criteria and who participated in the studies. The total sample consisted of 1039 employees. Team size ranged from 3 to 10 members. About two thirds of participants were male (64.3%) and 35.7% female. More than half of the participants were Caucasian (55.6%), with 34.8% Asian, 0.4% African, and 9.1% 'Other'. The average age of participants was 27.9 years (range 21 to 35) and the amount of post-secondary education completed ranged from 0 to 8 years (mean = 3.5 years). The average length of time that participants had been members of their team was 4.38 years (range 1.1 to 14.6 years).

## Procedure

The two tasks employed in the research were designed to fit in with and compliment the other team building activities carried out during the team building program. Participation in the program was voluntary, but the organization encouraged employees to participate. All 203 teams participated in the team building program. The activities making up this research program comprised only a small element of the total array of team building activities organised for employees. In all, the team building program was run for a period of approximately one month. However, the total time allocated to the team building activities forming part of this research program was approximately 30-40 minutes.

Each of the teams participating in the team building program was allocated a unique identification number and randomly allocated a day in which participation in the team building activities would take place. Teams were notified via email of the day in which they would be participating in the team building activities. If two or more team members were unable to participate in the team building activities on their allocated day (due to ill-health or unavoidable circumstances) then these teams were re-allocated to participate on another day. Using a random numbers list from SPSS, participants were randomly allocated to either high or low task complexity conditions. Two additional manipulations were originally incorporated into the task but are not investigated here as they were not relevant to the research questions.

These manipulations are unlikely to have affected the study results because the manipulations were balanced across teams.

### ***Testing Phase***

Each team was allocated to a consultant who was their main contact throughout the entire team building process so that they could ask questions or clarify any aspect of the activities. Consent forms were completed following an introduction to the day's activities and prior to commencement of any team building activity. At this stage, participants completed the first on-line questionnaire which contained the demographic measures and both measures of team potential (Raven's Progressive Matrices for the Origami task and prediscussion preferences for the NASA Moon task). Each question on the Raven's Progressive Matrices was displayed on a large screen in a central team activity room, with team members keying their individual answers into an electronic answer form accessed via individual computers.

Following completion of these measures each team was taken to another activity room where they completed both the NASA Moon and Origami tasks (described in detail in the next section). The Origami task was completed first because it was considered to be a serious, yet fun introductory team building activity, followed by the NASA Moon task. Consultants directed teams to the task instructions provided on an instruction sheet prior to commencing each task. Team members were given the opportunity to ask questions about the instructions they had been provided. After all questions had been clarified teams were given approximately 10-15 minutes to undertake each task. The observation of team communication activity was undertaken by either one, but usually two consultants during each team activity.

After both tasks were completed, team members completed the second on-line questionnaire, which contained the manipulation check of task complexity. A number of additional measures were included in this questionnaire but are not relevant to this research program. All team participants were thanked for their participation in the team building

tasks and debriefed by the consultants on the aims of the research. The team's performance on the two tasks was also discussed as part of the larger team building exercise.

### ***Team Tasks***

The first task that the team completed was a production task that involved the creation of origami. Origami is a form of Japanese paper art. It involves folding paper to create different shapes or designs. This task was chosen because it has low material/resource demands, it is easy to administer in a standardised way, the level of complexity can be manipulated, and it is a culture-free team task. Team members were provided with several diagrams of origami creations. The teams' task was to replicate the designs and produce as many origamis as possible.

Each team was provided with instructions on how the task was to be completed. For example, teams were instructed that all team members were required to participate in the task; they were free to discuss the task with team mates throughout the exercise, and how they went about completing the task was up to them. Teams were expected to communicate about how they would approach the task; techniques team members could employ that produced the best quality origami; systems they could put in place to make the origami quickly; consensus about ideas recommended to the team; and words of encouragement to support the team. Examples of team interaction included: *"That design looks hard. Who thinks they know how to do it well?"*; *"How about we set up a production line with each of us doing several folds each?"*; *"We are going too fast! We need to make sure the end product looks right"*. *"I think that approach will work well – let's get going with it"*. *"Our origamis are the best – we should get top marks"*.

The second task was a modification of the NASA Moon Survival Problem. First developed by Hall (1963), this task (in its original format) requires participants to rank order the relative value and importance of fifteen items of equipment in order to survive following a crash landing on the moon. The task can be undertaken both individually and in teams. A

small amount of background detail is provided to participants before they commence the task in order to familiarise them with the nature of the task and their instructions for completing it. In short, participants are told they are members of a space crew whose spaceship has crash-landed on the moon due to mechanical difficulties. The crash is more than 200 miles from the intended rendezvous point. No material has survived the crash except for fifteen items of equipment. In order to survive, the crew has to trek 200 miles back to the mother ship. Participants have to rank order the fifteen items of equipment in terms of their relative value and utility for survival.

This task is attractive to researchers as it has an objectively correct answer developed by the NASA Scientists upon which to evaluate team decision making performance. This task and variations of it, have been successfully used by other researchers in investigating team decision making performance (Hirokawa, 1980, 1987; Lafferty & Eady, 1973; Lafferty, Eady, & Pond, 1974) and was therefore considered to be a suitable team-based decision making task for the current research. However, a modified version of the task (developed and validated by Salazar, 1997), was employed for the current research. This modification incorporates a manipulation of task complexity (low and high) and meant that the research protocol was comparable with that employed by Salazar (1997) in his test of the functional perspective. Salazar was contacted to request permission to use his protocol in the current research. Details regarding task manipulations are presented in the next section of this Chapter.

Similar to the Origami task, instructions about how the task was to be completed were provided to participants. Teams were instructed that the team had to reach consensus regarding the survival items and that they needed to determine the optimal choice of survival items in getting the crew back to the mother ship. Teams were expected to communicate about how best to solve the problem; ideas team members had about what survival items might be most useful or less useful; agreement and

disagreement about these items; confirmation of the list of items in order of survival importance, and words of encouragement to support the team. Examples of team interaction included: *“We had a plan to send two team members out and then use the flares to signal in space”*; *“How do you eat in space?”*; *“First aid would be useful, but I am not sure how that would work in space”*; *“Oxygen is most important and heating is redundant”*; *“It is unanimous that the compass should come first so we know where we are going”*; *“I want to know who brought matches to the moon – not very smart!”*.

The complete set of instructions and answer sheets for each task is provided in Appendix A (NASA Task) and Appendix C (Origami Task).

### ***Task Manipulations***

#### ***NASA Task***

The task complexity manipulation followed the procedure developed and validated by Salazar (1997). In short, this involved selecting every third item from the original 15 item list for the low complexity condition and then the first five items in sequence for the high complexity condition. The original 15-item list had been ordered by NASA scientists with items close together being similar in terms of their survival value. It was argued that items selected in sequence would be more difficult to differentiate in terms of their survival value because a number of other good choices were available. The selection of every third item would make decision making easier because the poorer choice items could be more easily discerned (Salazar, 1997). The order of items was randomised within conditions. Table 4-1 provides an overview of the items for the high task complexity and low task complexity conditions.

**Table 4-1: High Task Complexity and Low Task Complexity Items**

High task complexity items	Low task complexity items
Two .45 calibre pistols (1)	2 hundred-pound tanks of oxygen (1)
1 case dehydrated pet milk (2)	Food concentrate (2)
Portable heating unit (3)	First aid kit containing injection needles (3)
Magnetic compass (4)	Signal flares (4)
Box of matches (5)	Portable heating unit (5)

### *ORIGAMI Task*

The complexity of the Origami task was manipulated by giving the team either a very simple origami design (low complexity) and a more challenging origami design (high complexity) to construct. Complexity was determined on the basis of the number of folds in the origami design and the intricacy of the design to be developed.

Before the actual team building activities took place, a pilot session with a mock team was undertaken to ensure all aspects of the experimental protocol, such as the clarity of the instructions, the proposed format for running the team building activities, and the communication coding system, were clear and would achieve the intended aims. The mock team comprised some of the external consultants assisting with running the team building program. Any potential amendments to the experimental procedure were to be made during this period prior to the commencement of the team building exercises. However, no amendments were found to be necessary from the pilot testing.

## **Measures**

The team performance measures, observational measures, and questionnaire measures used will be discussed in turn below.

## ***Team Performance Measures***

### *Objective Measure of Decision Quality*

An objective measure of decision quality was obtained for the NASA Moon task by comparing teams' rank ordering of NASA items with the expert rank ordering supplied by NASA scientists. A score is produced that represents the summed deviations of the team rank ordering from the expert rank ordering. The larger the summed deviations the poorer the decision quality. Conversely, the smaller the summed deviations the better the decision quality. The range of possible values for the summed deviation score was between 0 – 10.

### *Objective Measure of Productivity*

An objective measure of productivity was obtained for the Origami task by calculating the number of origami completed within the designated task period. Partially completed origami was also counted and scored by the consultants as  $\frac{1}{2}$  completed (0.5), quarter completed (0.25), etc. Partially completed origami were reviewed by both consultants and consensus reached regarding the level of completion. The total number of origami completed was then divided by the number of team members completing the task to obtain a final team productivity score.

## **Observational Measure of Communication Activity**

An observational measure of team communication was provided by consultants overseeing each team activity, who served as raters. A separate communication activity measure was obtained for each team task undertaken. These data were coded using the method adopted by Salazar (1997) and Hirokawa (1988). This approach classifies communication activity of team members according to pre-established categories. The central purpose of coding communication via this method is to examine the frequency of each requisite function and how it relates to performance. Table 4-2 provides an overview of the communication activity categories that formed the coding system. Salazar (1997) found



this approach to be effective in categorising and differentiating the range of requisite functions that teams engaged in.

**Table 4-2: Requisite Functions or Interaction Coding System**

Category	Description	Example
Orientation	Utterances concerned with managing the team. These utterances function to make known team operating procedures and other logistics. Specify how the team will resolve/approach the problem.	“What is the best way to tackle this task?” “Why doesn’t everyone take turn in providing their input?”
Problem definition/redefinition and analysis	Utterances that attempt to identify and define the nature of the team’s task/problem or the problem’s causes, effects and symptoms.	“Does food concentrate need cooking?” “Can someone show me how that Origami fold is done again?”
Criteria development	Utterances concerned with the value(s) to be employed in evaluating decision options or in other words the goals or standards that acceptable choices or solutions must meet in order to become options worthy of consideration.	“We need to consider all survival items listed” “I think we need to focus on quality not just how many items we are producing”.
Solution development	Utterances concerned with any concrete, particular, specific proposal for action.	“Matches would work at home but not in space” “Why are you folding the paper in that order? I am not sure that is correct”
Solution evaluation	Utterances that indicate evaluation of a proposal. Utterances for or against a proposal.	“We can’t choose a compass because our space suits would have metal in them” “I don’t think that is good option”
Miscellaneous	Utterances concerned with functions other than those previously identified.	“I wish I was in the other team” “I want to know who stuffed everything up?”

The coding instructions provided to the consultants are provided in Appendices B (NASA Task) and D (Origami Task). Similar to Salazar (1997), all consultants were trained as a group on how to code communication using the interaction method and practiced using the

coding system during the pilot testing phase. Inter-rater reliability of the coding was also checked during the pilot testing phase. Two consultants were allocated to the coding of communication activity for each team, although in a few instances, only one consultant was available. An utterance was defined as the uninterrupted speech of a particular team member (Salazar, 1997). To obtain one measure of team communication activity, consultants' coding of utterances was averaged for each requisite function. This approach differed slightly from Salazar (1997) but was adopted because of its relative ease and it helped standardise totaling team communication activity irrespective of whether one or two consultants were involved. The coding form used by the consultants to code communication activity for each team is also provided in Appendices B and D.

## **Online Questionnaire Measures**

The complete questionnaire (which contained some additional measures not used for this research) is provided in Appendix E. Details on the measures employed in this research are provided in this section.

### ***Demographic Diversity***

The existing literature guided the choice of measures used to operationalize demographic diversity which were age, number of years of post-secondary education, team tenure, gender and race (or cultural heritage). Age was measured as a continuous variable with participants required to state their current age in years. Post-secondary education was also measured as a continuous variable with participants requested to indicate the number of years of post-secondary education they had completed following Year 12. Team tenure was measured as a continuous variable representing in months, the length of time participants had been a member of their team. Gender was measured as a categorical variable with the categories of 'male' or 'female'. Finally, race was also measured as a categorical variable with the categories of 'Caucasian', 'Asian', 'African', and 'Other'. For the purposes of this research program, gender

diversity and race diversity were specifically chosen as moderators of the team communication — performance relationship. The other measures were used for describing the participant population.

### ***Work Value Diversity***

The 24-item Work Values Questionnaire (WVQ) by Elizur (1984) was used to measure work values. The WVQ requires respondents to indicate the extent to which they consider each work value item to be important. Items represent a broad range of work values ranging from achievement at work, benefits such as holidays and sick leave, job interest, job security, independence at work and job status. The questionnaire can be used to measure individual and team work values. To be consistent with other measures, the questionnaire was modified from a 6-item response category to a 5-item response category with the Likert scale ranging from “1” = very unimportant, to “5” = very important. To date, empirical work has focused on validating the conceptual structure of the WVQ. However, this measure of work values is relatively short and simple to complete and has been tested across a diverse range of populations (Elizur, 1996, 2001; Elizur, Borg, Hunt, & Beck, 1991; Elizur & Koslowsky, 2001; Tillquist, 1996) and therefore seemed most appropriate for this study.

### ***Team Potential***

Two measures of team potential were employed in the current research. The first measure (used in Study One only) was employed by Salazar (1997). This measure was based on team members’ prediscussion preferences for the NASA Moon task. Prediscussion preferences are obtained by asking team members to individually provide a rank order for each NASA Moon item prior to engaging in any team discussion. Individual rank orderings are then compared with expert rank orderings. While the best-member baseline is usually agreed to be the most conservative and appropriate measure for examining communication effects (Cooke & Kernaghan, 1987; Hill, 1982), Salazar (1997) adopted the average-member baseline. The current research will also measure the

average member baseline in order to generalise Salazar's findings. This involved summing the rank orderings and dividing by the number of team members.

A second measure of team potential, used for Study Two (Origami task) was the Raven's Standard Progressive Matrices (SPM) which measures cognitive ability. Permission was sought from the publishers to use the test for research purposes. The SPM consists of five sets of diagrammatic puzzles. Each puzzle has a component or part missing which the participant must find among a set of alternatives provided. Each set of twelve problems becomes progressively more challenging.

The SPM is can be administered as both a timed and un-timed measure, but is usually administered un-timed. In this format, the entire test is generally completed within a 30-40 minute timeframe. However, a restricted amount of time was available for the team building activities in the current research program; therefore the decision was made to use a reduced set of test items and place a time limit on the completion of the test. Three sets (A, C & E) were selected for completion. Set A was selected because it acts as a baseline for participants, providing a number of example questions to ensure they understand the nature of the questions being asked and the format for answering each question. As each set becomes progressively more challenging, Set C was chosen because it was considered to be of moderate difficulty and therefore possible for persons of at least average cognitive ability to complete. Set E was selected to ensure that a number of items on the test provided the highest form of cognitive challenge and therefore would be able to differentiate between persons of average and superior cognitive ability. Scores are calculated by summing all correct answers. A higher score indicates higher cognitive ability.

A pilot study was undertaken, prior to the formal team building exercises to determine whether the sets chosen would differentiate participants' cognitive ability levels. Five participants from a number of departments in a large not-for-profit organization completed the

shortened version of the SPM; these pilot participants were of a similar age and educational background to the participants in the study's research program. Three participants completed the three question sets within the 10 minute time-frame. A fourth participant almost completed the three question sets and the fifth participant only completed two of the three question sets. The pilot study confirmed that the chosen three sets were satisfactory in terms of level of difficulty in that there was variability in their responses. Only one participant achieved all correct responses. The remaining four participants each had a number of errors, within Set E in particular. In order to obtain a team-level measure, individual scores were summed and divided by the number of members in the team.

## **Ethical Clearance**

Ethical clearance for the research program was provided by the QUT Human Research Ethics Committee (no:3950H). A Memorandum of Understanding (MOU) was also agreed to with the external consultant and the participating organization regarding access to the data for the research program.

## **Preparation of Data for Analysis**

### ***Data Cleaning***

All data was checked for logical inconsistencies with no inconsistencies identified. Checks were made for missing data which was minimal (<.05%). There were 6 missing IQ values and 6 missing average self-rated team performance scores. These missing values were scattered randomly throughout the data set and were not highly correlated with other variables with no missing data. As such, the decision was made to retain these variables and insert a team mean score for the missing value (Tabachnick & Fidell, 2001).

### ***Data Preparation***

Before aggregating the individual-level measures to the team-level, two tests were performed to determine whether aggregation to the team level was viable. First, a one-way analysis of variance was undertaken to determine if there was significant between-group variance (Rousseau, 1985). All variables satisfied this first test. Second, the within-group agreement ( $r_{wg(j)}$ ) for each variable was calculated (James, Demaree, & Wolf, 1993). The mean ( $r_{wg(j)}$ ) values were all above 0.70 — the acceptable level for good agreement (James et al., 1993).

To create diversity measures for categorical variables Teachman's (1980) entropy-based diversity index was calculated ( $H = -\sum P_i (\ln P_i)$ ).  $P_i$  represents the proportion of the team that has this demographic characteristic. The outcome of the formula was divided by the natural logarithm of the number of categories of the variable. In doing this, the measures of diversity all then had the same weight. The diversity index ranges from 0 to 1. In each case, the higher the diversity index, the greater the distribution of this diversity characteristic within the team. For continuous variables, diversity was calculated using the coefficient of variation (Allison, 1978a, 1978b; Allison, McQueen, & Schaerfl, 1992). This involved dividing the team's standard deviation by its mean for the variable in question. Similarly, higher figures represent greater levels of team diversity.

### ***Analytic Techniques***

Moderated multiple regression was the statistical technique used in this research program to test the hypotheses of interest. Residual scatter plots were first generated and inspected to ensure there were no serious violations of model assumptions. Mahalanobis distance values were also generated in order to identify extreme values for the independent variables. No cases were identified lying outside  $\pm 2$  standard deviations of mean values.

Interaction terms must be calculated in order to detect moderator effects (Aiken & West, 1991). The interaction term is the product of the

independent variable and the moderator variable. Interaction or product terms are typically collinear with their component terms and as such, methods should be undertaken to reduce this risk of multicollinearity. Mean-centering all continuous predictor variables is suggested before calculating interaction terms (Aiken & West, 1991).

In the first step of the 2-way moderated multiple regressions, the dependent variable (e.g. NASA Deviation Score or Number of Origami Produced) was regressed onto the control variables (Team Size and Team Potential). Specific to the hypothesis being tested, the independent variable (Communication Activity) and moderator variable (Task Complexity or Team Member Diversity) was then entered as the second step. Task Complexity was a categorical variable and dummy coded insofar as low Task Complexity was assigned a value of 0 and high Task Complexity was assigned a value of 1. The last step of the analysis involved entering the 2-way product term. Moderated multiple regression is supported when the interaction term provides a significant increment in variance ( $R^2$ ) associated with the dependent variable. This variance is additional to the variance accounted for by the main effects (Chaplin, 1991; James & Brett, 1984). The rate of change in the slope of the regression line provides an indication of the magnitude of the moderator effects, with the simple slope coefficients providing a value of the strength of this relationship (Champoux & Peters, 1987). For this research program, a significant simple slope associated with the interaction term would indicate that Communication Activity varies across the range of values of Task Complexity and/or Team Member Diversity (the moderators).

Plotting the interaction is one of the key methods of better understanding the meaning of a significant interaction (Aiken & West, 1991). This is typically achieved by plotting a series of points, one standard deviation above and one standard deviation below the mean of the independent variable. In the graphs presented in the results section

of Chapter Five, Communication Activity is plotted on the x-axis, with the graphs detailing high and low levels of each of the moderators.

## **Summary**

The purpose of this Chapter was to provide an outline of the procedure adopted to collect the data for the studies that comprise this thesis and to describe the approaches adopted to prepare the research data for analysis. The next Chapter of this thesis focuses on the analysis and reporting of the findings for the research program.



## CHAPTER 5: STUDY ONE

The aim of this study was to investigate the extent to which task complexity and team member diversity moderated the relationship between team communication and performance for a decision making task (NASA Moon task) and production task (Origami task). This Chapter describes the study findings as they relate to these research aims.

### Manipulation Check

The efficacy of the task complexity manipulation was tested by conducting an independent samples t-test on the ratings of perceived task complexity for the NASA and the Origami task. Two items in the online questionnaire assessed perceived difficulty of the task and how challenging the task was (coefficient alpha = .91 NASA; coefficient alpha = .79 Origami). The t-test yielded a significant effect for complexity on both tasks; team members in the high task complexity condition for the NASA task ( $M = 6.23$ ,  $SD = 2.03$ ) regarded their task as more complex than did team members in the low task complexity condition ( $M = 5.12$ ,  $SD = 2.06$ ) ( $t(1, 201) = -3.889$ ,  $p < .01$ ). Similarly, team members in the high task complexity condition for the Origami task ( $M = 6.36$ ,  $SD = 2.40$ ) regarded their task as more complex than did team members in the low task complexity condition ( $M = 5.51$ ,  $SD = 1.99$ ) ( $t(1, 201) = -2.746$ ,  $p < .01$ ).

### Descriptive Statistics

Descriptive statistics and Pearson's product-moment correlations for the study variables for both tasks are reported in Table 5-1. When interpreting the relationships between the variables, it is important to keep in mind that a low score for the NASA Deviation Score represents better performance and a higher score represents poorer performance. Conversely, a higher score on Number of Origami Produced represents

**Table 5-1: Descriptive Statistics for the Study Variables**

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
<i>Mean</i>	5.12	6.56	9.30	0.52	0.49	0.68	0.10	32.19	34.01	7.47	47.75	31.92	32.33	34.39	8.31	49.08	31.56	6.39	15.04
<i>SD</i>	1.54	1.57	1.28	0.50	0.25	0.27	0.06	12.98	12.98	6.02	16.11	10.90	11.67	10.54	5.52	15.83	9.38	1.85	7.12
1. Team size	(-)																		
2. Prediscussion preference deviation	-.03	(-)																	
3. Team IQ score	-.01	-.03	(-)																
4.Task complexity	.05	.84**	.03	(-)															
5. Gender diversity	.32**	-.10	.01	-.13	(-)														
6. Race diversity	.27**	-.04	.08	.01	-.01	(-)													
7. Work value diversity	.08	.04	.11	.07	-.01	.12	(-)												
8. NASA Orientation	.03	.07	.16*	.18*	.01	-.03	.07	(-)											
9. NASA Problem definition	.03	.02	.16*	.17*	.12	.09	.14*	.19**	(-)										
10. NASA Criteria development	.02	.15*	.14*	.09	.01	.08	.18*	.05	.05	(-)									
11. NASA Solution development	-.04	-.01	.12	.09	.02	-.02	.05	.36**	.17*	.14*	(-)								
12. NASA Solution evaluation	.04	-.02	.08	-.01	.09	.03	.02	-.04	.14*	.14	.21**	(-)							
13. ORIGAMI Orientation	-.01	.07	.18*	.14*	.06	-.03	.04	.81**	.22**	.08	.44**	.00	(-)						
14. ORIGAMI Problem definition	.08	.02	.17*	.19*	.04	.04	.10	.27**	.80**	.16*	.27**	.15*	.28**	(-)					
15. ORIGAMI Criteria development	.05	.18*	.08	.12	.03	.04	.15*	.07	.12	.85**	.14*	.17*	.08	.19**	(-)				
16. ORIGAMI Solution development	-.03	-.05	.16*	.06	-.02	.04	.08	.37**	.19**	.16*	.87**	.16*	.46**	.27**	.17*	(-)			
17. ORIGAMI Solution evaluation	.05	.06	.09	.08	.04	-.04	-.01	-.03	.10	.12	.21**	.73**	-.02	.09	.12	.16*	(-)		
18. NASA deviation	-.01	.75**	-.07	.57**	-.09	-.08	.01	-.03	-.09	.11	-.14*	-.05	-.08	-.13	.13	-.16*	.00	(-)	
19. Number of origami produced	.58**	-.12	.13	.05	.20**	.17*	.03	.31**	.27**	.11	.31**	.17*	.33**	.37**	.13	.35**	.18*	-.21**	(-)

Note:  $N = 203$ ; \*  $p < .05$ . \*\*  $p < .01$ .

better performance and a lower score represents poorer performance. The relationships between study variables are described in further detail in the following paragraphs.

## **Correlations**

### ***Control Variables***

In terms of the relationship between the team potential measure for the NASA task (Prediscussion Preference Deviation) and communication across both tasks, a small, positive and significant correlation was found with Criteria Development communication for the NASA task ( $r = .15$ ,  $p < .05$ ) and Origami task ( $r = .18$ ,  $p < .05$ ). However, Prediscussion Preference Deviation was not correlated with any other communication measure for either task. Team potential for the Origami task (Team IQ) showed small, positive and significant correlations with communication across both tasks. Specifically, Team IQ was correlated with Orientation communication ( $r = .16$ ,  $p < .05$ ), Problem Definition communication ( $r = .16$ ,  $p < .05$ ), and Criteria Development communication ( $r = .14$ ,  $p < .05$ ) for the NASA task. Team IQ was correlated with Orientation communication ( $r = .18$ ,  $p < .05$ ), Problem Definition communication ( $r = .17$ ,  $p < .05$ ), and Solution Development communication ( $r = .16$ ,  $p < .05$ ) for the Origami task.

Team potential for the NASA task (Prediscussion Preference Deviation) correlated with team performance on the NASA task ( $r = .75$ ,  $p < .01$ ), but the corresponding correlation (between Team IQ and Number of Origami Produced) was not significant for the Origami task.

There were no significant correlations for the relationship between team size and communication on either task. Team size did however have a strong, positive and significant correlation with performance on the Origami task (Number of Origami Produced).

### ***Requisite Functions***

A number of significant, negative correlations between requisite functions and performance for the NASA task were expected, but only NASA Solution Development communication had a small, negative and significant relationship with NASA Deviation score ( $r = -.14, p < .05$ ). Origami Orientation ( $r = .33, p < .01$ ), Problem Definition ( $r = .37, p < .01$ ), Solution Development ( $r = .35, p < .01$ ) and Solution Evaluation ( $r = .18, p < .05$ ) communication were positively and significantly related to Number of Origami Produced.

Another unexpected finding was the large correlations between communication measures across tasks, but not within tasks. Specifically, NASA Orientation communication had a positive and significant relationship with Origami Orientation communication ( $r = .81, p < .01$ ); NASA Problem Definition communication had a positive and significant relationship with Origami Problem Definition communication ( $r = .80, p < .01$ ); NASA Criteria Development communication had a positive and significant relationship with Origami Criteria Development communication ( $r = .85, p < .01$ ); NASA Solution Development communication had a positive and significant relationship with Origami Solution Development communication ( $r = .87, p < .01$ ); and NASA Solution Evaluation communication had a positive and significant relationship with Origami Solution Evaluation communication ( $r = .73, p < .01$ ). The strength and size of these relationships was not found within tasks across each requisite function for either task.

### ***Task Complexity***

The effect of the task complexity manipulation was seen in that task complexity had a large, positive and significant correlation with the NASA Deviation score ( $r = .57, p < .01$ ), but not Number of Origami Produced. In terms of the relationship between task complexity and communication, task complexity had small, positive and significant correlations with Orientation ( $r = .18, p < .05$ ) and Problem Definition

( $r = .19$ ,  $p < .05$ ) communication for the NASA task and Origami task ( $r = .14$ ,  $p < .05$  for Orientation); ( $r = .19$ ,  $p < .05$  for Problem Definition).

### ***Team Member Diversity***

Gender Diversity ( $r = .20$ ,  $p < .01$ ) and Race Diversity ( $r = .17$ ,  $p < .05$ ) had small, positive and significant correlations with Number of Origami Produced, but not NASA Deviation score. Work Value Diversity had small, positive and significant correlations with NASA Problem Definition communication ( $r = .14$ ,  $p < .05$ ), NASA Criteria Development communication ( $r = .18$ ,  $p < .05$ ) and Origami Criteria Development communication ( $r = .15$ ,  $p < .05$ ). Gender Diversity and Race Diversity were not correlated with any type of communication activity for either task.

### **Moderation Effects - NASA Task**

In order to test the hypothesized effects, each moderation effect was analysed individually as well as together. Table 5-2 provides an overview of the significant findings for each approach to testing the regression effects. Neither of these approaches produced more significant results than would be expected by chance, nor were there any consistent or meaningful pattern in the significant effects that were observed. Given this, the results for the effects tested individually and together are reported.

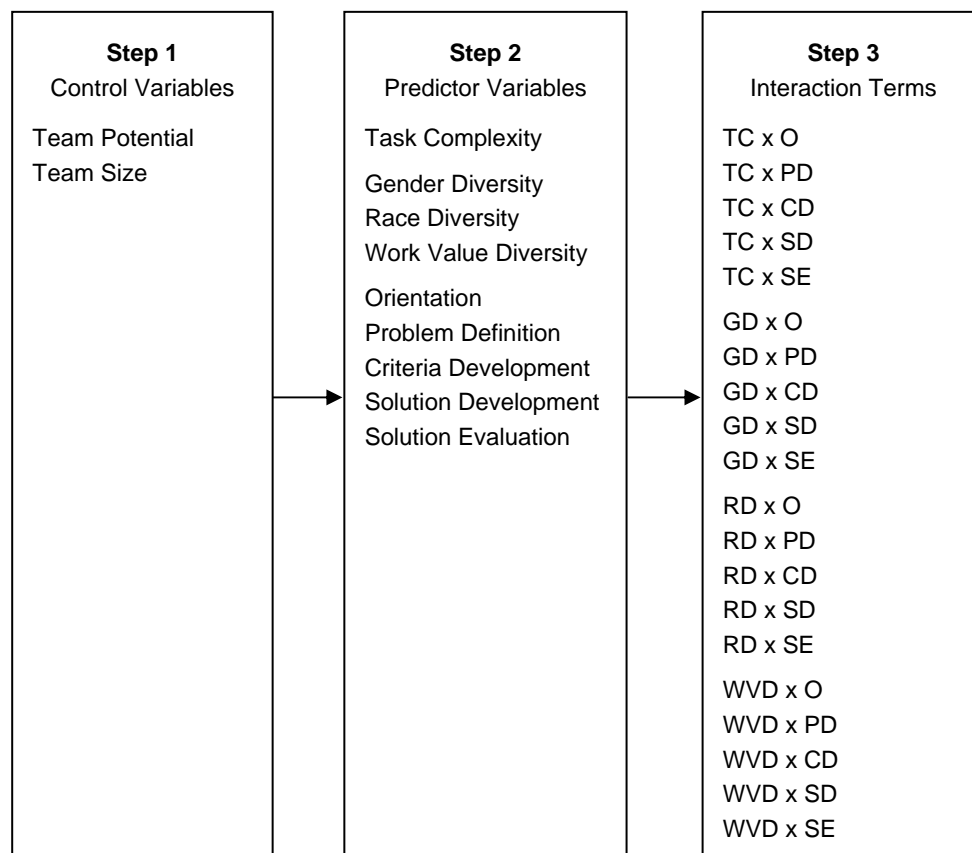
**Table 5-2: Overview of Significant Regression Findings when Tested Individually and Together**

		Regressions with Moderation Effects Tested Individually		Regressions with Moderation Effects Tested in Combination	
Task	Interaction Term	Standardised Coefficient	Significance Level	Standardised Coefficient	Significance Level
NASA	TCxSD	.453	<b>.004**</b>	.644	<b>.001**</b>
NASA	RDxPD	-.427	<b>.027*</b>	-.413	<b>.063†</b>
NASA	WVDxSD	-.327	<b>.053†</b>	-.424	<b>.054†</b>
NASA	WVDxPD	-.262	<b>.096†</b>	-	-
NASA	GD x CD	-	-	.259	<b>.057†</b>
Origami	GDxSD	.471	<b>.064†</b>	.473	<b>.051†</b>

Note: (-) indicates the result for this regression was not significant.

†  $p < .10$ . \*  $p < .05$ . \*\*  $p < .01$ .

Figure 5-1 summarises the steps in the regression analyses that were carried out to test the study hypotheses.

**Figure 5-1: Overview of analyses undertaken testing hypotheses for NASA task**

Note: NASA Deviation Score is the dependent variable

**Table 5-3: Regression Results for the Effects of Task Complexity, Team Member Diversity and Communication on Performance for a Decision Making Task**

Predictors	$\beta$	$R^2$	$\Delta R^2$	F change
<u>Step 1 (control variables)</u>				
Team size	.006			
Prediscussion preference deviation	.747**	.558	.558	126.451**
<u>Step 2 (linear effects)</u>				
Task complexity	-.107			
Gender diversity	-.026			
Race diversity	-.059			
Work value diversity	.001			
NASA orientation	-.023			
NASA problem definition	-.068			
NASA criteria development	.026			
NASA solution development	-.104*			
NASA solution evaluation	-.004	.592	.033	1.724†
<u>Step 3 (two-way interactions)</u>				
TC x O	-.263			
TC x PD	.110			
TC x CD	-.047			
TC x SD	.644**			
TC x SE	-.040			
GD x O	-.083			
GD x PD	.268			
GD x CD	.259†			
GD x SD	.172			
GD x SE	.038			
RD x O	-.033			
RD x PD	-.413†			
RD x CD	-.011			
RD x SD	.170			
RD x SE	.006			
WVD x O	.177			
WVD x PD	-.140			
WVD x CD	.066			
WVD x SD	-.424†			
WVD x SE	.108	.657	.066	1.642*

Note: NASA Deviation Score is the dependent variable. Standardized betas of the final model are presented. N = 203.

†  $p < .10$ . \*  $p < .05$ . \*\*  $p < .01$ .

Where a number of results emerged as being very close to significant (i.e.  $< .10$ ) then these outcomes have also been reported. The significant interaction effect for Work Value Diversity and Problem Definition (WVD x PD) when tested individually is also reported (as outlined in Table 5-2).

Table 5-3 provides an overview of the regression results, tested together for the NASA task and shows that at Step 1, team potential, as

one control variable, was a significant predictor of performance on the NASA task ( $\beta = .75, p < .01$ ), however team size was not significant as a control variable ( $\beta = .01, p = ns$ ). Step 1 accounted for a large and significant 55.8% of the variance in team performance.

In Step 2, team potential ( $\beta = .831, p < .01$ ) remained a significant predictor of team performance when the other predictors were added to the equation. Solution Development was the only form of communication activity to be a significant negative predictor of team performance ( $\beta = -.104, p < .05$ ). It can be inferred from this result that teams engaging in greater amounts of Solution Development communication performed better on the NASA task. The  $F$  change value indicated that  $R^2$  change was close to significant ( $F(9, 191) = 1.724, p < .10$ ). The amount of change associated with Step 2 was not large — only 3.3%, indicating that the addition of the communication measures and the diversity and task complexity measures only provided a small improvement to the prediction of team performance.

With the inclusion of the interaction terms at Step 3, an examination of the standardised beta coefficients suggested that the interaction between task complexity and Solution Development ( $\beta = .64, p < .01$ ) was significantly related to team performance; while Gender Diversity and Criteria Development ( $\beta = .30, p < .10$ ); Race Diversity and Problem Definition ( $\beta = -.41, p < .10$ ); and Work Value Diversity and Solution Development ( $\beta = -.42, p < .10$ ) were all marginally significant in terms of their relationship with team performance. The  $F$  change value for this Step was significant ( $F(20, 171) = 1.642, p < .05$ ), indicating that the addition of the interaction terms did significantly improve the prediction of team performance on the NASA task, explaining an additional 7% of the variance. The final model accounted for 65.7% of the explained variance in team performance.

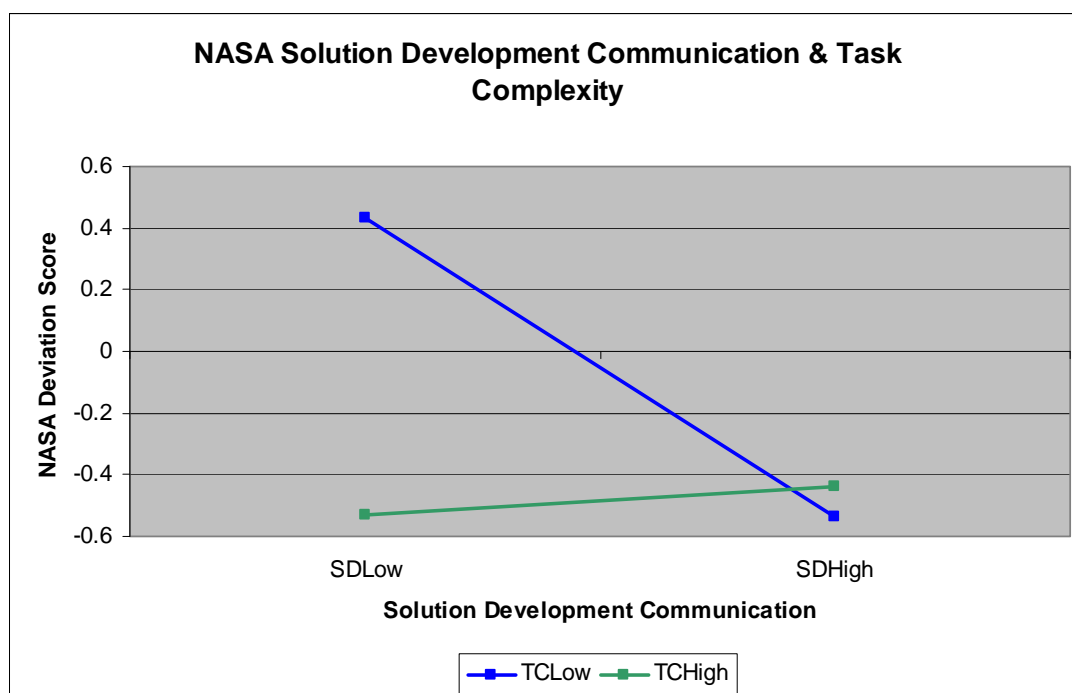
The significant and marginally significant interaction effects are plotted in Figures 5-2 to 5-6. Examination of the figures reveals support and partial support for Hypotheses 7, 8 and 9. Hypotheses 1, 2, 3, 4, 5, 6,



and 10 were not supported by the regression results due either to non-significant findings or significant findings not in the hypothesized direction.

### ***Task Complexity & Solution Development (NASA Task)***

Whilst the interaction effect between task complexity and Solution Development communication was significant, the form of the interaction effect (shown in Figure 5-2) was not consistent with Hypothesis 4. Whereas Solution Development communication was expected to have a stronger effect on performance when task complexity was high, the results show that the effect of Solution Development on performance was when task complexity was low. Simple slope analysis suggested that under conditions of low task complexity, varying levels of Solution Development communication had a significant difference on team performance ( $\beta = -.257$ ,  $t = -3.970$ ,  $p < .01$ ). However, varying levels of Solution Development communication had no impact on team performance under conditions of high task complexity ( $\beta = .028$ ,  $t = .429$ ,  $ns$ ). Therefore, this significant interaction does not support Hypothesis 4.

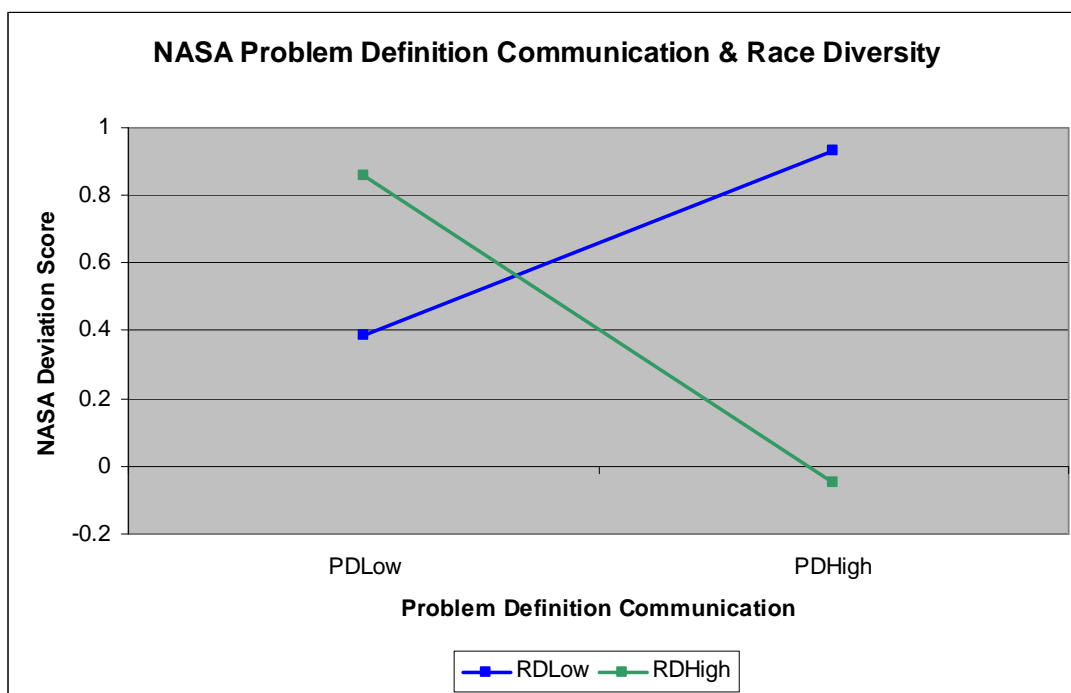


**Figure 5-2: Relationship between solution development communication and team performance as a function of task complexity**

Note: Low NASA deviation score represents better performance

### ***Race Diversity & Problem Definition (NASA Task)***

The interaction effect between Race Diversity and Problem Definition communication was marginally significant ( $p < .10$ ), and the form of the interaction effect (shown in Figure 5-3) was consistent with Hypothesis 7. That is, Problem Definition communication was expected to have a stronger effect on performance when Race Diversity was high. Simple slope analysis suggested that under conditions of low Race Diversity, varying levels of Problem Definition communication did not have a significant difference on team performance ( $\beta = -.013$ ,  $t = -2.02$ ,  $p = ns$ ). However, varying levels of Problem Definition communication did have a significant difference on team performance under conditions of high Race Diversity ( $\beta = -.225$ ,  $t = -3.169$ ,  $p < .01$ ). Therefore, this marginally significant interaction provides partial support for Hypothesis 7.

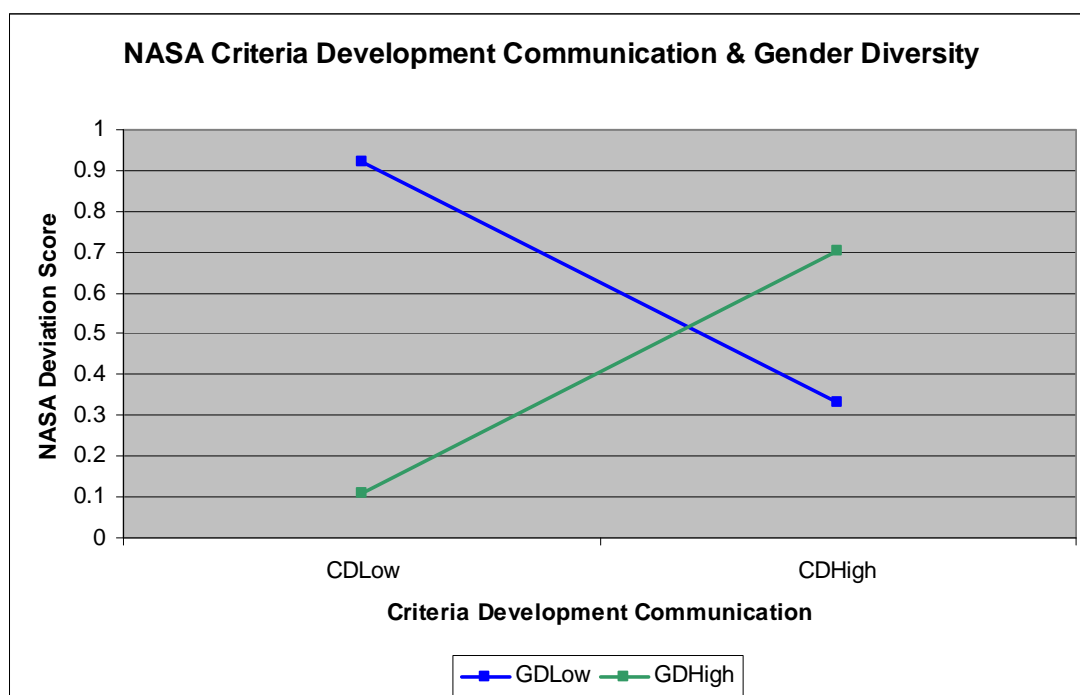


**Figure 5-3: Relationship between problem definition communication and team performance as a function of race diversity**

Note: Low NASA deviation score represents better performance

### ***Gender Diversity & Criteria Development (NASA Task)***

The interaction effect between Gender Diversity and Criteria Development communication was marginally significant ( $p < .10$ ), and the form of the interaction effect (shown in Figure 5-4) was consistent with Hypothesis 8. Criteria Development communication was expected to have a stronger effect on performance when Gender Diversity was low, and the results show this effect. Simple slope analysis suggested however that varying levels of Criteria Development communication had no significant difference on team performance under conditions of low Gender Diversity ( $\beta = -.080$ ,  $t = -1.132$ ,  $p = \text{ns}$ ) and high Gender Diversity ( $\beta = .075$ ,  $t = 1.170$ ,  $p = \text{ns}$ ). This marginally significant interaction provides partial support for Hypothesis 8.



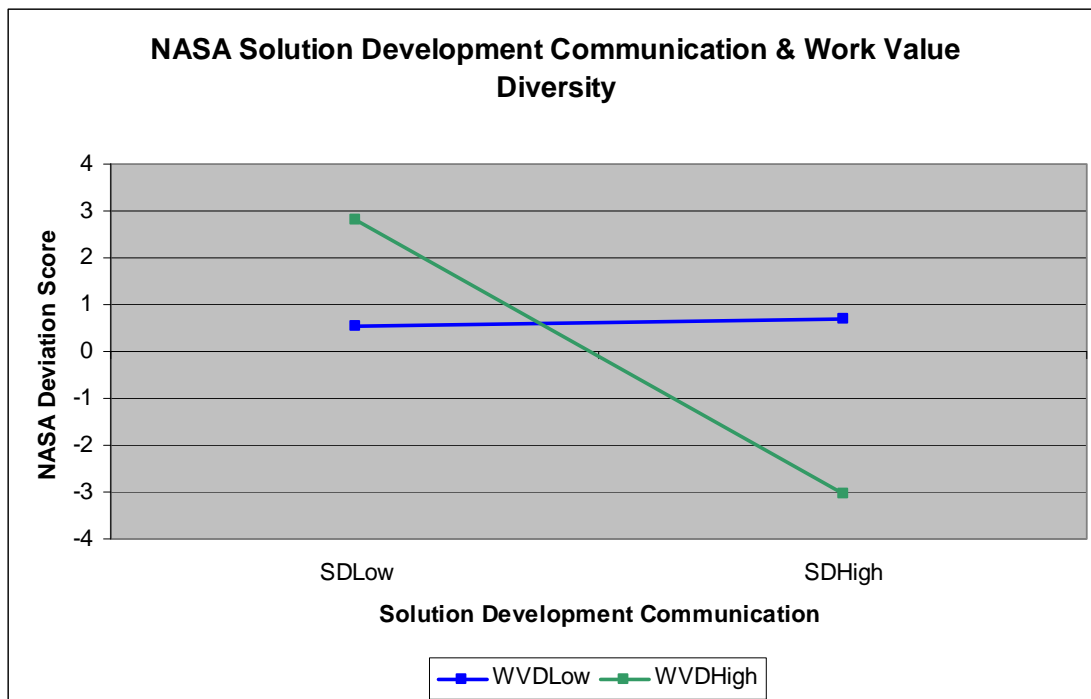
**Figure 5-4: Relationship between criteria development communication and team performance as a function of gender diversity**

Note: Low NASA deviation score represents better performance

### ***Work Value Diversity & Solution Development (NASA Task)***

The interaction effect between Work Value Diversity and Solution Development communication was marginally significant ( $p < .10$ ), and the

form of the interaction effect (shown in Figure 5-5) was consistent with Hypothesis 9. That is, Solution Development communication was expected to have a stronger effect on performance when Work Value Diversity was high. Simple slope analysis suggested that under conditions of low Work Value Diversity, varying levels of Solution Development communication did not have a significant effect on team performance ( $\beta = -.043$ ,  $t = -6.76$ ,  $p = ns$ ). However, varying levels of Solution Development communication did have a significant effect on team performance under conditions of high Work Value Diversity ( $\beta = -.222$ ,  $t = -3.364$ ,  $p < .01$ ). Therefore, this marginally significant interaction provides partial support for Hypothesis 9.



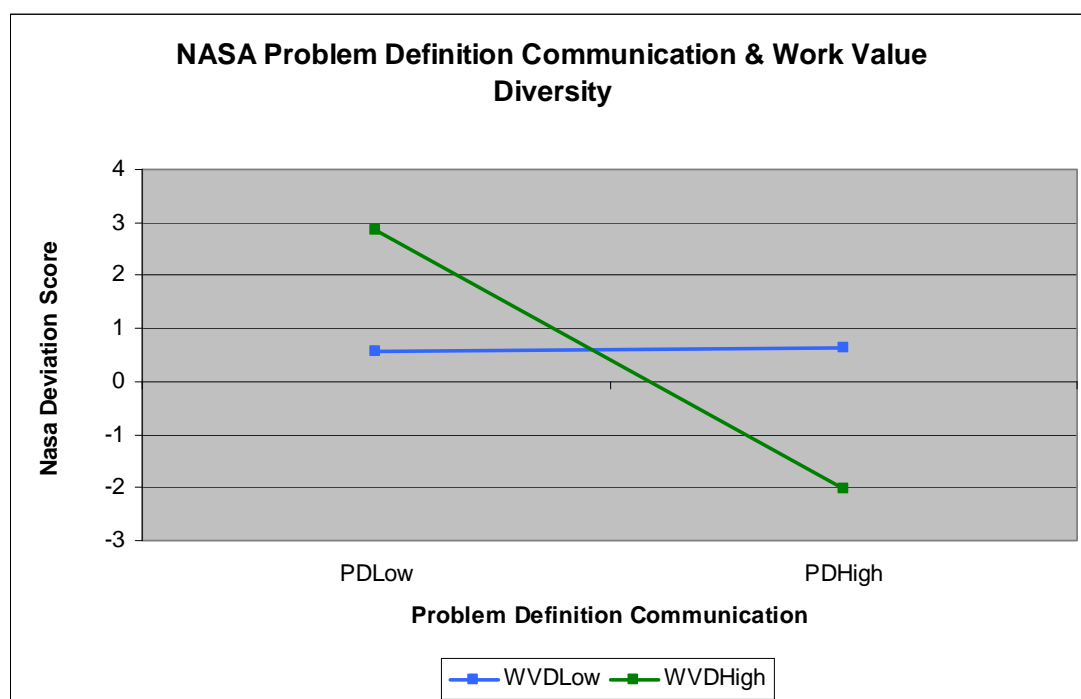
**Figure 5-5: Relationship between solution development communication and team performance as a function of work value diversity**

Note: Low NASA deviation score represents better performance

### ***Work Value Diversity and Problem Definition (NASA Task)***

The interaction effect between Work Value Diversity and Problem Definition communication was marginally significant ( $p < .10$ ), and the form of the interaction effect (shown in Figure 5-5) was consistent with

hypothesis 7. That is, Problem Definition communication was expected to have a stronger effect on performance when Work Value Diversity was high. Simple slope analysis suggested that under conditions of low Work Value Diversity, varying levels of Problem Definition communication did not have a significant difference on team performance ( $\beta = -.044$ ,  $t = -.705$ ,  $p = ns$ ). However, varying levels of Problem Definition communication did have a significant difference on team performance under conditions of high Work Value Diversity ( $\beta = -.191$ ,  $t = -2.862$ ,  $p < .01$ ). Therefore, this marginally significant interaction provides partial support for Hypothesis 7.



**Figure 5-6: Relationship between problem definition communication and team performance as a function of work value diversity**

Note: Low NASA deviation score represents better performance

## Moderation Effects — Origami Task

The second set of analyses examined whether the study hypotheses (1-10) would generalise to the Origami production task. The total Number of Origami Produced by each team was the dependent variable for these analyses. As before, team potential, measured as the teams' average IQ score and team size were entered as control variables in the first step of

each analysis to partial out their effects. Predictor variables were entered as the second step and interaction terms entered as the third step of the analyses.

**Table 5-4: Regression Results for the Effects of Task Complexity, Team Member Diversity and Communication for Performance on a Production Task**

Predictors	$\beta$	$R^2$	$\Delta R^2$	F change
<u>Step 1 (control variables)</u>				
Team size	.585**			
Team IQ	.063	.337	.337	50.920**
<u>Step 2 (linear effects)</u>				
Task complexity	-.062			
Gender diversity	-.010			
Race diversity	.016			
Work value diversity	-.060			
ORIGAMI orientation	.186**			
ORIGAMI problem definition	.224**			
ORIGAMI criteria development	.011			
ORIGAMI solution development	.209**			
ORIGAMI solution evaluation	.101*	.562	.225	10.912**
<u>Step 3 (two-way interactions)</u>				
TC x O	.106			
TC x PD	.024			
TC x CD	.192			
TC x SD	-.061			
TC x SE	-.065			
GD x O	-.127			
GD x PD	-.064			
GD x CD	.158			
GD x SD	.473†			
GD x SE	-.127			
RD x O	.000			
RD x PD	.000			
RD x CD	.139			
RD x SD	.098			
RD x SE	-.325			
WVD x O	-.068			
WVD x PD	-.205			
WVD x CD	.256			
WVD x SD	.048			
WVD x SE	-.189	.599	.036	.774

Note: Number of Origami Produced is the dependent variable. Standardized betas of the final model are presented. N = 203. †  $p < .10$ . \*  $p < .05$ . \*\*  $p < .01$ .

Table 5-4 demonstrates that at Step 1, team size emerged as a significant predictor of performance on the Origami task ( $\beta = .585$ ,  $p < .01$ ), however team potential was not significant ( $\beta = .063$ ,  $p = ns$ ). Step 1 accounted for a significant amount of variance in team performance at 33.7%.

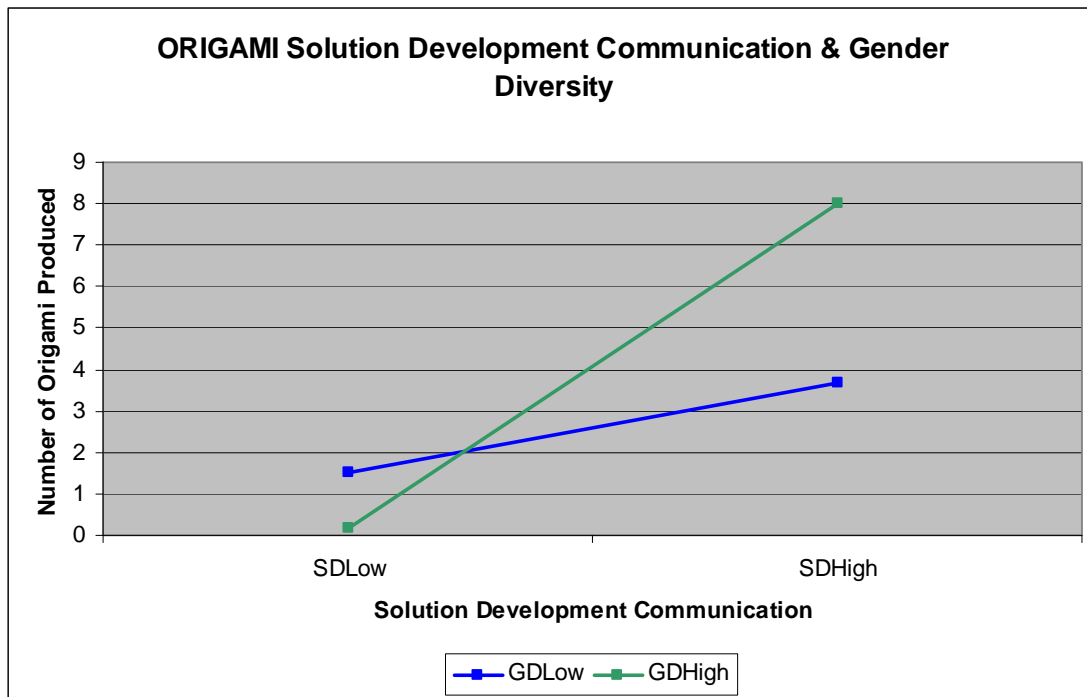
In Step 2, team size ( $\beta = .574, p < .01$ ) remained a significant predictor of team performance when the other predictors were added to the equation. Orientation ( $\beta = .186, p < .01$ ), Problem Definition ( $\beta = .224, p < .01$ ), Solution Development ( $\beta = .209, p < .01$ ) and Solution Evaluation ( $\beta = .101, p < .05$ ) were all significant predictors of team performance. These results suggest that teams engaging in greater amounts of each of these types of communication activity produced a greater number of origami. Taking into account the level of communication activity within each team explained an additional 23% of the variance in team performance on the Origami task  $\Delta R^2 = .225 F(9, 191) = 10.912, p < .01$ .

The addition of the interaction effects in the third step of the analysis did not significantly improve prediction of team performance on the Origami task  $\Delta R^2 = .036 F(20, 171) = .774, p = ns$ . However, the tests of the standardized regression coefficients indicated that the effect of the interaction between Gender Diversity and Solution Development ( $\beta = .473, p < .10$ ) was very close to significant.

The marginally significant interaction effect is plotted in Figure 5-7. This figure reveals partial support for Hypothesis 9. Hypotheses 1, 2, 3, 4, 5, 6, 7, 8 and 10 were not supported by the regression results.

### ***Gender Diversity & Solution Development (ORIGAMI Task)***

The interaction effect between Gender Diversity and Solution Development communication was marginally significant ( $p < .10$ ), and the form of the interaction effect (shown in Figure 5-7) was consistent with Hypothesis 9. That is, Solution Development communication was expected to have a stronger effect on performance when Gender Diversity was high. Simple slope analysis suggested that varying levels of Solution Development communication did have a significant difference on team performance under conditions of low ( $\beta = .114, t = 3.113, p < .01$ ) and high Gender Diversity ( $\beta = .201, t = 6.045, p < .01$ ). Therefore, this marginally significant interaction provides partial support for Hypothesis 9.



**Figure 5-7: Relationship between solution development communication and team performance as a function of gender diversity**

Table 5-5 identifies the study hypotheses and whether or not the study findings supported them.



**Table 5-5: Summary of Findings Supporting and Not Supporting Study Hypotheses**

	Hypothesis	Support	
		NASA	ORIGAMI
H1	The effect of <b>orientation</b> communication on performance will be weaker when <b>task complexity</b> is high compared to when <b>task complexity</b> is low.	×	×
H2	The effect of <b>problem definition</b> communication on performance will be stronger when <b>task complexity</b> is high compared to when <b>task complexity</b> is low	×	×
H3	The effect of <b>criteria development</b> communication on performance will be stronger when <b>task complexity</b> is high compared to when <b>task complexity</b> is low.	×	×
H4	The effect of <b>solution development</b> communication on performance will be stronger when <b>task complexity</b> is high compared to when <b>task complexity</b> is low.	×	×
H5	The effect of <b>solution evaluation</b> communication on performance will be stronger when <b>task complexity</b> is high compared to when <b>task complexity</b> is low.	×	×
H6	The effect of <b>orientation</b> communication on performance will be weaker when <b>team member diversity</b> is high compared to when <b>team member diversity</b> is low.	×	×
H7	The effect of <b>problem definition</b> communication on performance will be stronger when <b>team member diversity</b> is high compared to when <b>team member diversity</b> is low.	✓	×
H8	The effect of <b>criteria development</b> communication on performance will be weaker when <b>team member diversity</b> is high compared to when <b>team member diversity</b> is low.	✓	×
H9	The effect of <b>solution development</b> communication on performance will be stronger when <b>team member diversity</b> is high compared to when <b>team member diversity</b> is low.	✓	✓
H10	The effect of <b>solution evaluation</b> communication on performance will be stronger when <b>team member diversity</b> is high compared to when <b>team member diversity</b> is low.	×	×

× = Does not support study hypothesis; ✓ = Supports study hypothesis

## Discussion of Research Findings

The purpose of this study was to test task complexity and team member diversity as moderators of the relationship between team communication and performance across a decision making task (NASA task) and production task (Origami task). A number of significant and close to significant moderating relationships were found, more so for the

decision making task compared to the production task. However, these findings were no more than would be expected by chance given the number of analyses undertaken. The following paragraphs discuss these findings, including a number of unexpected findings, and further outline the major contributions of this research to the current literature and its limitations.

## ***Relationship between Communication & Performance***

### ***Task Complexity as a Moderator***

Communication was expected to have a stronger effect on performance when task complexity was high. However, findings suggested that of all the requisite functions, only Solution Development communication had a stronger effect on performance and this was under conditions of low task complexity. Interestingly, this finding related only to the decision making task. For teams in this research, performance on the decision making task improved significantly as they engaged in greater amounts of Solution Development communication, but only when the task was simple. Contrary to expectations, performance of teams in the high task complexity condition was unrelated to the amount of Solution Development communication. Task complexity did not moderate the relationship between any requisite functions and performance for the production task. These findings are inconsistent with both the literature on the functional perspective and the moderating role of task complexity. Reasons for this finding are discussed in the following paragraphs.

While task complexity has not specifically been tested within the functional perspective, evaluation demand, which is a conceptually similar construct has been tested as a moderator both theoretically (Orlitzky & Hirokawa, 2001) and empirically (Salazar, 1997). Orlitzky's meta-analysis concluded that evaluation demand was a significant moderator of the relationship between Solution Evaluation and team decision making performance. More specifically, Solution Evaluation communication became more important for team decision making performance under conditions of high evaluation demand. Salazar's work

concurred with this finding and also suggested that communication becomes more important for team decision making performance under conditions of high evaluation demand. However, Salazar's (1997) research is not directly comparable to this study because evaluation demand in his research was not correctly tested as a moderator. However, the pattern of his findings did provide some support for the proposition that communication (for no one requisite function specifically) becomes more important for team decision making under conditions of high evaluation demand.

The literature on task complexity as a moderator provides clear evidence that communication becomes more important for team performance when the nature of the task becomes more complex (Abdel-Halim, 1983; Bowers, Pharmer, & Salas, 2000; Brown & Miller, 2000; Campbell & Gingrich, 1986; Cohen & Bailey, 1997; Duncan, 1973; Frey, 1994; Fry & Slocum, 1984; Higgs, Plewnia, & Ploch, 2005; Hirokawa, 1988; Jehn, 1994; Shaw & Penrod, 1964; Van de Ven & Delbacq, 1974). It is therefore both puzzling and unclear why teams in this research improved their decision making performance only under the low task complexity condition. The choice of survival items in the NASA task in the low task complexity condition should have been easily identified by team members. Team members' perceptions that these survival items were less complex and therefore easier to identify was confirmed by the task complexity manipulation test. Increasing amounts of Solution Development communication should have only helped to confirm the team's decision about the most appropriate survival items. Given this scenario, a pattern of results similar to what was found under the high task complexity condition was expected. That is, decision making performance remained high irrespective of the amount of Solution Development communication the team engaged in. Alternatively, under the high task complexity condition, decision making performance should improve as teams engaged in more Solution Development communication. This is because the increased complexity of the task should have necessitated more communication specifically relating to the team's

approach to solving the problem. However, teams showed that increasing amounts of Solution Development communication was not necessary in order for them to be able to solve the more complex survival decision problem.

Research undertaken by Roberts, Cheney, Sweeney and Hightower (2004) helps provide some explanation for these unexpected findings regarding the moderating effect of task complexity. In their research which investigated the effects of project complexity on team interaction, they found that patterns of team interaction were more effective and greater amounts of communication took place on less complex tasks. This effect however was specific to what the researchers described as 'hands-on' tasks as opposed to conceptual or decision making tasks. This finding was attributed to greater levels of participation by team members in less complex tasks. Roberts et al (2004) argued that on less complex tasks, more team members possess the skills to perform the task and are more comfortable with their roles within the team compared to more difficult tasks where fewer team members have the expertise to complete it. Based on this argument, team members undertaking more complex tasks might be communicating less because these teams may be relying on only one or two team members to solve the problem or complete the task. These research findings help provide some explanation for these unexpected findings in relation to the moderating role of task complexity. In this research, team members were not reliant on Solution Development communication in order to generate the correct answer to the problem. Given the use of established teams, team members may have used their knowledge about each other's knowledge and abilities to determine who in the team would likely know the answer or best be able to solve the problem and rely on this solution for the overall team decision.

Another puzzling finding in this research is that task complexity did not moderate the relationship between any requisite functions and performance for the production task. This is an important research finding because this research was specifically designed to determine

whether the moderating effects of task complexity would generalise from a decision making task to a production task. All tasks, irrespective of whether they are a decision making task, brainstorming task, or production task, require team members to communicate in order to complete the task, solve the problem, or generate ideas. Therefore, there was an expectation that a positive and strong relationship between communication and team decision making performance under conditions of high task complexity would also be seen for the production task. The fact that this relationship wasn't observed suggests that task complexity may be an important moderator of the communication — team performance relationship for certain types of tasks (e.g. decision making) only.

#### *Team Member Diversity as a Moderator*

A significant and unique contribution of this research was investigating team member diversity as a moderator of the communication — team performance relationship. Very little previous research has explored team member diversity as a moderator and this research sought to extend the literature by better understanding diversity's effects on the communication — team performance relationship in this way. It was expected that Problem Definition, Solution Development and Solution Evaluation communication would have a stronger, positive relationship with performance when team member diversity was high. However, team member diversity wasn't expected to moderate the relationship between Orientation and Criteria Development communication and team performance.

A number of moderation effects, all in the hypothesized direction, were found for both the decision making and production tasks. First, Problem Definition communication was found to have a stronger effect on performance under conditions of high Race Diversity and Work Value Diversity for the decision making task. Second, Criteria Development communication was found to have a stronger effect on performance under conditions of low Gender Diversity for the decision making task. That is,

the relationship between Criteria Development communication and performance was poorer for teams with high Gender Diversity. The direction of this finding was consistent with the study hypothesis. Third, Solution Development communication was found to have a stronger effect on performance under conditions of high Work Value Diversity for the decision making task and high Gender Diversity for the production task. Again, the direction of these findings supported the proposed hypotheses.

These findings have a number of important implications. First, they show that there is considerable value in exploring team member diversity as a moderator variable. For several years, the literature has argued that diversity research needs to move beyond only testing the main effects of diversity (Knippenberg & Schippers, 2007; Mannix & Neale, 2005). This research shows that different types of diversity play a role in the relationship between team communication and performance. More specifically, these findings are indicative of different types of diversity moderating the relationship between specific types of communication activity and performance and these effects vary across different types of tasks. The veracity of these findings must be evaluated in light of the small number of moderation effects found overall.

For the teams in this research, Race Diversity and Work Value Diversity were significant moderators for the decision making task only. These moderator effects were seen for both Problem Definition communication (RD and WVD) and Solution Development communication (WVD only). These results suggest that diversity in terms of the cultural background of team members and their work values helps bring a range of knowledge, skills, abilities and viewpoints to a team decision making environment and this facilitates improved team performance when team members are discussing and defining the nature of the task they are to perform and ideas or proposals for solving the task. Interestingly, Gender Diversity was the only significant moderator for the production task. The moderation effects for gender diversity were seen for both Criteria Development communication and Solution Development communication;

however their effects were in different directions. This result implies that teams with a mix of males and females perform better when they engage in more Solution Development communication for a production task and same-sex teams perform better when they engage in more Criteria Development communication for a decision making task. Given the nature of the production task being performed by teams in this research, this finding is not entirely unexpected. Previous research on gender differences shows that males perform better at ‘doing’ tasks, (such as making origami), compared to females who are considered better at ‘discussion’ based tasks (Myaskovsky, Unikel, & Dew, 2005). Diversity in terms of the gender composition of teams therefore helps facilitate improved team performance for a production task.

### *Communication Differences across Task Types*

One of the key aims of this research was to determine if the functional perspective could be generalised to different types of tasks, such as a production task. This research showed that there were a number of similarities and differences across each task type that warrant discussion. First, in terms of similarities, the relationship between Problem Definition and Solution Development communication and performance was consistently found across both the decision making and production task. This finding suggests that these two requisite functions, in particular, are important for team performance across both task types. This finding also provides partial support for previous research undertaken on the functional perspective, which has consistently found Problem Definition communication to be related to team decision performance (Graham et al., 1997; Hirokawa, 1980, 1982, 1983, 1985, 1987, 1988, 1990; Hirokawa & Pace, 1983; Hirokawa & Poole, 1996; Propp & Nelson, 1996). Inconsistent with this literature however is the finding of Solution Development communication being related to performance across both task types. A number of previous studies testing the functional perspective have found Solution Evaluation, not Solution Development communication to be related to team decision making performance (Graham et al., 1997; Hirokawa, 1980, 1982, 1983, 1988;

Propp & Nelson, 1996). For teams in this research, communication concerned with concrete, specific proposals for action was more consistently related to team performance. One possible explanation for this result is that in this study Salazar's (1997) method of operationalizing requisite functions was followed. This approach was slightly different to the varying communication measurement approaches adopted by Hirokawa (1980, 1982, 1983, 1985, 1987, 1988, 1990; Hirokawa & Pace, 1983; Hirokawa & Poole, 1996). Salazar's (1997) approach was adopted because i) his classification system for coding communicative behaviours was considered to be easier for coders compared to the approach used by Hirokawa and ii) consistency with Salazar's methodology was sought in order to replicate and extend his work on moderation effects using the functional perspective.

A notable difference between the two tasks relates to the main effects within each regression model. For the decision making task, Team Potential was a significant predictor of performance and accounted for a very large 55.8% of the variance. This result suggests that for a decision making task, the skills and abilities of team members' accounts for a significant amount of the variance in team performance. In contrast, for the production task, Team Potential was not a significant predictor of performance. Rather, Team Size was and accounted for 33.7% of the variance. This unexpected result suggests that the skills and abilities of team members played a small and insignificant role in team performance for the production task, but the number of people in the team did make a significant contribution to performance. It is difficult to understand how team member skills and abilities can provide such little or no significant variance in performance on a production task. This finding is contrary to the model proposed in this research and most other team performance models which include and account for team members' skills and abilities (Cohen & Bailey, 1997; Cragen & Wright, 1990; Gladstein, 1984; Gouran, 1983; Hackman & Morris, 1975). While it is not clear why this finding has emerged, it is important to note that the measure of Team Potential for each task in this research was different. For the decision making task,



Team Potential represented the deviation score of the prediscussion preference of individual team members on the NASA problem. This measure was chosen as it replicated the Team Potential measure employed by Salazar (1997). For the production task, team member IQ scores were used as a measure of Team Potential which is consistent with other measures of Team Potential employed in the team performance literature.

The main effects in each regression model reveal several more unexpected findings concerning the relationship between team communication and performance. For the decision making task, Solution Development communication was the only requisite function to be a significant predictor of decision making performance. This finding suggests that teams engaging in greater amounts of Solution Development communication performed better on the decision making task. The variance associated with this step in the regression model however was a small 3.3%, suggesting that the inclusion of requisite functions, Task Complexity and team member diversity only provided a small improvement to the prediction of team decision making performance. For the production task however, Orientation, Problem Definition, Solution Development and Solution Evaluation communication were all significant predictors of team performance. Prior research (Hirokawa, 1985, 1988, 1990) provided a stronger basis for expecting communication activity to be related to team performance for decision-making tasks rather than for production tasks. However, these results provide evidence that teams who engaged in greater amounts of each of these types of communication activity produced more origami. The variance associated with this step in the regression model for the production task was a significant 23%. This finding establishes the importance of communication for 'hands-on' or 'doing' tasks.

Finally, the inclusion of the interaction terms in the regression model for the decision making task did significantly improve the prediction of team performance and explained an additional 7% of the

variance. However, the inclusion of the interaction terms did not improve the prediction of team performance for the production task.

These findings provide valuable empirical support for the functional perspective. This research has provided findings that partially confirm findings in the existing literature, but has also shown that, for these teams at least, Solution Development communication is more strongly related to team performance as opposed to Solution Evaluation communication. Importantly, this research has also shown that the functional perspective is a useful theoretical framework explicating the relationship between communication and team performance for both a decision making and production task.

The results of each regression model reveal much in terms of the relative contribution of team potential and communication across both types of tasks. While the regression model for the decision making task shows that team potential accounts for a significant amount of variance in team performance, importantly, the model also shows the additional variance (albeit small) accounted for by team communication activity and the interaction between communication and the moderators. The regression model for the production task on the other hand, is inconsistent with not only the team communication — performance model proposed in this research, but many other team performance models insofar as team potential accounted for little or no variance in team performance. Yet, communication accounted for considerably more variance in performance than in the decision making task.

### ***Further Unexpected Findings***

An unexpected, but interesting finding emerged from the correlations undertaken that is worthy of further discussion. In exploring the relationships between study variables it was found that all requisite functions for the decision making task showed very large, positive and significant relationships with the same requisite functions for the production task. Relationships of this strength were not found within tasks across each requisite function for either task. This finding implies

that while teams do not engage in one particular requisite function at a 'typical' level (i.e. all high or all low), teams do tend to engage in different requisite functions to the same extent across different task conditions. Although no specific hypotheses about profiles of communication activity across task types were proposed in this research, previous literature would suggest that team interaction behaviours vary according to task characteristics (Bales, 1950; Carter, Haythorn, Meierowitz, & Lanzetta, 1951; Deutsch, 1951; Morris, 1966). These findings however, suggest that irrespective of the task to be performed, teams in this research utilised very similar patterns of requisite functions to perform each task. In other words, teams were communicating in almost the same way when undertaking each task, despite these tasks being very different.

Previous research provides some support for this finding. Sorenson (1971), using Bales' IPA approach to measure team communication activity, did not find any differences in team interaction profiles across a production and problem solving task, except on the task interaction behaviour of structuring. In contrast however, Katz and Tushman (1979) found problem solving and administrative communication to only be important for research projects and not technical service projects in his research on communication patterns in established R&D teams.

In trying to explain this unexpected, but notable finding, it should be noted that a key difference with this research compared to almost all previous research on the functional perspective and much communication research in general, is the use of real, established organisational teams. To date, only Graham et al (1997) and Propp and Neilson (1996) have utilised real teams in their research on the functional perspective. It has long been noted that findings from one type of team cannot and should not be extrapolated to other types of teams (Hall & Williams, 1966). Yet much research on communication and team performance has been conducted with ad-hoc teams with the findings simply generalised to real, established teams. However, the way in which established teams interact is quite different to zero-history or ad-hoc teams (Gruenfeld, Mannix,

Williams, & Neale, 1996; Katz, 1982). Gruenfeld et al (1996) found for example that team members who were familiar with one another, felt significantly more comfortable working together and expressing disagreement and were subsequently more effective than teams of strangers. Real teams often have already established standard work practices and behaviours that are used to guide their team processes (Weick, 1969), which they apply to varying team situations. It is perhaps unsurprising therefore, that there was considerable consistency in the way in which established teams in this research communicated with one another across both task types. This aspect of the findings is significantly under-researched in the team communication and performance literature and therefore warrants further investigation. As such team communication patterns or profiles and their relationship with team performance became the focus of the second study in this program of research.

### ***Limitations of Research Program***

Overall, these results were somewhat disappointing in terms of not finding more hypothesized moderation effects. The small number of significant findings limits the extent to which firm conclusions can be drawn about task complexity and team member diversity as moderators of the communication and team performance relationship. However, these findings have extended the literature on the functional perspective and further provided very useful insight into the nature of team communication especially for established teams. Before discussing the contributions of this research, the limitations of this research will first be acknowledged.

First, the lack of significance in terms of the moderation effects is a limitation of this research. However, there are noted difficulties in detecting moderation effects in field studies or studies undertaken in organisational environments with natural teams (McClelland & Judd, 1993). It has been suggested that the difficulties in detecting moderation effects in field studies are so considerable, that even those effects

explaining as little as 1% of the total variance should be considered important (Evans, 1985). Field studies typically account for 1-3% of the variance (Champoux & Peters, 1987; Chaplin, 1991). Given the noted difficulties in detecting statistical significance, the relatively small number of significant moderation effects found in this research does provide some evidence that task complexity and team member diversity moderate the team communication — performance relationship. While the chances of finding more moderator effects could have been improved in a more controlled laboratory experiment, this would have reduced the external validity of the research. Field studies are critical in ensuring the external validity of research findings and must be pursued in order to substantiate the value of theoretical models in a real world context.

Second, the amount of time teams had available for discussion or producing origami was relatively short (approx 15 minutes). Given both tasks were part of a larger team building exercise that the organisation was undertaking, it was not possible to prescribe a longer time frame in which the team building tasks specific to this research could be undertaken. This relatively short time frame may have impacted the extent to which teams felt they could adequately complete each task. Previous literature does suggest that time limits do affect task performance, in both positive and negative ways (Davis, 1969; Kelly & McGrath, 1983; Locke, Shaw, Saan, & Latham, 1981). Teams may have sacrificed quality or more thorough discussion in order to reach a solution. However, the time frames for each task in this research are not dissimilar to Salazar (1997), whose teams engaged in approximately 12 minutes of discussion when solving the NASA Moon Survival problem. Another advantage this research had that could well have minimised any possible negative impact of time constraints is the use of established teams. Given each team member was relatively familiar with all other team members and established patterns of team processes in place, these teams would not have had to spend valuable team activity time establishing team norms. Therefore, teams would have been able to use the entire team activity period for task completion.

Third, only three dimensions of diversity — Gender, Race and Work Values were used in this research. While data were originally collected on other diversity measures, these measures of diversity were included in the analysis in order to have some generalisability with previous research. Further to this, the chosen measures of diversity reflected both surface-level diversity (Gender and Race) and deep-level diversity (Work Values). It is possible that other measures of diversity that weren't tested may have produced stronger moderation effects. Also, the diversity effects reflect only one organisational context. The effects of Gender, Race and Work Value Diversity might be different in other organisations and for other types of teams.

Despite these noted limitations, a number of valuable conclusions can be drawn from this research. There are a number of research strengths that improve the validity of these conclusions. One strength is that there were data for a relatively large number of teams (1039 individuals; 203 teams). No previous research testing the functional perspective has utilised such a large number of teams. In addition to large team numbers, this research utilised real, established teams. The veracity of these findings is substantially improved as a result of these two research strengths. An additional strength of this research is the use of objective measures of team performance which eliminates biases that can contaminate more subjective performance measures.

### ***Theoretical and Practical Contributions of Research Program***

While there has been a plethora of theories and research concerning the role of communication in team performance, an understanding of *when* communication becomes important for team performance has been lacking. The functional perspective has made a significant contribution to the team communication literature in terms of identifying the specific types of communication activity or requisite functions that are important for team decision making performance and has more recently sought to explore factors, or moderating variables, that impact the relationship

between requisite functions and team decision making performance. This research has extended this work in a number of ways.

First, two moderators were tested, one task-based and the other team-based; both theoretically derived from the literature. To date, very few moderators of the team communication — performance relationship have been empirically tested. Salazar's (1997) work was the first to explore the notion that the team communication — performance relationship was contingent upon varying task and team factors. However, Salazar's work, although suggestive of moderator effects, failed to properly test these relationships. This research has shown that the complexity of the task a team is undertaking does impact when communication becomes important for that team in reaching a high level of performance. This research has also shown that the composition of a team, in terms of its gender, race and work values, impacts when communication becomes important for team performance. These findings have contributed to the need to advance the functional perspective and provide greater clarity regarding the role of communication in team performance. The key proposition underlying the functional perspective is the notion that teams use communication to achieve goals (Hirokawa & Poole, 1996). To this end, the research has provided support for a) those requisite functions most important for teams in delivering high or quality performance and b) the moderators that tell us *when* these requisite functions become more important for team performance.

Second, this research improved the external validity of the functional perspective by testing the theory with established teams in a real organisational context and extended the application of the functional perspective by testing the theory across a decision making and production task. Almost all previous research adopting the functional perspective has utilised ad-hoc or zero-history teams. This research showed that, similar to research using ad-hoc teams, engaging in Problem Definition communication is important for team performance. Propp et al (1996) also found Problem Definition communication to be strongly related to team

performance in their research using established teams. However, in contrast to existing findings from the literature, it was found that Solution Development communication was more important for team performance for established teams. Solution Development has not been found to be significantly related to team performance in any other study of the functional perspective. Perhaps the importance of this requisite function needs to be more closely investigated in future research. It seems both reasonable and logical that team communication about concrete, specific proposals for action would be important for team performance. Without such discussion, teams cannot then move onto evaluating these suggestions in terms of their possibility as decision alternatives. For established teams, who already have customary team behaviours and processes in place, communicating positive and negative feedback about proposed solutions is likely to be more straightforward than for teams who have never worked together before. Thus, the emphasis and therefore importance for established teams would be focussed on their communication concerning what the proposed solutions to the task actually are.

A significant theoretical advancement of this research is the testing of the functional perspective using different types of team tasks. To date, the functional perspective has only been tested with decision making teams. However, as this thesis argued, all team members, irrespective of the task they are charged to perform, must communicate with one another in the execution of that task. This thesis has shown that communication is important for teams undertaking a production task. Communication was in fact more important, in terms of the variance in team performance it represented, for the production task compared to the decision making task. What this thesis was not able to establish to the same extent as the decision making task, was the moderation effects of task complexity and team member diversity. Future research should extend the work of this thesis and explore the functional perspective with other types of production tasks to see if these results generalise, and/or test the functional perspective with different types of team tasks. The



overall value of the functional perspective would be extended considerably if it could be shown that teams use communication to achieve goals for not just decision making tasks, but many different types of tasks.

## **Overall Summary**

This research has provided a number of key learnings about the relationship between communication and team performance. We know that Problem Definition communication, which is communication about the nature of the teams' problem and its causes and effects, is important for team performance for both a decision making and production task. We also know that Solution Development communication, which is communication about concrete, specific proposals for action is important for team performance for both types of tasks. Not only have we learned of the value of these two types of communication activity for team performance in this research, but we know that Problem Definition and Solution Development communication become more or less important for team communication under certain conditions. These conditions involve the complexity of the task that the team is undertaking and the amount of diversity among team members.

An unexpected, but important finding generated from this research is the notion that established teams appear to have a characteristic or typical way of communicating, irrespective of the type of task they are performing. This is a finding that has yet to receive any substantial attention in the team literature. As such, this thesis has sought to explore this finding in further detail and provides an overview of this work in the next Chapter.



## CHAPTER 6: STUDY TWO

### Introduction

The findings presented in Chapter Five only provided partial support for task complexity and team member diversity as moderators of the relationship between communication and team performance. However, the analyses revealed an unexpected but interesting finding, namely, that team communication measures were highly correlated across the two task types. This pattern of results indicates that teams may have a characteristic way of communicating that is consistent across task types and contexts. Such a possibility seemed worthy of further investigation through a final, unplanned study.

In attempting to explain the observed consistency in team communication measures, it was found that there was a dearth of research evidence, not only in terms of consistency in patterns of communication activity across tasks, but also more generally as regards communication within established work teams. Thus, the current investigation addresses a significant gap in the literature by exploring three additional research questions. These questions were:

1. What is the relative importance of task versus team factors in explaining the variance in team communication ratings for established teams?
2. Do teams demonstrate consistent team communication profiles? And if so,
3. Are these team communication profiles related to team performance?

In this Chapter, these research questions are addressed, first by reviewing the existing literature relating to this line of research enquiry and then by re-analysing the data from Study One of this thesis.

## **Task Effects on Communication Profiles**

The proposition that different types of tasks will be associated with different team communication profiles seems highly plausible. Indeed, the literature provides strong theoretical support for the contention that task characteristics affect team processes (Carter, Haythorn, Meirowitz, & Lanzetta, 1951; Carter, Haythorn, Shriver, & Lanzetta, 1950; Deutsch, 1951; Hackman & Morris, 1975; McGrath, 1984; Morris, 1966). For the most part, the literature investigating the relationship between task type and team processes has focused on the relationship between task type and the amount of information exchanged within the team. That is, different types of tasks (decision making versus production versus brainstorming, etc) are thought to determine the amount of information that a team must exchange in order to accomplish a task or solve a problem (Poole, 1978). Thus, the focus of the literature has largely been on the effect of task type on quantity of communication, rather than on the effect of task type on type of communication or information exchanged. In addition, most if not all of these studies were undertaken using ad-hoc teams.

Unfortunately, the functional perspective, while concerned with different types of communication activity, does not look at communication across different types of tasks. To date, investigations of the functional perspective have focused (both in terms of theory development and empirical testing) on decision making tasks. In reviewing this literature however, it can be seen that different types of decision making tasks have been used to test this theory. For example, Hirokawa (1985, 1988) used decision making tasks that required the team to reach consensus, as did Propp and Neilson (1997) and Graham et al (1996) in their field experiments testing the functional perspective. Salazar (1997; 1994) on the other hand, used decision making tasks with an objectively correct answer in his studies testing the functional perspective. Thus, there is some variation in the nature of the tasks completed by teams within this literature. However it is not possible to determine whether differences in

communication activity observed in these studies are the result of the different decision making tasks employed or other methodological differences across studies.

It is reasonable to suggest that task effects for ad-hoc teams might be different to task effects for established teams given the previous working history and knowledge that established team members have about one another. Ad-hoc teams cannot be considered the same as teams who have worked together for long periods of time and who are considerably more familiar with one another. Extrapolating inferences from ad-hoc to established teams is common place (Hall & Williams, 1966) but there is considerable evidence to suggest that these types of teams are different from one another, particularly in terms of team processes and performance.

The team development literature provides a sound starting point for highlighting how established teams differ from ad-hoc teams. Gersick (1988) argues that in order to understand what makes teams work effectively; team development or team change over time must be taken into account. Much has been written about team development (see Arrow, Poole, Henry, Wheelan, & Moreland, 2004 for a review of this literature), the most well known model being the work of Tuckman (1965). Tuckman's original model proposed four stages of team development including *forming*, *storming*, *norming* and *performing*. A later review of this model proposed the inclusion of a fifth stage, labeled *adjourning*. Criticisms regarding the validity of Tuckman's and other team development models have been made. However, despite these criticisms, the team development literature clearly proposes that established teams are different to ad-hoc teams, particularly in terms of their team processes.

For established teams specifically, there is only a small evidence base on task effects and this evidence relates more broadly to team processes rather than communication in particular. To highlight, English, Griffith and Steelman (2004) investigated task type as a moderator of the

relationship between team conscientiousness and performance for established flight crews. Using Steiner's task taxonomy (1972), these researchers hypothesized that highly conscientious teams would perform better on additive and disjunctive tasks compared to conjunctive tasks. These hypotheses were supported. Flight crews, representing highly conscientiousness teams, performed better on both the additive and disjunctive task measures. No significant relationship was found between conscientiousness and performance on the conjunctive task measure. Thus, this study suggests that task effects affect the impact of other team characteristics on team performance.

However, in another study exploring task type as a moderator of the relationship between team processes and performance (Stewart & Barrick, 2000), no task effects were found for the relationship between communication and performance. Established teams undertaking a production task were the focus of this study. However the researchers argued that teams rarely perform only one type of task. Rather, all tasks vary on a continuum of behavioural (execution of manual and psychomotor tasks) and conceptual (planning, deciding and negotiating) dimensions. It was hypothesized that the relationship between communication, conflict, shirking and flexibility and team performance would be positive and significant for the conceptual component of the production task compared to the behavioural component of the task. While not all of the proposed moderation effects were supported, of interest to this thesis was the fact that team communication measures did not change significantly for behavioural and conceptual components of the task and the relationship between communication and performance did not vary for the different components of the task. These findings are consistent with my own in that they illustrate consistency in team communication patterns for established teams.

However, Katz and Tushman's (1979) work in a research and development setting provides some limited evidence that task type has an effect on communication for established teams. The projects or 'tasks'

investigated in this study included research tasks, development tasks and technical service tasks. The two types of communication activity explored were problem solving communication and administrative communication. Findings revealed that problem solving communication was positively correlated with project performance for research tasks only, suggesting that teams performing research tasks engaged in more problem solving communication. Administrative communication was also positively correlated with project performance for research tasks, but negatively correlated with project performance for technical service tasks. No significant correlations were found for either type of communication activity and project performance for development tasks. These results imply that the relationship between communication and performance in a research and development setting did vary for different types of tasks.

Thus, although there has been some investigation of the effect of task type as a moderator of the relationship between team processes and team performance, there has been little focus on the relationship between task type and team processes. Furthermore, a review of the relevant data presented in these studies provides only limited support for an effect of task type on team processes. Overall, relatively few studies have examined team processes within established teams and across different tasks. In addition to this, a range of task taxonomies are presented in the literature, which has led to varied approaches to determining task effects. Thus, it is difficult to draw any firm conclusions from the literature about the nature of the relationship between task type and team processes in established teams.

## **Team Processes and Established Teams**

A fairly under explored topic in the literature, particularly relevant for established teams is team habitual routines. Team habitual routines are said to “...exist when a team repeatedly exhibits a functionally similar pattern of behavior in a given stimulus situation without explicitly selecting it over alternative ways of behaving” (Gersick & Hackman 1990, p. 69). Team habitual routines are said to be a pervasive

phenomenon (Gersick & Hackman 1990). There is much research evidence to show that established teams use routine processes or habitual ways of dealing with information, handling conflict, and making decisions (Argyris, 1969; Gersick, 1988; Hackman & Morris, 1975; Janis, 1982; McClelland, 1984). Team habitual routines can be created early on in the development of a team and therefore be relevant to ad-hoc teams, but they typically evolve over time and therefore are most evident within established teams (Gersick & Hackman 1990).

Team habitual routines can have both positive and negative effects on team processes and performance. Considerable time and energy spent on team orientation and overall management and coordination of the team can be saved when established teams take advantage of their team routines. Habitual team behaviors can further help minimize uncertainty with a task and also help team members to feel more confident with their role in the team (Gersick & Hackman 1990). However, habitual routines can also mean that established teams fail to recognize changes in familiar situations and fail to take full advantage of task or interpersonal innovation that might enhance their overall team performance. Team norms, which have evolved throughout the team development process, are central to the maintenance of habitual routines in established teams (Gersick & Hackman 1990).

The team development literature, especially the literature relating to team habitual routines, suggests that we should see consistency in team processes within established teams. The next section of this Chapter presents empirical evidence that shows established teams have consistent team processes, both over time and across different settings.

### ***Consistent Team Processes over Time and Across Settings for Established Teams***

A central feature of established teams is the increased familiarity team members have with one another. Team member familiarity has important implications for the amount of shared and unique knowledge that team members bring to and discuss during a team decision making



situation. Gruenfeld, Mannix, Williams and Neale (1996) sought to explore how teams of familiar (established) and unfamiliar (ad-hoc) members communicated and discussed information on a decision making task. Their findings indicated that familiar teams felt more comfortable than unfamiliar teams in working together and familiar teams also felt more comfortable disagreeing with one another. Familiar teams felt they worked as a team more effectively than unfamiliar teams.

Interestingly, in terms of team decision processes, this study showed that in reaching a team decision under partial-information conditions (i.e. information about the task or issue is distributed to only some team members), unfamiliar teams did not share the unique information that individual team members held about the task and therefore did not perform as well. This effect of team familiarity is consistent with the work of Stasser and Titus (1985; 1987) who similarly found that unfamiliar or ad-hoc teams often failed to pool unshared information effectively. Familiar teams, on the other hand utilized a different team decision process. In partial-information conditions, familiar team members pooled all of their available knowledge (both unique and shared) about the task before making a decision, therefore leading to a better (correct) decision outcome. These different approaches to team decision making imply that communication for decision making occurs differently with familiar or established teams compared to unfamiliar or ad-hoc teams. An inference that can be drawn from this finding is that familiar teams have established norms and standards for dealing with interpersonal differences; therefore they are more likely to feel comfortable disagreeing with other team members and less likely to feel the need to conform to poor decision choices. Stasser and Titus (1985; 1987) have similarly suggested that established teams, through their history of working on similar tasks together, may develop an established method or approach to communicating.

There is additional evidence to suggest that established teams communicate differently to ad-hoc teams (Hall & Williams, 1966;

McGrath, Arrow, Gruenfeld, Hollingshead, & O'Connor, 1993; Sorenson & McCroskey, 1977). More specifically, due to increased team member familiarity and the evolution of normative team processes, established teams tend to interact and communicate with one another less than ad-hoc teams (Carney, 1986; Gersick, 1990; Gruenfeld, 1996; Katz, 1979; Katz, 1982). This reduction in team communication can have positive and negative consequences for team performance. In exploring the effects of team longevity on project communication and performance in a research and development setting, Katz (1982) found that as team longevity increased, communication with other organizational teams, external R&D teams, and with other team members reduced significantly. Katz (1982) argued, consistent with team development theory, that teams with greater longevity become more stabilized in their team roles and contributions. That is, established teams rely on their normative team processes and behavior in communicating and carrying out their tasks. This reduction in team communication (all types) in Katz's (1982) research however was associated with a corresponding decrease in team performance. Importantly, this decline in team performance was not considered to be the direct result of less communication per se, but rather the fact that by communicating less, team members were ignoring and becoming more isolated from other critical sources of information that could assist them in making a better or more informed decision.

A collection of work from McGrath (1993, 1984, 1991, 1990) provides further support that established teams develop consistent team processes. The findings from these studies showed that as teams gain greater experience in working together on a given set of tasks, in a particular organizational context, they tend to routinize the way in which they do those tasks. This routinization was associated with a corresponding reduction in the amount of intragroup coordination and information exchange required by the team (McGrath et al., 1993). Increased team experience was also found to routinize the team's division of labor and resource exchange patterns, increasing predictability within the team and

reducing the amount of coordination and information exchange the team had to engage in to carry out a task successfully.

## **Summary and Proposed Hypothesis**

The literature presented above has provided an overview of task and team effects as they relate to team processes (particularly communication) and performance. It has been found that, for established teams at least, there is only limited evidence for task effects on communication profiles. Furthermore, research which examines established teams over time and across different settings has demonstrated that they develop consistent or standard ways of sharing and engaging in communication. Thus, there is some empirical evidence within the literature for proposing the following hypothesis:

*Hypothesis 1:* There will be greater team-level variance in team communication activity than task-level variance in team communication activity.

If established teams develop standard ways of communicating, then it seems plausible that established teams will be able to be described in terms of their characteristic profile of communication activity. That is, established teams may typically emphasize certain communication functions when undertaking a task. Thus, the second objective of this study is to explore whether communication profiles exist for established teams. If discernable communication profiles can be identified, then the relationship these communication profiles have with performance will be important to identify. The next section of this Chapter provides an overview of the literature relevant to these questions.

## **The Existence and Form of Communication Profiles in Established Teams**

There is a dearth of literature that has specifically sought to identify communication profiles in teams, be it ad-hoc or established teams. However, the work of Stempfle and Badke-Schaub (2002) and Wheelan

and Williams (2003) provides some evidence of there being discernable communication profiles in established teams and a brief overview of their findings will be described in the following paragraphs.

Stempfle and Badke-Schaub (2002) sought to investigate the collective thinking processes in design teams. Although the three design teams investigated were represented by a university student population, the students involved represented established work teams, having worked together for several years over the course of their studies. Each team was required to complete a complex design task within a six-hour time frame. Similar to the communication coding process utilized in Study One in this thesis, all communication acts were coded via utterances and the frequency of these utterances were counted. Specific to Stempfle's study however, frequencies were tallied according to categories of communication that reflected content-related communication (goal clarification, solution generation, analysis, evaluation, decision and control) and process-related communication (planning, analysis, evaluation, decision and control).

Stempfle and Badke-Schaub (2002) found that all three teams had a similar distribution of communication utterances among content and process communication categories. That is, the profiles of communication for the three teams were similar, with the correlation of distributions between the three teams being 0.98. The most frequently engaged-in types of utterances by all three teams were analysis — content (46%), analysis — process (17%), evaluation — content (13%), goal clarification (7%), and evaluation — process (5%). An important finding for this thesis was that despite the total number of utterances across communication categories being significantly different across teams, the relative distribution of utterances across content and process communication categories between teams remained highly similar. Thus, this study suggests that all teams may share the same communication profile, rather than teams being differentiated by their communication profiles.

The work of Wheelan and Williams (2003) not only provides evidence of discernable communication profiles in established teams, but also suggests that these communication profiles differ based on the length of time team members have been working together. In this research, a visual mapping tool was used to identify the communication profiles in 16 established teams from a range of organizations. Communication within teams was transcribed and coded by 'complete thoughts' or simple sentences. These sentences were then coded into one of eight communication categories. Sentences within each communication category were then sequentially entered into software that produced a colour representation of the team's communication profiles.

Findings showed that the visual representation for the 16 teams could be arranged in three clusters based on key similarities and differences. The communication profiles in the first cluster were described as being more symmetrical in their tone, less erratic and communication between team members was sustained longer compared to the second and third clusters. Communication profiles in the second and third clusters had less symmetry in their tone and teams were described as having a more active and erratic communication style. Teams in the second cluster engaged in more communication that was not task related compared to teams in the first cluster. Teams in the third cluster were described as having difficulty in maintaining the direction of their communication and keeping their communication focused on the task. Wheelen and Williams (2003) concluded that a possible explanation for the differences in communication profiles was team history. Teams in the third cluster had been working together for only four months or less, whereas teams in the second cluster had been working together longer than 4 months, and teams in the first cluster had the longest team history.

The work of Stempfle and Badke-Schaub (2002) and Wheelan and Williams (2003) provides evidence that established teams can develop distinct communication profiles and also provides some indication of what form these profiles might take. The next section of this Chapter presents

evidence in support of the hypothesis that there is a relationship between communication profiles and team performance.

## **The Relationship between Communication Profiles and Performance**

The evidence presented above provides support for the notion that established teams may have characteristic communication profiles. However, there appears to be little or no research evidence to date that has examined the relationship between communication profiles and team performance for established teams. Nevertheless, there are some theoretical frameworks and empirical findings which provide preliminary support for this proposition.

First, the input-process-output (IPO) model remains the key approach to modeling the relationships among variables associated with team performance (LePine, Piccolo, Jackson, Mathieu, & Saul, 2008). The IPO model proposes that characteristics associated with a team (inputs) impact team performance (and other outcomes) indirectly through team process factors (process), including communication. A range of other variables are also identified as team process factors including cohesion, commitment, conflict, interdependence, and shared mental models (Campion, Medsker, & Higgs, 1993; Cohen & Bailey, 1997).

There is much research evidence supporting the relationship between team process factors and performance (Bettenhausen & Murnighan, 1991; Cohen & Bailey, 1997; Guzzo & Shea, 1992; Sundstrom, McIntyre, Halfhill, & Richards, 2000), although this evidence is not always consistent. In an effort to provide a more definitive explanation of the relationship between team processes and team performance, a recent meta-analysis (LePine et al., 2008) sought to explore this relationship using the team process model developed by Marks et al (Marks, Mathieu, & Zaccaro, 2001). This model of team processes was chosen because it provides greater articulation of the role of team processes and the relationships among them. More specifically,

this model suggests that team processes have a dimensional structure. The three higher-order team process categories include transition processes, action processes, and interpersonal processes. Each of these categories also has a number of more specific team process activities associated with them including goal specification; strategy formulation; monitoring progress; system monitoring; team monitoring; coordination; conflict management; motivation; and affect management. The model proposes that teams utilize these higher-order and more specific team process activities during different phases of team performance.

Findings of the meta-analysis supported the proposed multidimensional structure of team processes. These results extend our understanding of team processes and the IPO model by better defining team process concepts. Future research exploring team process factors is now better placed to select either broad or more specific team process factors based on the generalisability of the predictor and criterion constructs employed by the research. Findings of the meta-analysis also revealed that all broad and specific team process factors were significantly related to team performance, therefore providing theoretical and empirical support for the relationship between team communication profiles and performance.

## **Examining Communication Profiles within the Functional Perspective**

While there isn't a wide range of empirical evidence in this area, the research presented above provides some support for the argument that established teams will have developed relatively stable communication profiles across different task situations. The intent is to explore team communication profiles specifically within the functional perspective using the requisite functions framework. The following scenarios illustrate the concept of communication profiles based on requisite functions.

First, consider an emergency medical response team. They are charged with responding as soon as possible to accidents and emergencies to provide medical assistance. Upon receiving a brief call-out outlining the nature of the emergency they are to attend and the current status of injured persons (Problem Definition), they move swiftly into action; their team leader spending only a short time outlining some basic procedures for how the team is going to best provide medical support and intervention (Orientation) as they make their way to the waiting helicopter. The team only has a short 10-minute flight to reach the emergency and therefore can only spend this period of time collectively developing strategies for dealing with the range of injuries they will be confronted with. The team however is experienced in dealing with these situations and can capably consider their criteria for triage and their contingencies for dealing with injuries that require high-level medical intervention during this 10 minute flight (Criteria Development). At the emergency, although they need to work quickly to treat the injured, the team has a greater amount of time to discuss the nature of each injury and options for treatment (Solution Development). While other medical staff are tending to the injured, the team leader can consider the best course of action for the more serious injuries based on the assessment undertaken at the emergency site and advice provided by staff back at the hospital (Solution Evaluation). The time this team can spend developing and evaluating solutions to assist injured people is considerably more than the other communication functions, but also more important given the nature of the problem at hand.

Contrast the communication profile of the emergency medical response team with that of a police special investigations team investigating a serial murderer. They might receive a relatively quick initial briefing of the crimes to be investigated (Orientation). Next, they spend a considerable amount of time going over the details of each case, the people involved, potential suspects, and if any progress in finding the person(s) responsible has been made (Problem Definition). Defining and understanding the nature of the crimes is critical for this team because it



provides the foundation upon which the direction of the investigation will take. The team then considers and brainstorms a strategy for solving the crimes, the people they need to interview, and the locations they might need to consider visiting (Criteria Development). This highly experienced team uses their knowledge and contacts to undertake this task relatively quickly. The team then quickly revisits their process about which team members are going to be responsible for different aspects of the investigation, and the timeframes they expect certain elements of the investigation to be completed within (Orientation). Much time is spent with the team meeting weekly to provide feedback on the information they have gathered and to brainstorm ideas about the crime and what steps need to be undertaken to progress the investigation (Solution Development). For a short period at the end of each meeting, the Senior Sergeant heading the investigation uses his experience to weigh up all ideas and provide reasons why some suggestions are better than others and then proposes the next steps to be taken (Solution Evaluation).

To summarise, findings from Study One revealed strong between-task correlations for the communication measures, with relatively low within-task correlations for different communication measures. This pattern of findings suggests that teams may be differentiated by characteristic communication profiles. This second study is designed to ascertain whether team communication profiles can be reliably differentiated, and if so, whether these communication profiles are related to team performance. The specific hypotheses being tested in this study are:

*Hypothesis 2a:* Reliable and discernable communication profiles will be seen in teams undertaking tasks.

*Hypothesis 2b:* The communication profiles of established teams will be related to their level of task performance.

Having provided an overview of the available literature that supports this new line of research enquiry, the next section of this Chapter outlines the methods adopted to test the hypotheses of interest.

## Method

The sample and procedure for the research was described earlier in Chapter Four. Rather than repeating this information, this section focuses on describing the statistical techniques that were used to test the study hypotheses. In order to test for the separate and joint effects of team and task factors in the variance in communication measures multilevel modeling and repeated measures analysis of variance is employed (H1). Cluster analysis is the technique most often used to identify cases (e.g. teams) that form relatively homogenous groups in terms of a set of variables (e.g. communication functions) that differentiate from one another and is used to investigate the existence and nature of different communication profiles (H2a and b).

### *Analytic Techniques*

#### *Multilevel Modeling and Repeated Measures Analysis of Variance*

Over the past few years, there has been a very deliberate move to progress the field of communication research through analyzing data via multilevel modeling (Slater, Snyder, & Hayes, 2006). Communication is said to involve multiple levels of analysis because it comprises, "...individual action that both is constrained by and generates social organization within a cultural context. Communication research thus 'crosses' levels of analysis..." (Price & Ritchie, 1991, p. 134). Multilevel modeling is advantageous in communication research because it allows researchers to analyze data collected at several levels simultaneously, cope with data concerning communication processes occurring over time, and to deal with cluster sampling (Slater et al., 2006).

Multilevel modeling takes into account the hierarchical (or nested) structure of the data (Hayes, 2006). Variables are classified at different levels which represents the varying structures of the data (e.g. level-1 variables, level-2 variables, etc). This hierarchical structure causes "intra-class dependency" among the higher level units of the hierarchy and the assumption of independence is violated. Failure to take the inherent hierarchical structure of the data into account may produce misleading

results caused by incorrect parameter estimates, aggregation bias, and model mis-specification due to lack of independence between measures (Goldstein, 1987a; Goldstein, Healy, & Rasbash, 1994; Heck & Thomas, 1999).

In multilevel modeling an outcome variable constitutes a linear combination of predictor variables, where each predictor variable is weighted by a coefficient which represents the extent to which variation in the predictor variable is related to variation in the outcome variable (Hayes, 2006). The coefficients in the model can be classified as fixed *or* random, as opposed to the coefficients only being fixed (as in ordinary least-squares regression).

This study represented a repeated measures design. Level-1 data, represented by *requisite function* and *task* were repeated measures and represented within-team variation and level-2 data represented *teams* and between-team variation. Data with repeated measures designs are typically analysed with repeated measures Analysis of Variance (ANOVA). However, multilevel modeling addresses a number of disadvantages associated with repeated measures ANOVA and is therefore seen to be a more useful statistical technique for repeated measures data (Quene & van den Bergh, 2006). In contrast to repeated measures ANOVA, multilevel modeling is considered to be robust against violations of homoscedasticity and sphericity; can better handle data from multi-level sampling schemes, and is robust against missing data (Quene & van den Bergh, 2006).

The key intent of multilevel modeling is to select a model that provides the best ‘fit’ to the observed data. A model testing approach was used for this study, sometimes referred to as a ‘step-up’ strategy (West et al., 2007). It involves first testing an unconditional or baseline model in which the fixed intercept is the predictor in the model. From here, level-1 covariates are added to the model, with or without random effects added and then level-2 covariates are added, etc until a model of best-fit can be established.

For this study, a two-level model was to be used to estimate parameters which enabled comparison of the relative importance of task and team effects. The dependent variable was the total amount of communication activity across each requisite function, of which there were five, for both tasks (ten in total). The level-1 predictors were *requisite function* and *task*. The level-2 predictor was *team*. Team and task were modeled as fixed effects and requisite function was modeled as a random effect. However, after testing the baseline model, it was found that when estimating the unstructured covariance matrix for the level-2 covariates, as is necessary in a mixed model framework, the analysis would not converge.

Given this result, the strategy was then to analyse the data using the more traditional repeated measures ANOVA. A 2 x 5 (task x requisite function) repeated measures ANOVA was conducted. While a mixed model approach was the analytic technique of choice for this study given the reasons noted above, repeated measures ANOVA offered a viable alternative for analyzing the study data. Mixed models allow other covariance structures to be modeled. For longitudinal repeated measures data, this is particularly important. However, for non-longitudinal repeated measures data where only fixed effects are being modeled (such as this study), compared to studies in which longitudinal data is the focus and random effects are being modeled, these benefits are not necessarily relevant (Maxwell and Delaney, 2003). A traditional univariate repeated measures ANOVA requires the assumption of sphericity, however a multivariate repeated measures ANOVA does not. Rather, an unstructured covariance matrix is modeled, removing the assumption of sphericity and conforming exactly to the structure that would be modeled within a mixed modeling approach (Maxwell and Delaney, 2003).

A multivariate repeated measures ANOVA is the appropriate model to use in the case of non-longitudinal repeated measures data, and particularly so when only fixed effects are of interest. The only remaining complication for such an analytic strategy occurs when there are one or

more between-subjects factors. Under these conditions, the multivariate repeated measures ANOVA should produce valid results. For these reasons, a mixed models approach through multi level modeling was not advanced in this Study beyond assessing the relative contribution of between-team variance to communication measures.

### *Cluster Analysis*

Cluster analysis is a multivariate technique that identifies groups of objects or participants in a sample or population that are homogenous (or relatively so) and different from other groups of objects or participants on a particular set of variables (Coakes & Steed, 1999; Hair, Anderson, Tatham, & Black, 1998). Groups or clusters formed are different to other clusters with respect to scores on the same set of variables. For the purposes of this study, cluster analysis was used to identify different communication profiles of requisite functions within the sample of teams. The cluster analysis was based on the amount of communication across each requisite function for both tasks. Because there was only one independent variable (requisite function) and therefore one measurement scale, we avoided the problem of comparing Euclidean distances based on different measurement scales (Everitt, 1993).

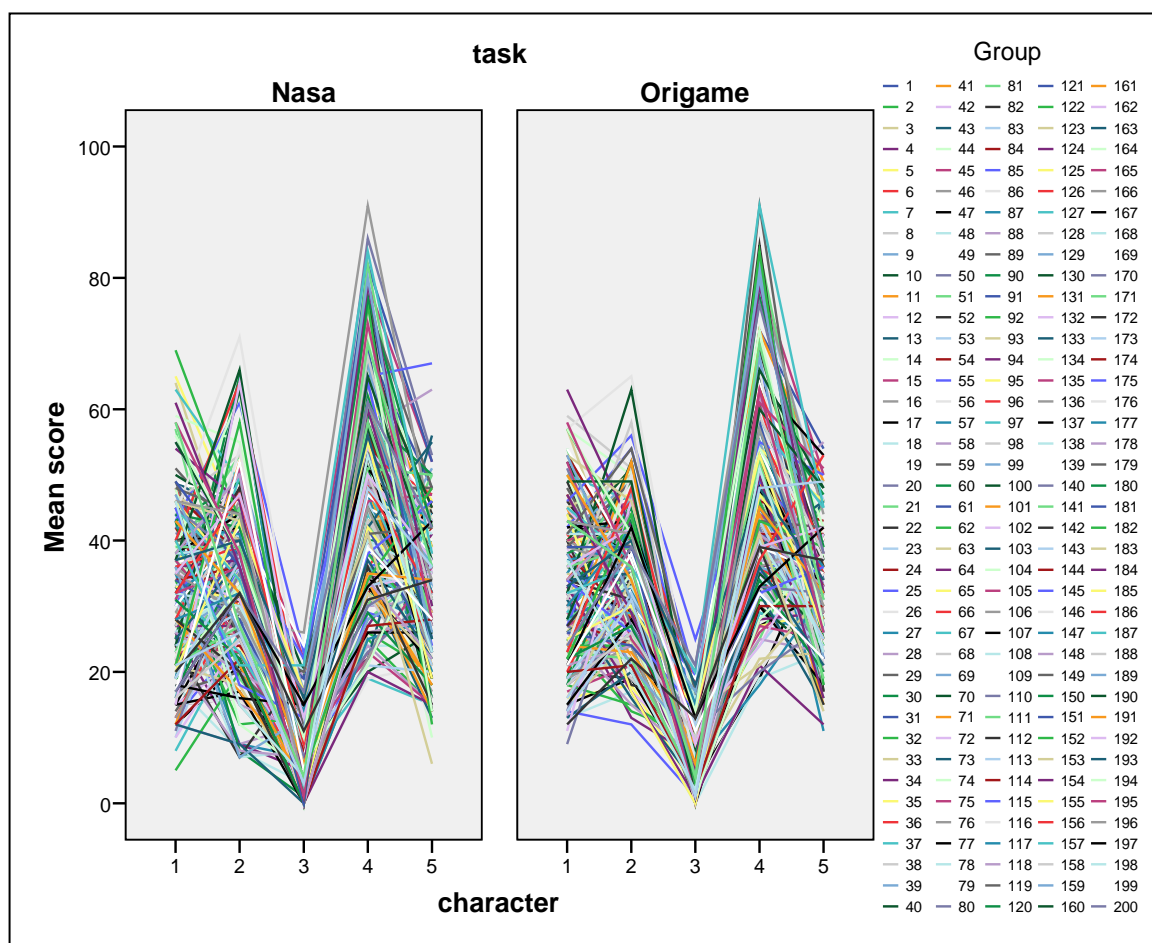
The clustering method adopted is one of the most critical steps in the clustering process because not all methods are effective in representing the true structure of the data (Milligan, 1996). The clustering method chosen for this study was the k-means iterative partitioning approach using SPSS 'Quick Cluster'. This method was chosen because it is seen as the most appropriate approach for dealing with large data sets such as mine (i.e. 203 teams) (Norusis, 1993b). A k-means algorithm is used to assign a case to a cluster with the smallest distance between the case and the cluster centre. The cluster centre is the estimate of the average value of each clustering variable for the cases in a cluster (Aldenderfer & Blashfield, 1984). For this clustering method, the researcher either specifies the cluster centres, or nominates the number of clusters for the solution to generate (Norusis, 1993b).

Prior to using the k-means clustering method, a hierarchical agglomerative clustering approach should be employed to derive an estimate of the number of clusters (Hair et al., 1998). The results of this approach are typically presented in a dendrogram, illustrating in a two-dimensional diagram the cluster fusions and partitions (Everitt, 1993). Interpretation of the number of clusters is often challenging using this approach, necessitating the researcher to balance the desire for detail of many clusters with the desire for the simplicity of a few clusters (Aldenderfer & Blashfield, 1984). Examining the dendrogram for large changes in cluster fusions can assist in identifying cluster numbers, as can inspecting large changes in the value of the fusion coefficients (Aldenderfer & Blashfield, 1984). Because of the large data set used in this analysis, interpretation of the dendrogram was extremely difficult. Neither inspection of the dendrogram or changes in cluster fusion values indicated a clearly better solution in terms of the number of clusters. Previous literature on team communication clusters is scant (Wheelan & Williams, 2003). However, Wheelan and William's (2003) study, which identified three communication patterns within his sample of teams, at least provided some guidance for the number of possible communication profiles to examine. As such, 3, 4, and 5 cluster solutions were selected and tested in the k-means cluster analysis.

## **Results**

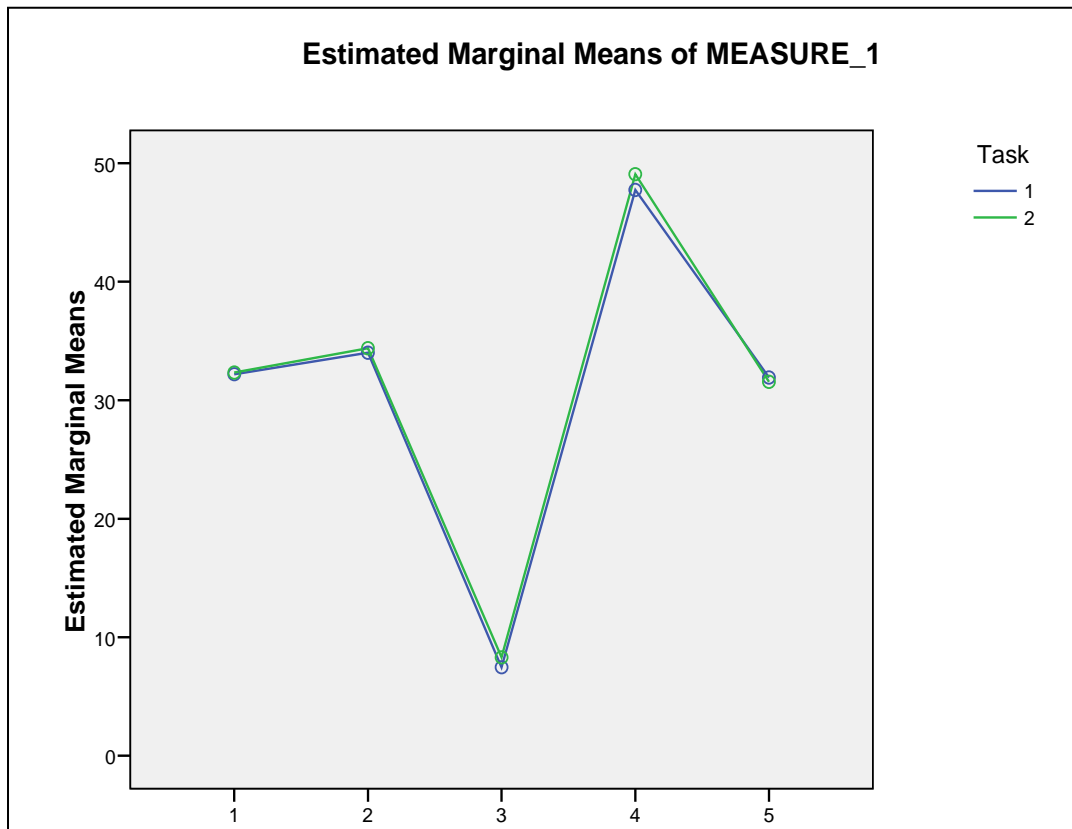
### ***Multilevel Modeling***

Prior to testing the Model as described in the Method section above, the data was investigated by creating line graphs of the average amount of requisite function activity across both team tasks. Consistency in requisite function activity across task types is evident in Figures 6-1 and 6-2. Figure 6-1 further highlights variation in the amount of requisite function activity within tasks and across teams which is consistent with the direction of Hypothesis 1.



**Figure 6-1: Line graphs of average requisite function activity across NASA and Origami tasks**

Note: 1 = Orientation; 2 = Problem Definition; 3 = Criteria Development; 4 = Solution Development; 5 = Solution Evaluation



**Figure 6-2: Plot of the estimated marginal means of requisite function activity across NASA and Origami tasks**

The plots do make apparent the strong similarity across tasks that teams exhibit in their requisite function scores. To further illustrate this similarity, several plots are provided for the teams that exhibited the greatest difference in the use of requisite functions across the two tasks, and for the teams that were most similar (Figures 6-3 and 6-4 below). The index of dissimilarity used was the sum of the absolute values of the difference between each requisite function score across the two tasks for each team. The plots show the scores on each requisite function for the three teams which exhibited the most difference between their requisite function scores on the two tasks, and the three teams which exhibited the least difference between their requisite function scores on the two tasks.



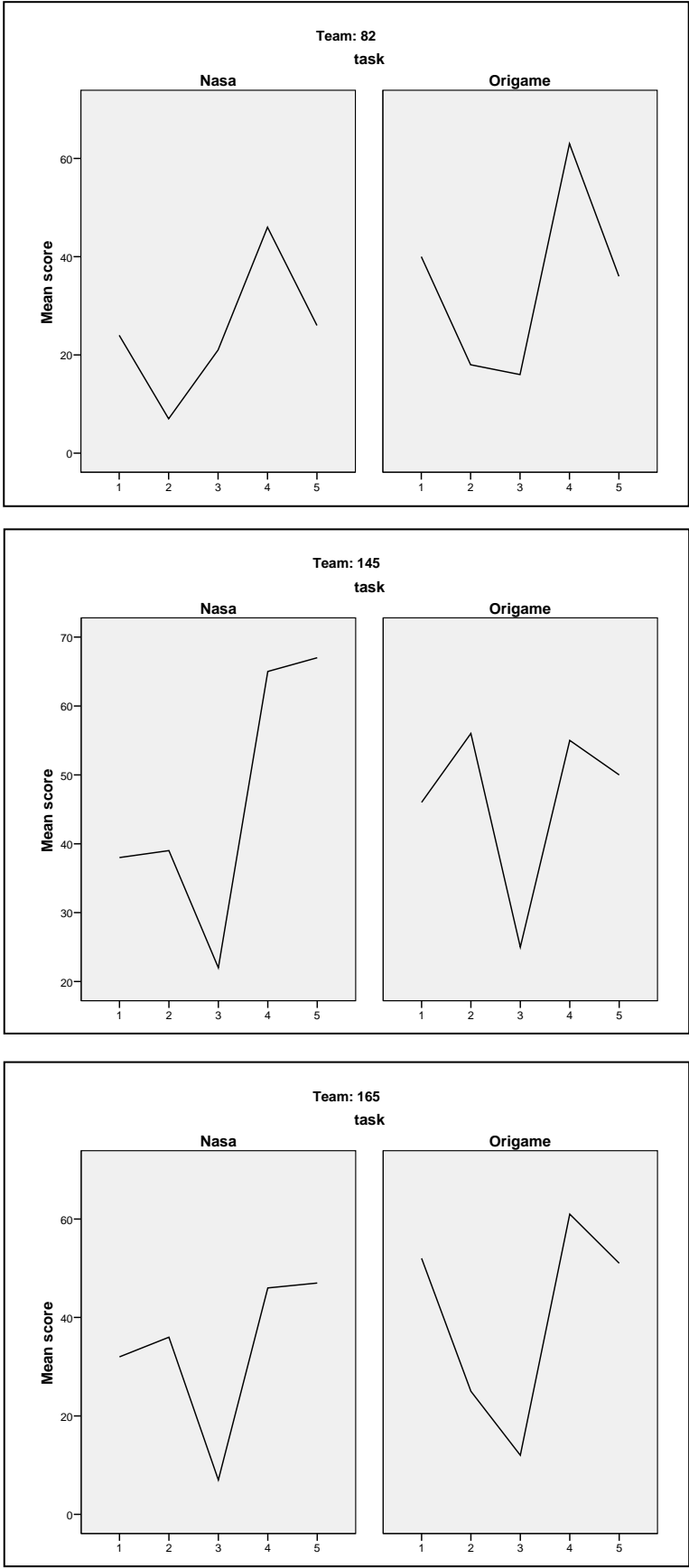
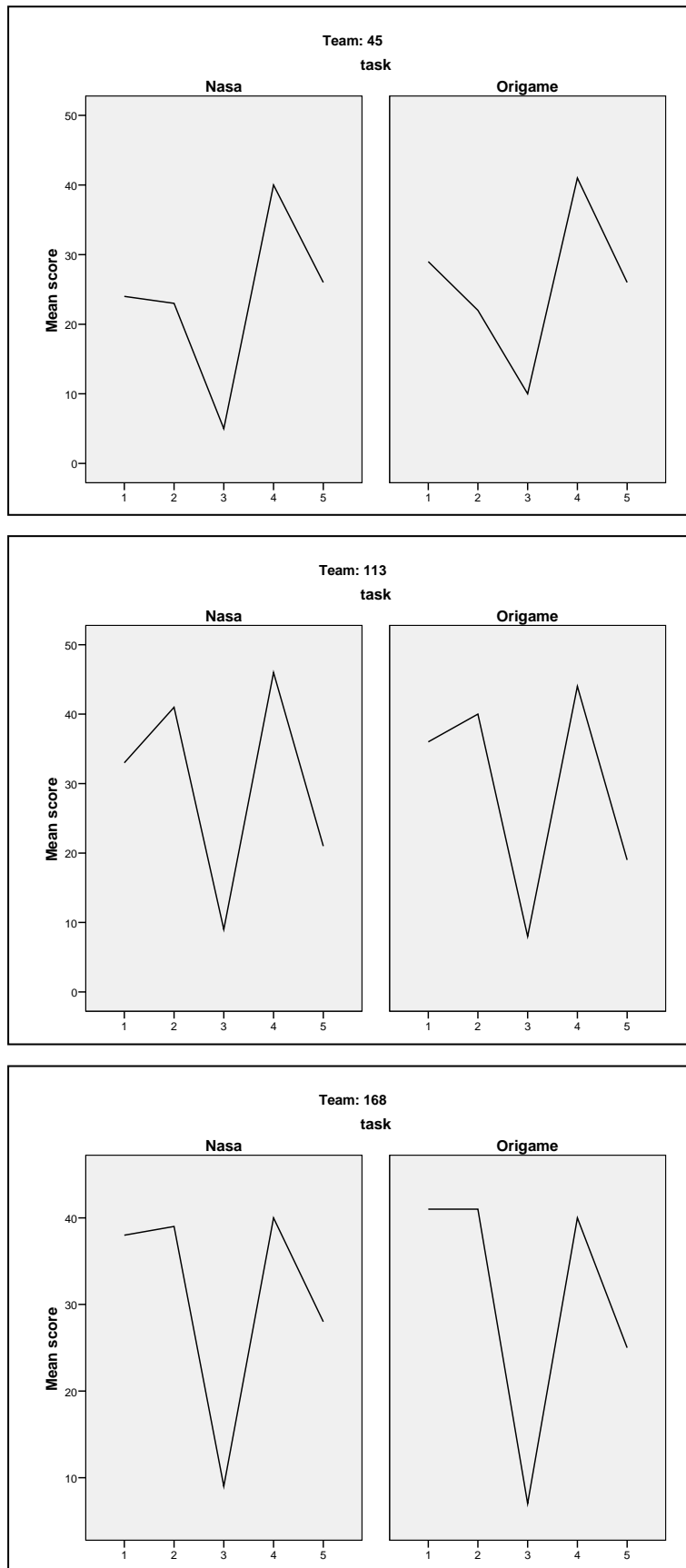


Figure 6-3: Line graphs of average requisite function activity across NASA and Origami tasks for three most dissimilar teams



**Figure 6-4: Line graphs of average requisite function activity across NASA and Origami tasks for three most similar teams**

As can be seen from the plots, the similarity in the profiles between the requisite function scores across the two tasks, even for the three most dissimilar teams, are still remarkably similar in shape. These plots further illustrate support for the hypothesis that established teams have stable communication profiles across different tasks.

The relative contribution of team, task and requisite function was examined with a mixed model framework. A baseline or intercept-only model was estimated with three random intercept effects, one each for team, task and requisite function. The results showed that there was considerable variance accounted for by requisite functions (67%), but nearly no variance was attributable to task (0.01%). There was also a significant but smaller amount of variance due to between-team variability (24%) and considerable residual or unexplained within-team variability (76%). This result confirms the graphs presented above and further supports Hypothesis 1; that there is greater team-level variance in team communication activity than task-level variance. Teams do differ from each other in their use of requisite functions, but they exhibit substantial similarity in the amount of use of different requisite functions.

The results of the Model testing are outlined in Table 6-1.

**Table 6-1: Summary of Multilevel Model Testing of Communication Data**

Baseline Model	REML <sup>a</sup> Variance Estimates	Wald Z	Significance	Variance
Residual	103.6849	30.183	.000	-
Team Variance (between)	32.966558	7.621	.000	24% <sup>b</sup>
Task Variance	.006430	.042	.967	0.01%
Requisite Function Variance	212.2004	1.413	.158	67%

<sup>a</sup> REML: Restricted maximum likelihood estimation.

<sup>b</sup>ICC: Intra class correlation represents the proportion of between-team variance in communication activity. 1- ICC represents the proportion of within-team variance in communication activity.

### ***Repeated Measures ANOVA***

Results of the multivariate repeated measures ANOVA indicated that there was a significant albeit very weak main effect for task,  $F(1, 202) = .976$ ,  $p < .001$  ( $\eta^2 = .03$ ), and a very strong effect for requisite function,  $F(4, 199) = .078$ ,  $p < .001$  ( $\eta^2 = .92$ ). The task x requisite function

interaction was not significant  $F(4, 199) = .968, p = ns$ , indicating that the profile of teams' requisite function use did not differ across the two tasks. These results are consistent with the initial line graphs which showed a virtually identical pattern of requisite function activity across tasks, but variation in the amount of communication activity for each requisite function within tasks.

Post-hoc comparisons using the bonferroni adjustment for multiple comparisons were performed. The very weak main effect for task indicates that during the Origami task, teams made on average a slightly larger number of requisite function utterances (see Table 6-2).

**Table 6-2: Mean and Standard Deviations for Requisite Function Scores Across Tasks**

Requisite Function	NASA Mean (SD)	ORIGAMI Mean (SD)	Significantly Different
Orientation	32.19 (12.98)	32.33 (11.67)	$p > .05$
Problem Definition	34.01 (12.97)	34.39 (10.54)	$p > .05$
Criteria Development	7.47 (6.02)	8.31 (5.53)	$p < .001^{***}$
Solution Development	47.75 (16.11)	49.08 (15.83)	$p < .05^*$
Solution Evaluation	31.92 (10.89)	31.56 (9.38)	$p > .05$

\*  $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$ .

Further post-hoc comparisons show that the only requisite functions significantly different from one another across tasks are Criteria Development and Solution Development. Collectively, the results of the multi-level modeling and repeated measures ANOVA provide strong support for Hypothesis 1; that there is greater team-level variance in team communication activity than task-level variance in team communication activity.

### ***Cluster Analysis***

In order to determine whether our sample of teams had meaningful communication profiles, three k-means cluster analyses were explored. NASA Task data and Origami Task data were examined in the same analysis. Three-, four and five-cluster solutions were specified and each was considered as a potential solution. Following a consideration of the characteristics and grouping patterns among the proposed solutions, it

was decided that the 5-cluster solution was the best choice for the identification of meaningful differences between clusters due to the distinctiveness of each profile. Table 6-3 provides an overview of the means and standard deviations of the requisite function scores across the five clusters for both team tasks.

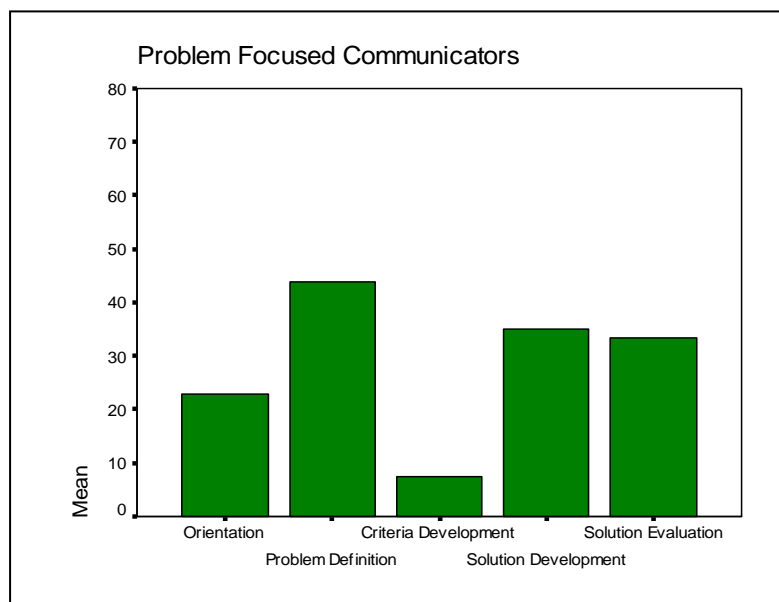
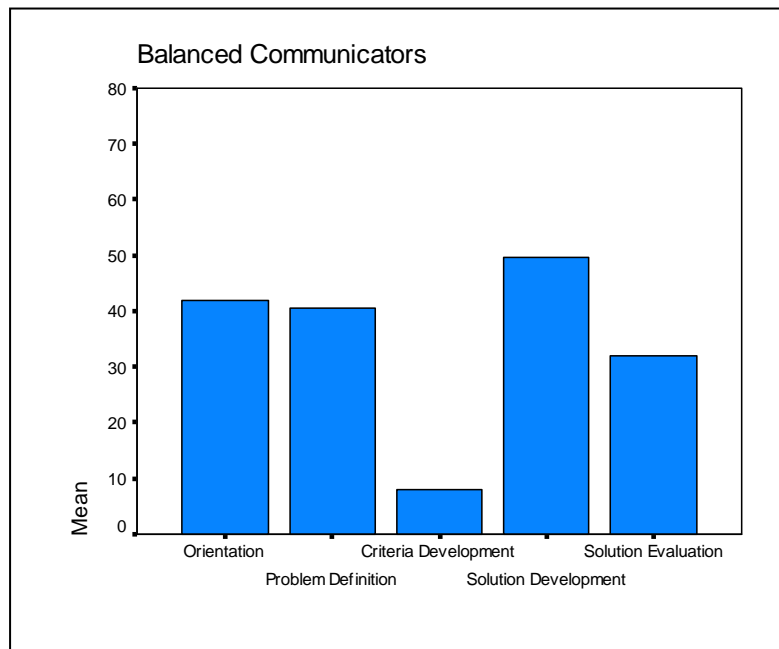
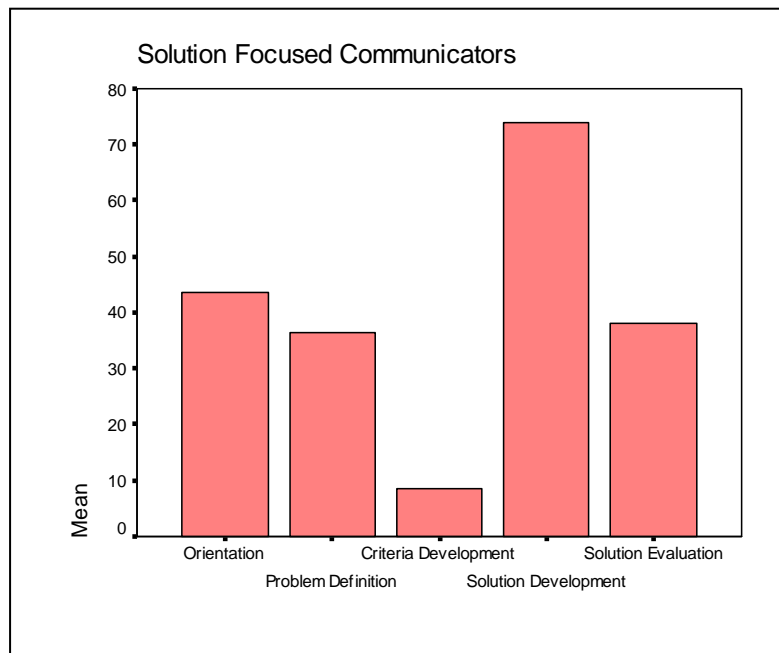
**Table 6-3: Cluster Means and Standard Deviations of Requisite Functions across Task Type for Five Clusters**

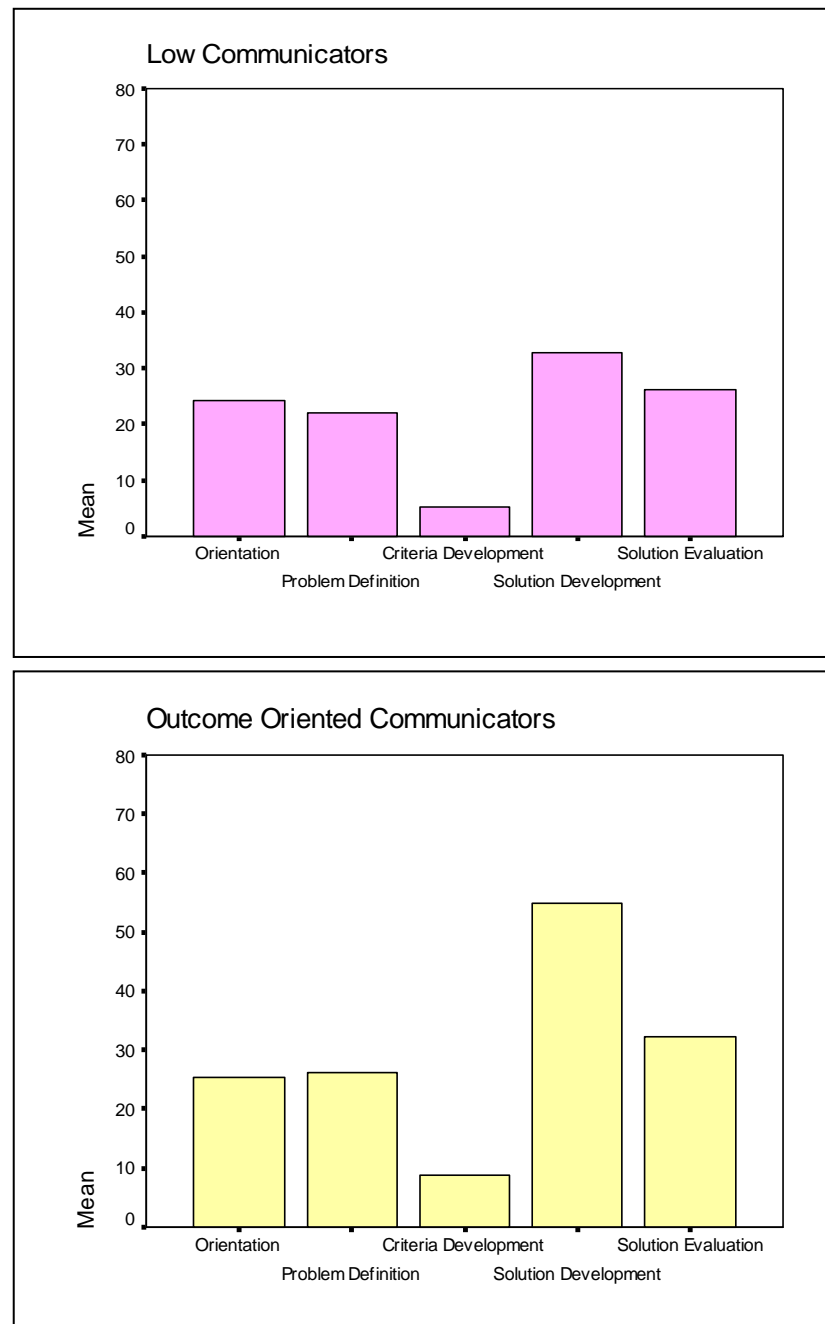
Measures	Cluster				
	Solution Focused Communicators n = 29	Balanced Communicators n = 60	Problem Focused Communicators n = 35	Low Communicators n = 45	Outcome Oriented Communicators n = 34
Orientation (N)	43.45 (11.9)	41.95 (8.7)	23.00 (8.5)	24.18 (8.8)	25.44 (9.4)
Orientation (O)	43.03 (8.72)	41.55 (9.0)	24.60 (7.3)	23.13 (6.7)	27.09 (6.8)
Problem Definition (N)	36.48 (11.4)	40.68 (10.2)	43.77 (10.1)	21.93 (7.8)	26.09 (9.9)
Problem Definition (O)	38.10 (9.9)	40.47 (8.9)	39.77 (6.7)	23.22 (5.9)	29.76 (7.6)
Criteria Development (N)	8.55 (7.7)	7.90 (5.9)	7.37 (5.4)	5.18 (4.3)	8.91 (6.5)
Criteria Development (O)	8.93 (6.8)	9.13 (5.4)	8.40 (4.9)	6.07 (4.3)	9.18 (6.1)
Solution Development (N)	73.93 (7.0)	49.55 (9.9)	35.06 (7.4)	32.91 (9.1)	54.94 (8.4)
Solution Development (O)	73.14 (10.4)	51.57 (8.6)	37.06 (9.4)	34.09 (8.1)	56.38 (9.8)
Solution Evaluation (N)	37.93 (12.6)	32.02 (9.7)	33.51 (9.6)	26.29 (10.3)	32.41 (10.6)
Solution Evaluation (O)	37.31 (9.8)	31.57 (9.8)	31.57 (8.5)	27.40 (7.5)	32.12 (9.0)
<b>Total Utterances NASA Task</b>	200.34	172.10	142.71	110.49	147.79
<b>Total Utterances Origami Task</b>	200.51	174.29	141.40	113.91	154.53

Note: Higher means indicate greater amounts of communication activity specific to that requisite function; standard deviations are in parentheses. (N) = Nasa Task; (O) = Origami Task

### *Communication Profiles*

The five communication profiles identified from the cluster analysis are represented graphically in Figure 6-5. Given the almost identical profiles across the decision making and production task, profiles have been combined for ease of presentation.





**Figure 6-5: Average requisite function activity across a decision making and production task for Clusters 1-5**

The communication profile for teams in the first cluster represented 14% of the teams in the sample. Teams in this cluster tended to display relatively high levels of communication activity compared to teams in other clusters. The highest amount of communication activity falls within the Solution Development category, then the Orientation category, followed by roughly equal amounts of Problem Definition and Solution

Evaluation communication. Teams with this profile can be characterized as having high communication frequency overall, but devoting most of their time to the solution phase of the communication process. That is, these teams spent most of their time communicating concrete, specific proposals for action that will solve the problem or shape how the task is completed. In contrast to the other profiles, teams in Cluster One also engaged in relatively more Orientation communication. Teams with this profile therefore appear to be more active at the beginning and final stages of the communication process.

Cluster 2, representing 30% of teams, tended to engaged in more Solution Development communication, followed by Orientation and Problem Definition communication like teams in Cluster 1. However, the amount of communication across some requisite functions was quite different to Cluster 1. For example, teams in Cluster 2, on average, only communicated about 50 Solution Development utterances compared to 73 utterances for teams in Cluster 1. Virtually similar amounts of Orientation and Problem Definition communication were engaged in for teams in Cluster 2, with slightly less Solution Evaluation communication. The profile for this Cluster seems to represent a more balanced approach to communication activity, with teams communicating about the management of the team, how to define and tackle the task, and proposing methods for solving the problem or completing the task. Teams were therefore relatively active across each phase of the communication process.

Cluster 3 represents the communication profiles of 17% of teams. In contrast to both Clusters 1 and 2, teams in this cluster tended to engage in a high level of Problem Definition communication. However, otherwise, this cluster of teams tended to display a relatively low level of communication activity. Solution Development and Solution Evaluation were the next two most commonly occurring requisite functions, yet the average number of utterances for Solution Development communication in this cluster is substantially lower than the average number of



utterances for this requisite function in Clusters 1 and 2. This is similarly the case for Orientation. Teams in Cluster 3 engaged in, on average, about 23 Orientation utterances compared to about 42 utterances in Clusters 1 and 2. Teams with this profile were therefore more active at the beginning stages of the communication process, spending most of their time defining the nature of the team's task or problem and the task's causes, effects and symptoms.

Twenty-two percent of teams fell within the communication profile represented by Cluster 4. This cluster is characterized by a slightly more even distribution of communication activity across requisite functions. Teams in this cluster spent the least amount of time engaged in Criteria Development — with the lowest average of utterance ratings across all clusters for this requisite function. Teams in this cluster also engaged in the least amount of communication activity overall, with nearly half the amount of communication activity compared to teams in Cluster 1. The communication profile represented by Cluster Four is very similar to Cluster One; however the key difference is the amount of communication teams represented by this profile engaged in. The amount of Problem Definition and Solution Development communication in Cluster Four is lower than the corresponding requisite functions in Clusters One, Two and Three. Similarly, the amount of Orientation communication is lower than this requisite function in Clusters One and Two. Although the amount of communication across requisite functions in this profile was quite small; these teams were reasonably active across most phases of the communication process.

Cluster 5 represented 17% of the teams in the sample. The communication profile of this cluster is very similar to Cluster 2 in terms of the average amount communication activity across Criteria Development, Solution Development and Solution Evaluation. However, dissimilar to Cluster 2, teams in Cluster 5 engaged in less Orientation and Problem Definition communication. The profile for Cluster Five is similar to Cluster One in terms of the relatively larger amount of

Solution Development communication teams engaged in. Teams in this profile could be described as very solution-focused or outcome oriented. Teams in this profile spent very little time communicating about how the team would be managed or how they would go about solving the problem; they focused mainly on discussing solutions to the problem or task. Similar to the communication profile in Cluster One, teams in Cluster Five were far more active at the end stages of the communication process.

### ***Differences between Communication Profiles***

A one-way between-groups analysis of variance (ANOVA) was conducted to explore whether the observed differences in requisite functions for the clusters were significant. This analysis was carried out separately for each task. There was a statistically significant difference at the  $p < .05$  level in average requisite function scores for all five communication profiles for the decision making and production tasks. These significant differences are summarised in Table 6-4.

**Table 6-4: Statistical Significance Levels of Between-Groups ANOVA Exploring Cluster Differences**

Requisite Function	Significance Level	
NASA Task		
Orientation	F(4, 198) = 50.48	$p < .001^{***}$
Problem Definition	F(4, 198) = 38.45	$p < .001^{***}$
Criteria Development	F(4, 198) = 2.53	$p < .05^*$
Solution Development	F(4, 198) = 134.35	$p < .001^{***}$
Solution Evaluation	F(4, 198) = 5.13	$p < .001^{***}$
ORIGAMI Task		
Orientation	F(4, 198) = 58.39	$p < .001^{***}$
Problem Definition	F(4, 198) = 40.59	$p < .001^{***}$
Criteria Development	F(4, 198) = 2.71	$p < .05^*$
Solution Development	F(4, 198) = 110.61	$p < .001^{***}$
Solution Evaluation	F(4, 198) = 4.77	$p < .001^{***}$

\*  $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$ .

Post-hoc comparisons using the Dunnett T3 test are shown in Table 6-5 and highlight which requisite functions in each cluster are significantly different to requisite functions in other clusters. It can be seen that the results of the analysis were substantively the same for the

decision making and production task, indicating that cluster profiles on the requisite function differences do not vary across tasks.

**Table 6-5: Post-Hoc Comparisons of Differences between Communication Profiles**

	Cluster 1		Cluster 2		Cluster 3		Cluster 4		Cluster 5	
Requisite Function	M	SD	M	SD	M	SD	MD	SD	M	SD
<b>NASA Task</b>										
Orientation	42.47 <sup>cde</sup>	11.1	41.80 <sup>cde</sup>	8.9	22.40 <sup>ab</sup>	7.7	24.20 <sup>ab</sup>	8.9	24.37 <sup>ab</sup>	9.1
Problem Definition	39.66 <sup>de</sup>	12.8	38.84 <sup>de</sup>	8.8	43.51 <sup>de</sup>	10.2	21.68 <sup>abc</sup>	7.7	24.87 <sup>abc</sup>	9.5
Criteria Development	8.79	7.9	8.14 <sup>d</sup>	5.6	7.26	5.3	5.11 <sup>b</sup>	4.3	8.23	6.2
Solution Development	71.32 <sup>bcde</sup>	8.1	47.02 <sup>acd</sup>	8.9	35.51 <sup>abe</sup>	7.5	32.64 <sup>abe</sup>	9.0	55.70 <sup>acd</sup>	8.1
Solution Evaluation	36.79 <sup>d</sup>	12.2	31.91	9.4	33.43 <sup>d</sup>	9.7	26.55 <sup>ac</sup>	10.2	31.87	10.9
<b>ORIGAMI Task</b>										
Orientation	41.53 <sup>cde</sup>	9.4	41.46 <sup>cde</sup>	8.8	24.17 <sup>ab</sup>	6.9	23.14 <sup>ab</sup>	6.8	26.67 <sup>ab</sup>	6.9
Problem Definition	39.74 <sup>de</sup>	10.4	39.41 <sup>de</sup>	8.4	39.60 <sup>de</sup>	6.7	22.91 <sup>abce</sup>	5.6	29.03 <sup>abcd</sup>	7.3
Criteria Development	9.24	6.8	9.43 <sup>d</sup>	5.1	8.23	4.9	6.09 <sup>b</sup>	4.3	8.37	5.9
Solution Development	71.05 <sup>bcde</sup>	9.9	49.57 <sup>acd</sup>	7.5	37.34 <sup>abe</sup>	9.4	33.86 <sup>abe</sup>	8.0	56.33 <sup>acd</sup>	10.1
Solution Evaluation	36.21 <sup>d</sup>	10.4	31.18	9.3	31.63	8.4	27.52 <sup>a</sup>	7.5	32.20	9.3

- <sup>a</sup>. Significantly different than Cluster 1.  
<sup>b</sup>. Significantly different than Cluster 2.  
<sup>c</sup>. Significantly different than Cluster 3.  
<sup>d</sup>. Significantly different than Cluster 4.  
<sup>e</sup>. Significantly different than Cluster 5.

### ***Relationship between Communication Profiles and Performance***

As a test of Hypothesis 2b, a one-way between-groups ANOVA was conducted to explore whether cluster membership was related to task performance. The task performance measures used were the NASA deviation score for the NASA task and the total number of origami produced for the Origami task. In the analysis based on the cluster profiles for the Origami task, cluster membership was found to have a significant effect on performance ( $F(4, 198) = 12.98, p < .001$ ). However, in the NASA task analysis there was no relationship between cluster membership and team performance ( $F(4, 198) = 1.42, p > .05$ ).

Post-hoc comparisons using the Dunnett T3 test indicated that teams in Cluster 1 ( $M = 19.23, SD = 6.78$ ) performed significantly better

than teams in Cluster 3 ( $M = 13.76$ ,  $SD = 5.44$ ), Cluster 4 ( $M = 10.81$ ,  $SD = 5.28$ ) and Cluster 5 ( $M = 12.39$ ,  $SD = 6.67$ ). These post-hoc comparisons also indicated that teams in Cluster 2 ( $M = 17.73$ ,  $SD = 7.28$ ) performed significantly better than teams in Clusters 3, 4 and 5. The results of this analysis provide partial support for Hypothesis H2b; that two of the communication profiles of established teams were related to their level of task performance on the Origami task.

## **Discussion of Research Findings**

The purpose of this study was twofold. First, this study sought to follow up on the observed stability in communication activity (identified in Study One) by exploring the relative importance of task versus team factors in explaining the variance in this communication activity. Second, this study investigated whether reliable team communication profiles could be identified for established teams and if so, whether they were related to team performance. Consistent with the notion of teams having a stable communication profile, the analyses revealed that there was significant team-level variance in requisite functions and virtually no task-level variance. Furthermore, teams could be clustered according to their profile on the requisite functions, and these clusters differed in their performance on the production task.

### ***Task and Team Factors in Explaining Team Communication Variance***

Based on the findings in Study One, and the review of the literature relating to team processes in established teams, it was expected that team factors would explain a greater amount of variance in team communication activity than task factors. These expectations were confirmed through multi-level modeling. Specifically, it was found that task factors did not make a significant contribution to the variance explained, but that 24% of the variance in communication measures could be explained by team factors. Put another way, there was considerable team-level variation in the frequency with which different requisite functions occurred. Although the study did not provide an opportunity to

investigate the source of this team-level variance, it seems highly likely that team habitual routines are at work here. The pervasive nature of team habitual routines (Gersick & Hackman 1990) and the fact that the teams in this research had worked together, at minimum, for more than one year provides some indication that these teams were likely utilizing routine processes or ways of dealing with information and making decisions (Argyris, 1969; Gersick, 1988; Janis, 1982; McClelland, 1984). Team habitual routines also help teams to minimize uncertainty associated with a task and help team members feel more confident with their role in the team (Gersick & Hackman 1990). While the team building tasks used in this research were designed to be fun, they were also implemented to improve overall team functioning within the organization and therefore had a serious element to them. Team members may have relied on their habitual routines to reduce any anxiety or uncertainty experienced as a result of engaging in this process. A valuable step for future research would be to investigate the extent to which team-level variance in communication can be explained by team habitual routines, across a range of familiar and unfamiliar team tasks.

The findings from this study also inform the functional perspective and the requisite functions framework. The multi-level analysis revealed that requisite functions explained 67% of the total variance in communication activity. This represents a unique analytic approach to examining the requisite function framework and provides additional support for the utility of this approach to understanding team communication activity. It was found that certain requisite functions (e.g. Orientation, Problem Definition, Solution Development) were engaged in more than other requisite functions and the levels of communication activity for these requisite functions differed significantly to others (e.g. Criteria Development, Solution Evaluation). These findings are somewhat inconsistent with those of Hirokawa (1988) who found that Problem Definition and Criteria Development explained the most amount of variance in team decision making performance. Criteria Development and Problem Definition were also identified as accounting for the greatest

amount of variance in decision performance in both field studies of the functional perspective (Graham et al., 1997; Propp & Nelson, 1996). The reasons for these unexpected findings can be attributed to the fact that this study focused on established teams and testing the requisite function framework across different types of tasks. Another possible explanation for the inconsistency in findings, particularly as it relates to Criteria Development communication, is the nature of the tasks teams in this research were undertaking. Compared to findings from other studies employing the requisite function approach (Graham et al., 1997; Hirokawa, 1988; Propp & Nelson, 1996), the teams in this study showed comparatively low levels of Criteria Development communication. Teams in this research however, were given fairly explicit instructions regarding the nature and requirements of each task. These instructions may have minimized the need to engage in significant amounts of communication relating to the standards or criteria required for task completion. So while this research has not found Criteria Development communication to be important for performance as previous research has, this finding may reflect the way in which the tasks were set up for this research. Despite the lack of consistency in findings associated with the requisite function framework, the fact that the framework explains significant variance in communication activity across tasks indicates that it is a meaningful way of describing team communication.

One consistent finding from research employing the requisite function framework is that Problem Definition is an important type of communication activity for teams, be that ad-hoc or established teams. That is, the extent to which teams engage in communication that identifies and defines the nature of the team's task and its' causes, effects and symptoms is important for team performance. This study confirmed that finding in that the communication profiles that were positive related to team performance tended to have relatively high levels of Problem Definition communication.

The finding that task type did not have an effect on the pattern of communication activity is not congruent with propositions in the literature about task characteristics changing the information needs of the team and therefore the approach the team has to adopt in meeting those information needs (Kabanoff & O'Brien, 1979; Katz & Tushman, 1979). In contrast, this study suggests that teams applied a characteristic or habitual way of communicating for each task, regardless of its different requirements. Not only can team habits and routines be an explanation for these findings, but it is also possible that the study context influenced the communication approach adopted by teams. That is, given the unfamiliarity of the team tasks (compared to the normal work tasks for these teams), teams may have been relying more on their habits and routines to reduce anxiety or uncertainty associated with the tasks. Therefore, while we have not seen evidence of task type influencing communication for teams in this research, this is not to suggest that the nature of the task does not influence team communication. However, the current research is important for highlighting the consistency in team communication.

### ***Team Communication Profiles and their Relationship with Team Performance***

Following on from the multi-level analysis, this study sought to determine whether a subset of communication profiles could be identified amongst the teams in this sample, and if so, whether these communication profiles were related to their level of task performance. Consistent with hypothesis 2a, five discernable communication clusters were identified for the teams in this research which differed significantly in their profiles on the requisite function measures.

One basic differentiating factor associated with the communication profiles was the total amount of communication activity teams engaged in. For example, teams in Cluster 1 engaged in almost double the amount of communication activity of teams Cluster 4 across tasks, while in contrast, teams in Clusters 3 and 5 were very similar in total

communication activity. Comparatively, there was relatively little variability in the proportion of communication activity associated with each requisite function. This finding is consistent with Stempfle and Badke-Schaub's research (2002), where the total number of communicative acts across his three teams ranged from 810–2877. However, despite this variation, the distribution of this communication activity as a proportion of content and process communication activity showed remarkable similarity across teams. For each team, approximately two thirds of communication activity represented content-related communication and the remaining third represented process-related communication.

Another notable finding was the form of the communication profiles found in each of the five clusters. Given the dearth of research that has explored communication profiles with established teams, it is difficult to know how representative the profiles in each of the clusters are. Wheelan and Williams's (2003) research applied visual mapping software, which used colour and wavelet images to represent communication activity. There is no real basis for comparison with her research given that she didn't use the requisite function framework. Stempfle and Badke-Schaub's (2002) research however allows some level of comparison to be made. Teams in Stempfle and Badke-Schaub's (2002) research engaged in content analysis communication nearly 50% of the time. This communication category reflected questions and answers about the solution. This category cannot be compared directly to any one category in the requisite function framework but probably best represents Solution Development and Solution Evaluation communication. In my research, these requisite functions accounted for approximately 50% of team communication activity. The next most often engaged in communication activity for Stempfle and Badke-Schaub's (2002) teams was process analysis (approximately 17% of the time). This communication category is likely to be most similar to Orientation communication, which in this research represented approximately 20% of team communication activity. Thus, the communication profiles from this research are reasonably



consistent with the overall profile of communication reported by Stempfle and Badke-Schaub (2002). This consistency suggests that, despite the unusual context for the teams in this study, the findings obtained are representative of team communication activity in general.

A significant contribution of this research was examining the relationship between communication profiles and team performance. Significant differences in performance scores for communication profiles were found for the production task, but not the decision making task. The profiles with the higher performance scores were characterized by a high level of communication activity overall and also relatively high levels of Solution Development, Orientation and Problem Definition communication. The fact that teams with high levels of Solution Development, Orientation and Problem Definition communication achieved higher levels of performance suggests that these requisite functions may be important for performance a production task. However, this shouldn't preclude the value of those requisite functions that were represented by less communication activity. The findings from this research suggest that high activity for some requisite functions, combined with a moderate level of activity on other requisite functions, represents an effective communication profile.

This study is the first of its kind for several reasons. First, team communication research has tended to focus on teams performing a decision-making task. By examining team communication across two different tasks, this research suggests that team factors play a greater role than task factors in determining the focus of team communication. Second, by focusing on established teams, this research has been able to identify the fact that teams can be characterized by their communication profile on the requisite functions. Finally, these findings suggest that these communication profiles have implications for team performance on a production task.

### ***Limitations and Directions for Further Research***

The limitations of this study should also be acknowledged. First, the questions explored in this study were not conceptualized in the initial development of this thesis. Rather, the need to systematically explore these questions became evident based on the results from Study One. While the study data has lent itself reasonably well to the multi-level analysis, repeated measures analysis of variance and cluster analysis, the study design might have been improved if the research questions for Study Two had been developed a-priori. For example, multi-level analysis is a useful statistical technique for exploring communication processes occurring over time and as such, this research could have explored team communication over a period of time as opposed to only one point in time when the team building tasks were being undertaken.

Second, while this research has identified five different profiles of communication activity and demonstrated that these profiles are reliably associated with performance on a production task, there exists considerable opportunity to further explore these findings in a wider range of tasks and contexts. Such research would help to establish how strong (i.e. stable) the team communication profiles found are. In particular, it would be desirable to carry out similar research with teams in their normal work context. It could be argued that the consistency of communication profiles observed in this study reflects the fact that the teams were in a training setting, working on novel tasks. Teams may be more likely to rely on habitual norms in a more novel context than in their normal work settings. This possibility could be examined through further research.

Third, it would have been desirable to examine the reliability of the cluster solution by re-running the analysis on a split sample of participants. Although the sample size for this study was relatively large, it was necessary to include the entire sample in the analysis because cluster membership is based on teams. Therefore, the reliability and external validity of the cluster solution needs further assessment.

Further research adopting the requisite function framework with similar and different team populations is therefore important.

In spite of the above-identified limitations, the sample size of this study compares very favourably with those of published studies in the area (Graham, Papa, & McPherson, 1997; Hirokawa, 1980, 1982, 1983, 1985, 1987, 1988, 1990; Hirokawa & Pace, 1983; Hirokawa & Poole, 1996; Propp & Nelson, 1996; Salazar, 1995, 1996, 1997; Salazar et al., 1994). A large sample size is important for multi-level modeling, repeated measures analysis of variance and cluster analysis as it gives greater confidence in the validity of the results obtained. Furthermore, the sample was unusual in that it represented established teams. This fact makes the study more representative of teams in real life work settings and thus enhances the external validity and general applicability of the findings.

## **Overall Summary**

This study has extended the literature on team communication by highlighting the existence of team communication profiles and their relevance for team performance. Currently, task effects are given more weight in the literature than are team communication profiles, whereas my findings suggest that team communication profiles are a more important driver of communication in established teams than are task requirements. This study revealed that established teams could be described in terms of five distinct communication profiles. These profiles reflect the team's tendency to emphasize certain requisite functions relative to others. Although there was consistency across the sample in the proportion of communication activity dedicated to the different requisite functions, teams could be meaningfully described in terms of how they varied from this overall pattern. Key differences across profiles were the total amount of communication activity engaged in and the proportion of communication activity engaged in for specific requisite functions. Of considerable interest was the fact that these communication profiles remained virtually the same across a decision making and

production task. Despite these almost identical communication profiles across tasks, this study revealed that profile membership was only related to performance for the production task, not for the decision making task. Chapter 7 discusses the findings of Studies One and Two in further detail and draws final conclusions from the research program.

# CHAPTER 7: DISCUSSION AND CONCLUSION

## Introduction

This program of research sought to better understand team communication and its relationship with team performance. The first approach that was taken in the research was to explore potential moderators of the team communication — performance relationship. Study One tested task complexity and team member diversity as moderators of the relationship between communication activity and performance across a decision making and production task. Unexpected findings led to a new approach in Study Two, which explored (a) the extent to which task and team factors explained variance in team communication measures and (b), identified team communication profiles and their relationship with team performance. This Chapter begins by providing an overview of how each research objective was met and then provides a brief summary of the findings from Study One and Study Two. Following this, the theoretical and practical implications of the research are explored. Finally, the limitations of the research and suggestions for future research in this area are noted.

## Overview of Research Questions

In this section, the original research questions are reviewed with the aim of establishing how they have been addressed by the program of research. In terms of research question one - *do task complexity and team member diversity moderate the relationship between team communication and performance?* – this research showed that team member diversity moderated the relationship between communication and team performance. Team member diversity moderated the relationship between Problem Definition, Criteria Development and Solution Development communication and performance for a decision making task, but only moderated the relationship between Solution Development

communication and performance for a production task. The research findings however haven't really resolved the question of whether task complexity moderates the relationship between team communication and performance because the number and direction of these moderation effects were not as this research had originally hypothesized.

Regarding research questions two – *do the effects of these potential moderators generalize across different types of team tasks?* - these results show that the moderation effects of task complexity and team member diversity are different for a decision making and production task, effectively suggesting that there is in fact a more complex interaction involving task type as well as team member diversity and team communication in determining the level of team performance.

In terms of research question three – *what is the relative importance of task versus team factors in explaining the variance in team communication ratings for established teams?* - this research showed that the effect of task did not provide any significant amount of variance in team communication measures, but differences between teams did. These analyses also provided new support for the requisite function approach in that requisite functions were found to account for about two thirds of the variance in communication activity.

Finally, in regards to research questions four and five – *do teams demonstrate consistent team communication profiles? And if so are these team communication profiles related to team performance?* - results from Study Two identified five reliable communication profiles for established teams. These communication profiles were found to explain variance in team performance on the production task, but not for the decision making task.

The findings of this research program provide further support for the functional perspective as a theoretical framework for investigating the communication — team performance relationship and also show that communication is important for team performance, but only under certain conditions. This research has produced a number of findings inconsistent

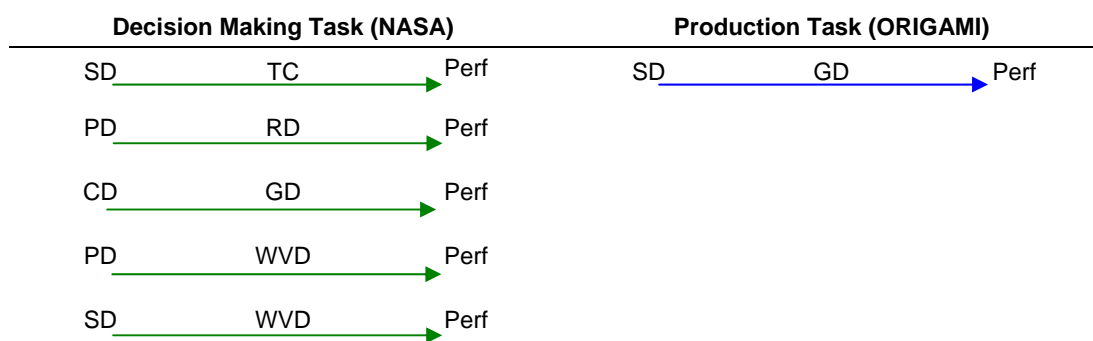
with the previous literature which warrant further investigation. These inconsistencies are more than likely due to my use of established teams, which highlights the value of understanding and incorporating the team development literature into any further research in this field. It also shows the importance of using established teams where research is intended to inform the management of real-world teams.

## **Summary of Research Findings**

Communication is a critical team process factor and within the literature is considered to play an important role in team performance. However, when the empirical evidence is reviewed, the relationship between communication and team performance appears somewhat indeterminate. The inconsistent pattern of findings from the literature was indicative that moderation effects might be at work, so this thesis was initially designed to explore potentially important moderators of the relationship between team communication and performance. Thus, in Study One task complexity (a task characteristic) and team member diversity (a team characteristic) were investigated as moderators of the relationship between communication activity and performance across both a decision making and production task. Using the functional perspective (Gouran, 1983; Gouran & Hirokawa, 1986; Gouran, Hirokawa, McGee, & Miller, 1994) as the underlying theoretical framework, a team communication — performance model was articulated that extended the functional perspective in general and the empirical work of both Hirokawa (1980, 1982, 1983, 1985, 1987, 1988, 1990; Hirokawa & Pace, 1983; Hirokawa & Poole, 1996) and Salazar more specifically (1995, 1996, 1997; Salazar, Hirokawa, Propp, Julian, & Leatham, 1994).

The findings from this first study supported only a small number of the hypothesized moderation effects, not all of which were in the expected direction. Furthermore, the nature of these moderation effects was different across task types. Figure 7-1 provides an overview of the moderators that impacted the relationship between requisite functions

and performance. In summary, task complexity moderated the relationship between Solution Development communication and team performance on the decision making task only. But this result was not in the expected direction. A number of measures of team member diversity were explored as moderators including gender diversity, race diversity and work value diversity. These measures of diversity showed a small number of moderation effects for both task types, but some of these moderation effects were only marginally or close-to-significant (i.e.  $< .10$ ). Interestingly, all of these effects were in the expected direction.



**Figure 7-1: Overview of moderation effects across requisite function and performance relationship**

Note: O = Orientation; PD = Problem Definition; CD = Criteria Development; SD = Solution Development; SE = Solution Evaluation; TC = Task Complexity; GD = Gender Diversity; RD = Race Diversity; WVD = Work Value Diversity; Perf = Performance.

Despite these inconsistent findings, this first study did inform our understanding of the relationship between communication and performance. First, the study suggested that the effect of communication on performance is stronger for a decision making task compared to a production task. This finding seems logical and was therefore expected. Communication was essential for teams to reach a decision for the NASA task. While teams needed to communicate for the production task, the critical feature of this task was making as many origami as possible in the time period available. Communication therefore wasn't the method through which teams were to achieve their outcome; team members using their hands to create origami was. Second, the relationship between Problem Definition and Solution Development communication and performance was consistently found across both tasks. This finding helps,



in part, to validate the functional perspective as Problem Definition has consistently been found to be related to team decision performance in previous research (Graham, Papa & McPherson, 1997; Hirokawa, 1980, 1982, 1983, 1985, 1987, 1988, 1990; Hirokawa & Pace, 1983; Hirokawa & Poole, 1996; Propp & Nelson, 1996). The finding relating to Solution Development however is not consistent with previous research, but given Solution Development communication was found to be important for performance across both task types, then this suggests that the result is not necessarily spurious and it might be an important type of communication activity for established teams in particular. Of all the requisite functions, Solution Development seems likely to be an important type of communication activity for teams (i.e. if a team cannot develop a range of viable solutions from which a decision can be made then the team might have difficulty achieving high performance). A key difference between this research and previous research is the use of established teams and it is for this reason that we may have seen this result.

Another potentially important finding was identified from Study One. That is, there were strong correlations between matching communication measures across the two different tasks. This finding suggested that teams were adopting very similar patterns of communication activity to perform each task. This finding was incongruent with the literature on task types which suggests that the nature of the task a team is performing should impact the type and amount of communication a team engages in (Carter, Haythorn, & Howell, 1950; Carter, Haythorn, Meirowitz, & Lanzetta, 1951; Deutsch, 1951; Hackman & Morris, 1975; McGrath, 1984; Morris, 1966). For this reason and given the use of established teams as apposed to ad-hoc teams in this research program, this finding was explored further in Study Two.

The second study sought to tease out these findings by investigating whether task or team factors explained the greatest amount of variance in team communication measures; whether reliable and discernable

communication profiles could be identified for established teams; and if any of these communication profiles was associated with better team performance. Three analytic approaches were adopted to investigate these research questions. First, multi-level modeling and repeated measures ANOVA was used to contrast the variance in communication measures (requisite functions) explained by team and task factors. These analyses revealed that task differences did not explain a significant amount of variance in team communication measures. Team membership on the other hand, did explain a relatively small, but significant amount of variance. The greatest amount of variance in the communication measures however was explained by the type of communication activity, or requisite function teams engaged in.

In order to determine whether teams could be meaningfully described in terms of their communication profile on the requisite functions, cluster analysis was also carried out. This analysis revealed five distinct clusters or communication profiles. Consistent with the findings from Study One and the multi-level modeling and repeated measures ANOVA, these communication profiles were found to be consistent across the decision making and production task. These findings challenge the established view that task requirements will have an effect on team communication (Hackman & Morris, 1975; McGrath, 1984; Morris, 1966). However, unlike much of the existing research, data for this research came from established teams where team members were very familiar with one another and had a history of working together. Thus, while these findings are inconsistent with the literature on task type, they can be understood in light of team development research which shows that established teams apply routine processes or habitual ways of dealing with information and making decisions (Argyris, 1969; Gersick, 1988; Janis, 1982; McClelland, 1984).

Through cluster analysis it was also shown that two specific communication profiles, characterised by high levels of Solution Development, Orientation and Problem Definition communication were

associated with better team performance on the production task. However, there was no relationship between type of communication profile and performance on the decision making task. Overall, these findings make a significant contribution to the literature insofar as they suggest that established teams may develop a consistent communication profile and that these profiles may have implications for team performance.

## **Theoretical and Practical Implications of the Research**

The findings of these studies provide new direction for the literature on team communication; and more specifically the functional perspective on team communication. They also provide support for models about team norms and routines by illustrating consistency in team communication across task types. The next section of this Chapter examines the theoretical and practical implications of this research and suggests how they might be examined through future research.

### ***Communication and Team Performance Relationship***

The functional perspective is well established in the communication literature, specifically as it relates to team decision making performance (Hirokawa & Poole, 1996). However, like the broader team communication literature, studies adopting the functional perspective have produced inconsistent findings. In reviewing this literature (see Chapter Two), it was apparent that there existed a number of methodological limitations that could at least, in part, explain some of these inconsistencies.

Findings from Study One, in particular the consistency in correlations for requisite functions across tasks, provide a unique approach to validating the requisite function framework. Effective team decision making is said to rely on how well team member communication satisfies these five requisite functions (Hirokawa, 1980, 1982, 1983, 1987, 1988). If requisite functions were not a meaningful method of

representing team communication activity, then high correlations of the requisite functions across tasks and the small and non-significant correlations between different requisite functions would not have been found. The framework used in this thesis, consisting of the requisite functions of Orientation, Problem Definition, Criteria Development, Solution Development and Solution Evaluation is therefore supported by these findings.

The findings from both Studies One and Two provide insight into the team communication and performance relationship, specifically in terms of learning more about the role of requisite functions. Much of the previous literature adopting requisite functions as a measure of communication activity (Hirokawa, 1980, 1982, 1983, 1985, 1987, 1988, 1990; Hirokawa & Pace, 1983; Salazar, 1997; Salazar et al., 1994) has drawn conclusions about specific requisite functions being associated with better team decision making performance. However, findings from the cluster analysis carried out in Study Two extend this by showing a profile or profiles of communication activity, encompassing all requisite functions. The representation of requisite functions in this way is possibly more useful to people wanting to learn about the role of requisite functions in team performance because it highlights that all requisite functions are utilised by teams, but that certain combinations (i.e. profiles) of requisite function activity are specifically related to improved team performance. By knowing which profiles are related to improved performance, teams are better placed to modify their communication activity to work towards improved performance. For example, these findings have identified that teams need to engage in all requisite functions, but in particular focus on relatively high levels of Solution Development communication and moderately high levels of Orientation and Problem Definition communication.

Findings from Study One also challenged the role of team potential (team member skills and abilities) in the communication – team performance model presented in this thesis. Despite the important role

that team potential is said to play in models of team performance (Cohen & Bailey, 1997; Cragen & Wright, 1990; Gladstein, 1984; Gouran, 1983), many studies investigating the relationship between communication and performance have failed to properly account for it. The work of Salazar (1997) showed that team potential accounted for 71% of the variance in team performance for a decision making task. The findings from the decision making task in this research provided support for this finding with about 56% of the variance in team performance being accounted for by team potential. However, team potential did not explain a significant amount of variance in team performance for the production task; 34% of the variance in team performance was accounted for by team size. This finding suggests that team potential might only be important for certain types of tasks (e.g. decision making tasks). Tasks, such as a production task, that are largely standardised and repititious in nature, might rely less on the skills and abilities of team members and more on the number of team members in order to perform well. This finding should be verified by future research which would help establish if models of team performance (such as the IPO model) need to be modified. One general model may no longer be sufficient in explaining the relationship between team inputs, processes and outcomes.

### ***Moderators of the Team Communication and Performance Relationship***

This research explored two moderators of the team communication — performance relationship; a task-specific moderator (task complexity) and a team-specific moderator (team member diversity). The choice of these moderators was guided by literature on the functional perspective and broader team communication literature. The results of Study One showed a small number of moderation effects, evidenced by the product term (based on the requisite function and either the task or team factor) explaining additional variance in the outcome (performance) measure for each task.

The first moderator, task complexity, had previously been applied as a moderator in the broader team communication literature, but had limited use as a moderator in studies of the functional perspective. Task complexity was expected to moderate the relationship between communication activity and performance such that communication would be more important for performance under conditions of high task complexity. Results from Study One did not support this hypothesis. Rather, it was found that Solution Development communication became more important for performance under conditions of low task complexity. It is possible that this finding is the product of random variation because it wasn't observed for any other requisite function other than Solution Development nor was it found for the production task. However, there are two alternative explanations for this finding.

In Chapter 6, it was suggested that team routine and normative processes provided an explanation for consistency in communication over time and across tasks for established teams. Team routines and norms might also help explain why the moderation effect was in the opposite direction to what was expected. Previous research suggests that a disadvantage associated with team habitual routines is that teams fail to take advantage of task innovations and team members talk less with one another compared to ad-hoc teams (Carley, 1986; Gersick & Hackman 1990). An advantage associated with established teams however, is that team members are familiar enough to understand each other's strengths and may be accustomed to solving problems or undertaking tasks using a particular approach or strategy. The teams in this research performed well under conditions of high task complexity irrespective of how much Solution Development communication they engaged in. Given what we know about team routines and norms, it is possible that, recognising the complexity of the task, team members relied on team member strengths and utilised a routine approach to discussing and solving the task. Teams may have known how to go about solving the problem based on their normative team processes rather than relying on more communication to discuss a strategy for solving the task. Under conditions of low task

complexity, team members might have also followed a routine approach to discussing the task, but not believed that the problem warranted much discussion (because it was simple). Lack of Solution Development communication may have contributed to poorer team performance. Teams that did engage in greater amounts of Solution Development communication (under conditions of low task complexity) however were likely to have better reflected on the problem and therefore performed better. We would expect Solution Development communication to be affected by task complexity more so than the other requisite functions because the task complexity manipulation for the decision making task specifically manipulated the selection of solution alternatives that teams had to choose from. The moderation effects found highlight how team routines and norms might be useful for established teams when the nature of the task they are performing is more complex, but also highlight their possible disadvantages when the nature of the task being performed is less complex.

A second explanation for the findings relating to task complexity is that although the task complexity manipulation had a statistically significant effect on the measure of task complexity, the difference in scores for teams in the high versus low task complexity conditions may not have been “practically” significant. That is, while teams in the high task complexity condition may have perceived their task to be more complex compared to low task complexity teams, the difference in mean scores on the manipulation test was relatively small ( $M = 6.23$  high task complexity versus  $M = 5.12$  low task complexity). With a stronger manipulation, we might observe more moderation effects for task complexity. This may be one further plausible explanation for not finding moderation effects of task complexity in the direction expected for both tasks.

The second moderator tested, team member diversity, has a long history in the team literature, but it has not been investigated as a moderator of the relationship between team communication and

performance before. The findings from Study One provided some support for diversity as a moderator given that moderation effects were observed for all three indicators of diversity. For example, this thesis showed that for both racially diverse teams and teams with diverse work values, greater amounts of Problem Definition communication were associated with improved performance on a decision making task. In addition, greater amounts of Solution Development communication were associated with improved performance on a decision making task for teams with diverse work values. In contrast, greater amounts of Criteria Development communication were associated with improved performance for same-sexed teams on a decision making task. Diversity's moderation effects were more limited for the production task. Here, only Solution Development communication was associated with improved performance for mixed-sex teams.

This pattern of results suggests that for a decision making task, racial and work value diversity creates a need for specific types of communication (e.g. Problem Definition and Solution Development), but gender diversity doesn't. This finding is important because it shows that despite workplaces becoming more diverse and people therefore becoming more accustomed to working with more diverse team members, the effect of diversity is still apparent. With people from multiple generations working together all with different work experiences and backgrounds, it seems probable that there will exist a range of different views and values about work. This diversity in values may well have created a range of different viewpoints in terms of how it related to solving the decision making task. Team members who differed in their views on work values are likely to have felt a greater need for team discussion on how the problem was to be defined (Problem Definition) or the approaches the team would take to developing solutions (Solution Development) because both of these requisite functions would have significant implications for how well the task would be performed. In terms of racial diversity, team members who were born and/or raised and perhaps worked in a different country are likely to bring different viewpoints and experiences to a team.



These viewpoints might make themselves more apparent at the beginning of the decision process where the nature of the problem and its possible causes and effects are defined.

For a production task, gender diversity is the only type of diversity that creates a need for communication and this is Solution Development communication specifically. While this finding might be the product of random variation given it was the only significant finding to emerge from 10 possible analyses, previous research can be used to suggest why this result might be valid. For example, if males are better at ‘doing’ tasks such as a production task and females are better at discussion based tasks (Myaskovsky, Unikel, & Dew, 2005) then the combination of these strengths for the origami task which required both ‘doing’ and ‘discussing’, might have helped mixed-sex teams to outperform same-sexed teams for Solution Development communication specifically. Same-sexed teams still improved their performance as they increased their amount of Solution Development communication, but not to the same extent as mixed-sex teams. This would suggest that there is much to be gained from having mixed-gender teams in the workplace for production type tasks; differences between genders in terms of how they go about solving a problem can be harnessed to improve team performance.

Overall, the pattern of findings from these analyses also suggest that the moderating effects of diversity impact a decision making task more so than a production task. A possible explanation for this finding is that the high level of team interaction required by a decision making task provides the best environment in which diversity’s effects can be seen. The creation of origami, whilst a team activity, actually reflects the culmination of individual team member effort and as such might not have been impacted by diversity’s effects in quite the same way as the type of team interaction that takes place for a decision making task. The origami task, as outlined in Chapter 4, is also considered a culture-free activity, which is why we might not have seen any effects of racial diversity for this task.

These findings extend the literature on diversity in a number of ways. First, by exploring diversity as a moderator variable we are able to better understand when diversity impacts the relationship between communication and performance. Second, while previous literature (outlined in Chapter 2) has explored diversity as a moderator of the relationship between other team process variables and performance, much of this literature has not explored a specific type of diversity. This research explored three specific types of diversity and has shown that their effects are different within and across tasks. Future research should therefore ensure that the effects of specific types of diversity are investigated as opposed to clustering different types of diversity into one general diversity measure.

A further contribution of this research is that the moderation effect of diversity was explored within established teams. Established teams are more representative of the work environment and they provide a more stringent test in that the literature suggests that effects of surface level diversity tend to be reduced over time as team members become more familiar with one another (Amir, 1969). The findings of this research reveal that even with established teams, diversity continues to play a role in team performance by moderating the impact of specific forms of communication. It would be helpful to understand if the moderation effects found in this research extend to ad-hoc teams and if these effects are different (i.e. more and stronger effects). It would also be helpful to understand if these effects generalise to other types of tasks and for other types of diversity. For example, the effects of cultural diversity on the relationship between communication and performance might be quite different for ad-hoc compared to established teams. Given the differences in communication styles between generations, we might also expect the effects of age diversity on the relationship between communication and performance to be different for ad-hoc and established teams too.

### ***Task Differences***

The literature on teams and communication generally suggests that differences in task type have a significant impact on the type and amount of communication (Carter et al., 1950; Deutsch, 1951; Hackman & Morris, 1975; McGrath, 1984; Morris, 1966). As the above discussion reveals, this research program found that a decision making task and a production task differed in terms of the moderators for the relationship between communication and performance for each task type. Reasons for why these differences occurred were discussed in earlier sections of this Chapter. However, the large correlations between communication measures across these tasks (Study One) suggested that there was no change in communication profiles for the decision making and production task. That is, the relative amount of communication dedicated to each of the requisite functions was fairly consistent for each team across the two tasks. In addition, the findings from the multi-level modeling and repeated measures ANOVA (Study Two) also found that task type did not explain significant variance in the communication measures. This finding is inconsistent with the literature on task effects, but is consistent with research into team norms and routines (Argyris, 1969; Gersick, 1988; Hackman & Morris, 1975; Janis, 1982; McClelland, 1984).

Based on the team norms and routine literature (Argyris, 1969; Gersick, 1988; McClelland, 1984) it could be assumed that a change in the type of task an established team is performing will have little bearing on the way in which that team goes about completing the task. Rather, an established team is likely to rely on its characteristic way of doing things to complete the task, even when facing a different task. When the elements of a task to be completed are not familiar, established teams may be relying more on their normative team processes to create sense and understanding of the task and their approach to completing it. This explanation can also help to provide explanation for when established teams might perform well or more poorly. For example, if an established team is performing a task or tasks that are familiar to them, they might become set in their communication routines and consequently

communicate less; relying more on the teams' shared perspective about the task or tasks (Carely, 1986; Katz, 1982). This could result in poorer performance over time if task changes are not properly recognised or specific skills or attributes from team members are not fully utilised. If an established team is performing a task that is new or unfamiliar to them, team norms and routines could create an environment that will enhance performance. That is, team members can utilise their norms and routines to reduce anxiety or uncertainty associated with a new task, but facilitate greater team coordination and overall management. This leaves more time for the team to focus on communication and completing the task. Established teams cannot rely on routine communication approaches to the same extent for new or unfamiliar tasks and this might result in better performance.

This explanation might also assist in providing insight into why communication profiles were only associated with team performance for the production task (as shown in Study Two). Established teams participating in this research would have been used to or familiar with decision making tasks (not necessarily the NASA task, but decision making tasks in general). However, they would not necessarily have been familiar with hands-on tasks that required them to make something. Although both tasks in this research were new to the teams, the production task was completely novel (and therefore unfamiliar). Communication might become more important for established teams when undertaking unfamiliar or novel tasks. Communication therefore would not only serve to develop solutions to the task, but make sense of the task and define its scope. This might explain why Orientation, Problem Definition and Solution Development communication were the requisite functions represented most strongly in the two communication profiles associated with higher performance for the production task. It would be valuable for future research to explore this finding further by determining whether communication profiles are associated with performance specifically for a production task, or tasks that are completely unfamiliar and novel to established teams.

Given these arguments, the need to further explore the nature of task effects, especially with established teams is important. Many of the purported task effects suggested in the current literature may simply be a function of using ad-hoc teams. Previous findings might have less to do with genuine task effects and have more to do with team development processes than previously considered.

## **Established Teams and Communication Profiles**

Previous research provides evidence that established teams utilise consistent or habitual methods of dealing with information (Argyris, 1969; Gersick, 1988). However, there is a dearth of literature that has specifically sought to investigate team communication profiles, in particular with established teams. This research (Study Two) showed that established teams do engage in reliable communication profiles when undertaking team tasks and in support of team development theory, these communication profiles remain virtually identical across task types. The cluster analysis revealed five team communication profiles, which reflected the relative emphasis given to the five requisite functions (Orientation, Problem Definition, Criteria Development, Solution Development and Solution Evaluation). It is not clear from this research what the causes of these different forms of communication profiles are, but a number of team factors might be responsible. For example, organisational culture has been identified in the literature as a form of behavioural guidance for teams (O'Reilly, 1989). The teams in this study were all from the same organisation, but they came from a range of divisions within the organisation and given this, we could expect the culture of these teams to be quite different. Team leadership might also contribute to differences in communication profiles. The literature shows that certain leader attributes predict team behaviour (Rozell & Gundersen, 2003). There would be much value in research that unpacks the factors contributing to the development of teams' characteristic communication profiles.

Study Two also found that the communication profiles for Clusters 1 and 2, which were characterised by greater amounts of Orientation, Problem Definition and Solution Development communication were associated with higher team performance than the other communication profiles for the production task. Further research is necessary to not only determine the overall generalisability of these findings, but to also explore whether these communication profiles are associated with improved team performance across a range of other team tasks. If this was the case, then there exists much scope and opportunity from a training point of view to assist teams to focus on this ‘style’ of communication or to train teams on how to be more effective at those specific types of requisite functions.

## **Limitations of Research**

This research had a number of features that helped to significantly improve or overcome existing methodological limitations of prior research. However, despite these improvements, this research also had some limitations. Each of these limitations will now be discussed.

First, although data were collected from a large sample of established teams, the decision making and production task employed in the research design were fairly contrived. This research did not utilise the kind of tasks that team members from the participating organisation were used to undertaking. The use of these contrived tasks may have created a sense of artificiality for the teams and therefore the results obtained may not accurately reflect ‘typical’ communication for these established teams. These particular tasks were chosen because they were consistent with the organisation’s objective to engage all staff in team building exercises — a program of training that was intended to improve team functioning and overall team performance. From this point of view, the selected tasks reflected the fun, but also serious nature of the team building program. Further to this, the decision making task (NASA Moon Survival Problem) was selected because it had been used in previous research employing a decision making task that required an objectively

correct answer. The use of this task helped provide generalisability with other study findings. Future research is needed to determine whether these findings can be replicated. In this research, it would be useful to employ team tasks that better reflect team member's normal work duties.

A second and related limitation was the relatively short period of time available for teams to engage in communication activity. Teams were given only fifteen minutes to undertake each task. Compared to the time a team would have available to complete a task in their normal work environment, this was a very short period of time. Previous research suggests that teams performing under time pressure often compromise on quality in order to complete the task (Kelly & McGrath, 1983). While it is not known whether this short time period for task completion may have compromised the performance of the teams, it remains a possibility. It is also possible that this short time period has contributed to the findings relating to the relationship between communication and performance (Study One). For example, teams may have allocated greater time to particular types of requisite functions that would facilitate decision making (i.e. Problem Definition and Solution Development) if additional time had been allocated for the task. This limitation means that communication profiles identified in Study Two might not be a true representation of communication profiles for these teams. For this reason, enabling teams to have longer discussion or task completion time is an important consideration for future research.

A third limitation in this program of research was the use of established teams from only one organisation. The choice of the participating organisation was influenced by their interest and availability to participate in an organisational exercise that was consistent with the topic area for this research program. Furthermore, the organisation had a very large number of established teams available to participate in the research program. No other previous research on the functional perspective and very little previous research on established teams have been fortunate enough to have such a large sample of teams.

The limitation of only using one organisation, however, is the lack of generalisability of the research findings. The research would have been strengthened if participants had been recruited from established teams from at least two different organisations. In terms of future research opportunities, it would be worthwhile to determine not only whether comparable results are obtained in similar types of organisations (e.g. information technology organisations), but whether my results also generalise to established teams in other types of organisations.

## **Directions for Future Research**

The results from the Studies in this research program provide a number of directions for future research. In terms of Study One, the results provided some support for the relationship between communication and team performance being moderated by task complexity and team member diversity. These results do help provide a better understanding of when communication becomes important for team performance — something that previous research has long alluded to and had started to investigate, but not provided any definitive answer to. Several other areas of investigation would be worth pursuing here. First, there would be value in further testing both task complexity and team member diversity as moderators under similar and different task and team conditions. Examples of different task types that might be considered in future research include brainstorming, negotiation, and discussion tasks. A multitude of different teams would also be valuable to explore in future research including medical teams, teams in the armed forces, and legal teams. In doing so, the results of this research could be validated and then extended to determine whether these effects change when tested across different types of tasks or teams.

This research has made a significant contribution to the literature in terms of redefining the role of team member diversity in team research. Whereas team diversity has been examined as a main effect, this research suggests that it may be an important moderator of the effect of team processes on team performance. If further research is carried out



exploring team diversity as a moderator variable, we will be in a far better position to understand when diversity's effects can be used to facilitate improved team performance. There are many types of diversity and it would be useful to understand how other types, such as functional background diversity, culture diversity, age diversity and team tenure diversity moderate the communication — team performance relationship particularly for established teams. Research is also needed to understand whether the moderating effect of team diversity is dependent on the type of task performed by the team (as these findings suggest) or the context in which the team is operating.

Third, in testing moderators of the communication — team performance relationship, there is a change or reconceptualisation of the traditional Input-Process-Output (IPO) Model of team effectiveness. While the model tested in this research was only a component of the traditional IPO Model, it has been shown that input factors and process factors can also be used as moderators of the relationship between team processes and outputs. In relating this back to the traditional IPO Model it can be seen that this creates a more complicated, but nonetheless possibly more accurate model of team effectiveness. Given this, future research endeavours could consider testing an IPO Model of team effectiveness similar to the one tested in this thesis, taking into account different moderators proposed to impact the relationship between team processes and outcomes.

Finally, this thesis has offered new insight into the communication and team performance relationship largely because of the use of established teams. Only two studies adopting the functional perspective as their theoretical model have utilised real, established teams. The inconsistencies found between the results of this research and previous research, both within the functional perspective and broader communication and team performance literature could be due to the differences between ad-hoc and established teams. Future research could not only seek to establish whether certain types of communication

activity are more important than others in undertaking varying types of team tasks, but also identify whether the five communication profiles identified in this research are reflective of established teams across other types of organisational settings. This kind of information could then be used for team training purposes; helping teams to improve their communication approach and having them recognise the value of certain types of communication to improve their performance.

## **Conclusion**

In conclusion, the results obtained in this research have helped inform the complex relationship between communication and team performance, by showing that this relationship is contingent upon task complexity and team member diversity. This research has also provided insight into the nature of this relationship for established teams and shown that teams consistently apply specific profiles of communication when undertaking tasks. An effort to work with new teams and help them develop functional norms is an area where the outcomes of this research could be applied. It could be expected that this research will assist not only other researchers with a range of research areas in which future research can be directed, but also organisations who wish to better understand the linkages between communication and team performance, the circumstances that might make team communication more important for performance and the specific types of communication activity that could be an area of focus in team communication training programs.

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## **Appendix A: Protocols and Answer Sheets for Decision Making Task**

### **Experimental Protocol – NASA Moon Task [LRA/LC: 1]**

1. Greet team and thank them for participating.
2. Please read to team the following:

“You are now going to participate in a team activity that will involve discussing and solving a problem. In this task, each team member is to assume his/her typical team role at work. Your team must reach consensus in reaching a decision. Consensus may be said to exist when all team members are in agreement as to the choice of the one item that would have the greatest utility in ensuring the survival of the spaceship crew. The team is to avoid the use of majority vote, tossing a coin, and the like in reaching a consensus decision. Keep in mind that your task is to agree, as a team, on the optimal choice of the items in terms of the value in getting you, the crew, to the mother ship”.
3. Hand the team a “TEAM ANSWER FORM”
4. When everybody has had the opportunity to view the instructions and items, inform the team of when to start.
5. Split the team in half. Each consultant is to code communication for half of the team. Each consultant is to be clear about the team members for whom they will code all communication activity.
6. Make sure you have read and understood the communication coding instructions. Code all communication activity according to the coding system as the team undertakes the task.
7. When the team task has finished, thank the team for their involvement.
8. Collect the team’s ANSWER FORM. Remember to note the team’s identification code and the number of team members on the top of the answer form and coding sheet.



**Experimental Protocol – NASA Moon Task**  
**[HRA/LC: 2]**

1. Greet team and thank them for participating.
2. Please read to team the following:

“You are now going to participate in a team activity that will involve discussing and solving a problem. Your team must reach consensus in reaching a team decision. Consensus may be said to exist when all team members are in agreement as to the choice of the one item that would have the greatest utility in ensuring the survival of the spaceship crew. The team is to avoid the use of majority vote, tossing a coin, and the like in reaching a consensus decision. Keep in mind that your task is to agree, as a team, on the optimal choice of the items in terms of the value in getting you, the crew, to the mother ship”.
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6. Make sure you have read and understood the communication coding instructions. Code all communication activity according to the coding system as the team undertakes the task.
7. When the team task has finished, thank the team for their involvement.
8. Collect the team's ANSWER FORM. Remember to note the team's identification code and the number of team members on the top of the answer form and coding sheet.

**Experimental Protocol – NASA Moon Task**  
**[LRA/HC: 3]**

1. Greet team and thank them for participating.
2. Please read to team the following:

“You are now going to participate in a team activity that will involve discussing and solving a problem. In this task, each team member is to assume his/her typical team role at work. Your team must reach consensus in reaching a team decision. Consensus may be said to exist when all team members are in agreement as to the choice of the one item that would have the greatest utility in ensuring the survival of the spaceship crew. The team is to avoid the use of majority vote, tossing a coin, and the like in reaching a consensus decision. Keep in mind that your task is to agree, as a team, on the optimal choice of the items in terms of the value in getting you, the crew, to the mother ship”.
3. Hand the team a “TEAM ANSWER FORM”
4. When everybody has had the opportunity to view the instructions and items, inform the team of when to start.
5. Split the team in half. Each consultant is to code communication for half of the team. Each consultant is to be clear about the team members for whom they will code all communication activity.
6. Make sure you have read and understood the communication coding instructions. Code all communication activity according to the coding system as the team undertakes the task.
7. When the team task has finished, thank the team for their involvement.
8. Collect the team’s ANSWER FORM. Remember to note the team's identification code and the number of team members on the top of the answer form and coding sheet.

**Experimental Protocol – NASA Moon Task**  
**[HRA/HC: 4]**

1. Greet team and thank them for participating.
2. Please read to team the following:

“You are now going to participate in a team activity that will involve discussing and solving a problem. Your team must reach consensus in reaching a team decision. Consensus may be said to exist when all team members are in agreement as to the choice of the one item that would have the greatest utility in ensuring the survival of the spaceship crew. The team is to avoid the use of majority vote, tossing a coin, and the like in reaching a consensus decision. Keep in mind that your task is to agree, as a team, on the optimal choice of the items in terms of the value in getting you, the crew, to the mother ship”.
3. Hand the team a “TEAM ANSWER FORM”
4. When everybody has had the opportunity to view the instructions and items, inform the team of when to start.
5. Split the team in half. Each consultant is to code communication for half of the team. Each consultant is to be clear about the team members for whom they will code all communication activity.
6. Make sure you have read and understood the communication coding instructions. Code all communication activity according to the coding system as the team undertakes the task.
7. When the team task has finished, thank the team for their involvement.
8. Collect the team’s ANSWER FORM. Remember to note the team’s identification code and the number of team members on the top of the answer form and coding sheet.

**NASA MOON ANSWER SHEET****Team Code** \_\_\_\_\_ **(LRA/LC: 1)****NASA MOON TASK**

In this task, each team member is to assume his/her typical team role at work. Consider yourself a member of a spaceship crew. Your spacecraft was originally scheduled to rendezvous with a mother ship on the lighted surface of the moon. Due to an entry failure, however, it was necessary for you and your crew to crash-land some two hundred miles from the mother ship. In landing, much of the equipment was damaged beyond use and several of the crew were injured. Five items of equipment were left intact and undamaged during the crash-landing. Because it is necessary for you to reach the mother ship as quickly as possible if you are to survive, only some of the undamaged equipment may be taken on the two hundred mile trek which lies ahead. At the bottom on this sheet you have been given a list of the five items of equipment that are still in serviceable condition.

Your task is to rank order all five items in terms of their utility and importance in ensuring your survival on the journey to the mother ship. Place a number "1" by the most important item, number "2" by the second most important item, and so on to number "5" for the least most important item. Consider at all times what you know about the moon conditions in making your selections. Also, provide a rationale in the space provided below each item for why you ranked it the way that you did.

\_\_\_\_\_ food concentrate

\_\_\_\_\_ Portable heating unit

\_\_\_\_\_ 2-100 lb. tanks of oxygen

\_\_\_\_\_ Signal flares

\_\_\_\_\_ First-aid kit also containing injection needles

**NASA MOON ANSWER SHEET**

Team Code \_\_\_\_\_ (HRA/LC: 2)

**NASA MOON TASK**

Consider yourself a member of a spaceship crew. Your spacecraft was originally scheduled to rendezvous with a mother ship on the lighted surface of the moon. Due to an entry failure, however, it was necessary for you and your crew to crash-land some two hundred miles from the mother ship. In landing, much of the equipment was damaged beyond use and several of the crew were injured. Five items of equipment were left intact and undamaged during the crash-landing. Because it is necessary for you to reach the mother ship as quickly as possible if you are to survive, only some of the undamaged equipment may be taken on the two hundred mile trek which lies ahead. At the bottom of this sheet is a list with the five items of equipment that are still in serviceable condition.

Your task is to rank order all five items in terms of their utility and importance in ensuring your survival on the journey to the mother ship. Place a number "1" by the most important item, number "2" by the second most important item, and so on to number "5" for the least most important item. Consider at all times what you know about the moon conditions in making your selections. Also, provide a rationale in the space provided below each item for why you ranked it the way that you did.

\_\_\_\_\_ Food concentrate

\_\_\_\_\_ Portable heating unit

\_\_\_\_\_ 2-100 lb tanks of oxygen

\_\_\_\_\_ Signal flares

\_\_\_\_\_ First-aid kit also containing injection needles

**NASA MOON ANSWER SHEET****Team Code \_\_\_\_\_ (LRA/HC: 3)****NASA MOON TASK**

In this task, each team member is to assume his/her typical team role at work. Consider yourself a member of a spaceship crew. Your spacecraft was originally scheduled to rendezvous with a mother ship on the lighted surface of the moon. Due to an entry failure, however, it was necessary for you and your crew to crash-land some two hundred miles from the mother ship. In landing, much of the equipment was damaged beyond use and several of the crew were injured. Five items of equipment were left intact and undamaged during the crash-landing. Because it is necessary for you to reach the mother ship as quickly as possible if you are to survive, only some of the undamaged equipment may be taken on the two hundred mile trek which lies ahead. At the bottom on this sheet you have been given a list of the five items of equipment that are still in serviceable condition.

Your task is to rank order all five items in terms of their utility and importance in ensuring your survival on the journey to the mother ship. Place a number "1" by the most important item, number "2" by the second most important item, and so on to number "5" for the least most important item. Consider at all times what you know about the moon conditions in making your selections. Also, provide a rationale in the space provided below each item for why you ranked it the way that you did.

\_\_\_\_\_ 1-case dehydrated pet milk

\_\_\_\_\_ 2 x .45 calibre pistols

\_\_\_\_\_ magnetic compass

\_\_\_\_\_ box of matches

\_\_\_\_\_ portable heating unit

**NASA MOON ANSWER SHEET**

Team Code \_\_\_\_\_ (HRA/HC: 4)

**NASA MOON TASK**

Consider yourself a member of a spaceship crew. Your spacecraft was originally scheduled to rendezvous with a mother ship on the lighted surface of the moon. Due to an entry failure, however, it was necessary for you and your crew to crash-land some two hundred miles from the mother ship. In landing, much of the equipment was damaged beyond use and several of the crew were injured. Five items of equipment were left intact and undamaged during the crash-landing. Because it is necessary for you to reach the mother ship as quickly as possible if you are to survive, only some of the undamaged equipment may be taken on the two hundred mile trek which lies ahead. At the bottom of this page is a list of the five items of equipment that are still in serviceable condition.

Your task is to rank order all five items in terms of their utility and importance in ensuring your survival on the journey to the mother ship. Place a number "1" by the most important item, number "2" by the second most important item, and so on to number "5" for the least most important item. Consider at all times what you know about the moon conditions in making your selections. Also, provide a rationale in the space provided below each item for why you ranked it the way that you did.

\_\_\_\_\_ 1-case dehydrated pet milk

\_\_\_\_\_ 2 x .45 calibre pistols

\_\_\_\_\_ magnetic compass

\_\_\_\_\_ box of matches

\_\_\_\_\_ portable heating unit

## Appendix B: Coding Instructions for Consultants Decision Making Task

### Communication Coding Instructions for Consultants

The purpose of coding communication is to determine the varying distributions of utterances of teams when they engage in communication activity. The following list provides an overview of the definitions of the interaction coding system to be used to code team communication activity. It is important that the following list be reviewed in detail, to ensure the overall accuracy of the coding process.

<b>ORIENTATION</b>	<ol style="list-style-type: none"> <li>1. <u>Requests for clarification</u> Questions that are directed at finding out the opinions of other group members regarding goals, objectives, or operating procedures (e.g. "Rob, what are we supposed to be doing today"?)</li> <li>2. <u>Requests for evaluation/justification</u> Questions that are directed at finding out how other group members regard the goals, objectives or operating procedure for the group ("How do you guys feel about going around the table and seeing what each of us picked up"?)</li> <li>3. <u>Clarification</u> Comments that make known an individual's preference about meeting times, or the group's operating procedure (e.g. "I think we should go around the table and see what everyone thinks about this"?)</li> <li>4. <u>Keeping on track</u> Statement directing the group's movement back to its goal path with regard to the group's goals, and objective (e.g. "I thought the reason we met today was to try to figure out an answer to this problem, and not talk about ____"?).</li> <li>5. <u>Simple agreement</u></li> <li>6. <u>Simple disagreement</u></li> <li>7. <u>Miscellaneous</u></li> </ol>
<b>PROBLEM DEFINITION AND ANALYSIS</b>	<ol style="list-style-type: none"> <li>1. <u>Requests for clarification</u> Questions regarding the nature of the problem the group is confronted with (e.g. What did the instructions say about ____"?)</li> <li>2. <u>Clarification</u> Comments that make known an individual's perspective of the task/problem the group is confronted with (e.g. I think the instructions told us to do ____").</li> <li>3. <u>Simple agreement</u></li> <li>4. <u>Extended agreement</u></li> <li>5. <u>Simple disagreement</u></li> <li>6. <u>Extended disagreement</u></li> <li>7. <u>Miscellaneous</u></li> </ol>



<b>CRITERIA DEVELOPMENT</b>	<p>1. <u>Clarification of existing criteria</u></p> <p>Statements that refer to pre-existing constraints that the group must perform under (e.g. "It says that we have to do this to complete the task").</p>
<b>SOLUTION DEVELOPMENT</b>	<p>1. <u>Simple identification</u></p> <p>Statement that identifies an individual's stance or disposition. Makes known an individual's preference for a solution without elaboration (e.g. "I think we ought to go with this alternative")</p> <p>2. <u>Request for elaboration/justification of a proposed solution</u></p> <p>(e.g. "Why did you choose that?")</p> <p>3. <u>Simple agreement with a proposed solution</u></p> <p>Statement that indicates affirmation or concurrence with a proposed solution without elaboration ("That's a great idea").</p> <p>4. <u>Simple disagreement with a proposed solution</u></p> <p>("No, I don't agree with that").</p> <p>5. <u>Consensus building</u></p> <p>("Do we all agree on this then?")</p> <p>6. <u>Miscellaneous</u></p>
<b>SOLUTION EVALUATION</b>	<p>1. <u>Positive qualities</u></p> <p>Statement that identifies an individual's preference and provides a favourable justification for solution ("I think we ought to do this because ____").</p> <p>2. <u>Simple agreement with a stated positive quality</u> (e.g. "That's a good reason").</p> <p>3. <u>Simple disagreement with a stated positive quality</u> (e.g. "That's not a good reason"; "I don't like that decision at all").</p> <p>4. <u>Negative qualities</u></p> <p>Statement that identifies an individual's preference for a solution and provides an unfavourable justification of solution (e.g. "We can't choose this because ____").</p> <p>5. <u>Simple agreement with a stated negative quality</u></p> <p>6. <u>Simple disagreement with a stated negative quality</u></p> <p>7. <u>Miscellaneous</u></p>
<b>MISCELLANEOUS</b>	Utterance concerned with functions other than those previously identified.

**Interaction Coding System (Consultants)****No. of Team Members:** \_\_\_\_\_ **Team Code:** \_\_\_\_\_**NASA MOON TASK**

<b>ORIENTATION: Utterance concerned with team management. These utterances make known team operating procedures and logistics</b>						
Requests for clarification	Requests for evaluation/justification	Clarification	Keeping on track	Simple agreement	Simple disagreement	Miscellaneous
<b>PROBLEM DEFINITION &amp; ANALYSIS: Utterance concerned with identifying and defining the nature of the team's task/problem</b>						
Requests for clarification	Clarification	Simple agreement	Extended agreement	Simple agreement	Extended disagreement	Miscellaneous
<b>CRITERIA DEVELOPMENT: Utterances concerned with the goals or standards that choices or solutions must meet</b>						
Clarification of existing criteria						
<b>SOLUTION DEVELOPMENT: Utterance concerned with any concrete, particular, specific proposal for action</b>						
Simple identification	Request for elaboration/justification of solution	Simple agreement with solution	Simple disagreement with solution	Consensus building	Miscellaneous	
<b>SOLUTION EVALUATION: Utterances that indicate evaluation of a proposal – for or against a proposal</b>						
Positive qualities	Simple agreement with positive quality	Simple disagreement with positive quality	Negative qualities	Simple agreement with negative quality	Simple disagreement with negative quality	Miscellaneous
<b>MISCELLANEOUS: Utterance concerned with functions other than those previously identified</b>						

## Appendix C: Protocols and Answer Sheets for Production Task

### Experimental Protocol – Origami Task [LRA/LTC/LC: 1a]

1. Greet team and thank them for participating.
2. Please read to team the following:  

“You are now going to participate in a team task that involves making origami. You will be provided with a diagram of the origami design your team is to make. Remember, this is a team task – all members of the team must participate in this task. It is important to note that to complete this task, each team member is to assume his/her typical team role at work. You are free to discuss the task with your team mates throughout the exercise. How you go about completing the task is up to you. Your team will be rated on two criteria: how many origami your team completes in total and the quality of the origami you make”.
3. Hand the team a “TEAM ANSWER FORM”
4. When everybody has had the opportunity to view the diagram, inform the team that they can start.
5. Split the team in half. Each consultant is to code communication for half of the team. Each consultant is to be clear about the team members for whom they will code all communication activity.
6. Make sure you have read and understood the communication coding instructions. Code all communication activity according to the coding system as the team undertakes the task.
7. When the team task has finished, thank the team for their involvement. [\*Inform them that they have one more task to complete. This will start in approximately 5 minutes].
8. Collect the team's ANSWER FORM. Remember to note the team's identification code and number of team members on the top of the answer form and coding sheet.

**Experimental Protocol – Origami Task**  
**[LRA/HTC/LC: 1b]**

1. Greet team and thank them for participating.
2. Please read to team the following:

“You are now going to participate in a team task that involves making origami. You will be provided with a diagram of the origami design your team is to make. Remember, this is a team task – all members of the team must participate in this task. It is important to note that to complete this task, each team member is to assume his/her typical team role at work. You are free to discuss the task with your team mates throughout the exercise. How you go about completing the task is up to you.
3. Hand the team a “TEAM ANSWER FORM”
4. When everybody has had the opportunity to view the diagram, inform the team that they can start.
5. Split the team in half. Each consultant is to code communication for half of the team. Each consultant is to be clear about the team members for whom they will code all communication activity.
6. Make sure you have read and understood the communication coding instructions. Code all communication activity according to the coding system as the team undertakes the task.
7. When the team task has finished, thank the team for their involvement. [\*Inform them that they have one more task to complete. This will start in approximately 5 minutes].
8. Collect the team’s ANSWER FORM. Remember to note the team’s identification code and number of team members on the top of the answer form and coding sheet.

**Experimental Protocol – Origami Task**  
**[HRA/LTA/LC: 2a]**

1. Greet team and thank them for participating.
2. Please read to team the following:

“You are now going to participate in a team task that involves making origami. You will be provided with a diagram of the origami design your team is to make. Remember, this is a team task – all members of the team must participate in this task. You are free to discuss the task with your team mates throughout the exercise. How you go about completing the task is up to you. Your team will be rated on two criteria: how many origami your team completes in total and the quality of the origami you make”.
3. Hand the team a “TEAM ANSWER FORM”
4. When everybody has had the opportunity to view the diagram, inform the team that they can start.
5. Split the team in half. Each consultant is to code communication for half of the team. Each consultant is to be clear about the team members for whom they will code all communication activity.
6. Make sure you have read and understood the communication coding instructions. Code all communication activity according to the coding system as the team undertakes the task.
7. When the team task has finished, thank the team for their involvement. [Inform them that they have one more task to complete. This will start in approximately 5 minutes.]
8. Collect the team's ANSWER FORM. Remember to note the team's identification code and number of team members on the top of the answer form and coding sheet.

**Experimental Protocol – Origami Task**  
**[HRA/HTA/LC: 2b]**

1. Greet team and thank them for participating.
2. Please read to team the following:

“You are now going to participate in a team task that involves making origami. You will be provided with a diagram of the origami design your team is to make. Remember, this is a team task – all members of the team must participate in this task. You are free to discuss the task with your team mates throughout the exercise. How you go about completing the task is up to you.
3. Hand the team a “TEAM ANSWER FORM”
4. When everybody has had the opportunity to view the diagram, inform the team that they can start.
5. Split the team in half. Each consultant is to code communication for half of the team. Each consultant is to be clear about the team members for whom they will code all communication activity.
6. Make sure you have read and understood the communication coding instructions. Code all communication activity according to the coding system as the team undertakes the task.
7. When the team task has finished, thank the team for their involvement. [Inform them that they have one more task to complete. This will start in approximately 5 minutes.]
8. Collect the team’s ANSWER FORM. Remember to note the team’s identification code and number of team members on the top of the answer form and coding sheet.

**Experimental Protocol – Origami Task**  
**[LRA/LTA/HC: 3a]**

1. Greet team and thank them for participating.
2. Please read to team the following:

“You are now going to participate in a team task that involves making origami. You will be provided with a diagram of the origami design your team is to make. Remember, this is a team task – all members of the team must participate in this task. It is important to note that to complete this task, each team member is to assume his/her typical team role at work. You are free to discuss the task with your team mates throughout the exercise. How you go about completing the task is up to you. Your team will be rated on two criteria: how many origami your team completes in total and the quality of the origami you make”.
3. Hand the team a “TEAM ANSWER FORM”
4. When everybody has had the opportunity to view the diagram, inform the team that they can start.
5. Split the team in half. Each consultant is to code communication for half of the team. Each consultant is to be clear about the team members for whom they will code all communication activity.
6. Make sure you have read and understood the communication coding instructions. Code all communication activity according to the coding system as the team undertakes the task.
7. When the team task has finished, thank the team for their involvement. [\*Inform them that they have one more task to complete. This will start in approximately 5 minutes].
8. Collect the team's ANSWER FORM. Remember to note the team's identification code and number of team members on the top of the answer form and coding sheet.

**Experimental Protocol – Origami Task**  
**[LRA/HTA/HC: 3b]**

1. Greet team and thank them for participating.
2. Please read to team the following:

“You are now going to participate in a team task that involves making origami. You will be provided with a diagram of the origami design your team is to make. Remember, this is a team task – all members of the team must participate in this task. It is important to note that to complete this task, each team member is to assume his/her typical team role at work. You are free to discuss the task with your team mates throughout the exercise. How you go about completing the task is up to you.
3. Hand the team a “TEAM ANSWER FORM”
4. When everybody has had the opportunity to view the diagram, inform the team that they can start.
5. Split the team in half. Each consultant is to code communication for half of the team. Each consultant is to be clear about the team members for whom they will code all communication activity.
6. Make sure you have read and understood the communication coding instructions. Code all communication activity according to the coding system as the team undertakes the task.
7. When the team task has finished, thank the team for their involvement. [\*Inform them that they have one more task to complete. This will start in approximately 5 minutes].
8. Collect the team’s ANSWER FORM. Remember to note the team's identification code and number of team members on the top of the answer form and coding sheet.



**Experimental Protocol – Origami Task**  
**[HRA/LTA/HC: 4a]**

1. Greet team and thank them for participating.
2. Please read to team the following:

“You are now going to participate in a team task that involves making origami. You will be provided with a diagram of the origami design your team is to make. Remember, this is a team task – all members of the team must participate in this task. You are free to discuss the task with your team mates throughout the exercise. How you go about completing the task is up to you. Your team will be rated on two criteria: how many origami your team completes in total and the quality of the origami you make”.
3. Hand the team a “TEAM ANSWER FORM”
4. When everybody has had the opportunity to view the diagram, inform the team that they can start.
5. Split the team in half. Each consultant is to code communication for half of the team. Each consultant is to be clear about the team members for whom they will code all communication activity.
6. Make sure you have read and understood the communication coding instructions. Code all communication activity according to the coding system as the team undertakes the task.
7. When the team task has finished, thank the team for their involvement. [Inform them that they have one more task to complete. This will start in approximately 5 minutes.]
8. Collect the team's ANSWER FORM. Remember to note the team's identification code and number of team members on the top of the answer form and coding sheet.

**Experimental Protocol – Origami Task**  
**[HRA/HTA/HC: 4b]**

1. Greet team and thank them for participating.
2. Please read to team the following:

“You are now going to participate in a team task that involves making origami. You will be provided with a diagram of the origami design your team is to make. Remember, this is a team task – all members of the team must participate in this task. You are free to discuss the task with your team mates throughout the exercise. How you go about completing the task is up to you.
3. Hand the team a “TEAM ANSWER FORM”
4. When everybody has had the opportunity to view the diagram, inform the team that they can start.
5. Split the team in half. Each consultant is to code communication for half of the team. Each consultant is to be clear about the team members for whom they will code all communication activity.
6. Make sure you have read and understood the communication coding instructions. Code all communication activity according to the coding system as the team undertakes the task.
7. When the team task has finished, thank the team for their involvement. [Inform them that they have one more task to complete. This will start in approximately 5 minutes.]
8. Collect the team’s ANSWER FORM. Remember to note the team’s identification code and number of team members on the top of the answer form and coding sheet.

## ORIGAMI ANSWER FORM

Team Code \_\_\_\_\_ (LRA/LTC/LC: 1a)

### ORIGAMI TEAM EXERCISE

The team has been provided with a diagram and some short instructions on how to make a particular origami design. To complete this task, each team member is to assume his/her typical team role at work. The team is to complete as many origamis as it can within 10 minutes. The team will be rated according to the total number of origami completed and the quality of the origami completed.

-----

(For Consultant to complete)

1. **TOTAL ORIGAMIS COMPLETED:** \_\_\_\_\_

2. Using the following scale, please rate the quality of the origamis completed according to the diagram provided to the team.

1	2	3	4	5	6	7
Completely Unsatisfactory						Completely Satisfactory

## ORIGAMI ANSWER FORM

Team Code \_\_\_\_\_ (LRA/HTC/LC: 1b)

## ORIGAMI TEAM EXERCISE

The team has been provided with a diagram and some short instructions on how to make a particular origami design. To complete this task, each team member is to assume his/her typical team role at work.

**ORIGAMI ANSWER FORM**

(Consultant Condition 1b)

(For Consultant to complete)

1. **TOTAL ORIGAMIS COMPLETED:** \_\_\_\_\_

2. Using the following scale, please rate the quality of the origamis completed according to the diagram provided to the team.

1	2	3	4	5	6	7
Completely Unsatisfactory						Completely Satisfactory

**ORIGAMI ANSWER FORM**

Team Code \_\_\_\_\_ (HRA/LTA/LC: 2a)

**ORIGAMI TEAM EXERCISE**

The team has been provided with a diagram and some short instructions on how to make a particular origami design. The team is to complete as many origamis as it can within 10 minutes. The team will be rated according to the total number of origami completed and the quality of the origami completed.

-----

(For Consultant to complete)

1. **TOTAL ORIGAMIS COMPLETED:** \_\_\_\_\_

2. Using the following scale, please rate the quality of the origamis completed according to the diagram provided to the team.

1	2	3	4	5	6	7
Completely Unsatisfactory						Completely Satisfactory

**ORIGAMI ANSWER FORM**

Team Code \_\_\_\_\_ (HRA/HTA/LC: 2b)

**ORIGAMI TEAM EXERCISE**

The team has been provided with a diagram and some short instructions on how to make a particular origami design.

**ORIGAMI ANSWER FORM**  
(Consultant Condition 2b)

(For Consultant to complete)

1. **TOTAL ORIGAMIS COMPLETED:** \_\_\_\_\_

2. Using the following scale, please rate the quality of the origamis completed according to the diagram provided to the team.

1	2	3	4	5	6	7
Completely Unsatisfactory						Completely Satisfactory



## ORIGAMI ANSWER FORM

Team Code \_\_\_\_\_ (LRA/LTA/HC: 3a)

### ORIGAMI TEAM EXERCISE

The team has been provided with a diagram and some short instructions on how to make a particular origami design. To complete this task, each team member is to assume his/her typical team role at work. The team is to complete as many origamis as it can within 10 minutes. The team will be rated according to the total number of origami completed and the quality of the origami completed.

-----

(For Consultant to complete)

1. **TOTAL ORIGAMIS COMPLETED:** \_\_\_\_\_

2. Using the following scale, please rate the quality of the origamis completed according to the diagram provided to the team.

1	2	3	4	5	6	7
Completely Unsatisfactory						Completely Satisfactory

**ORIGAMI ANSWER FORM**

Team Code \_\_\_\_\_ (LRA/HTA/HC: 3b)

**ORIGAMI TEAM EXERCISE**

The team has been provided with a diagram and some short instructions on how to make a particular origami design. To complete this task, each team member is to assume his/her typical team role at work.

**ORIGAMI ANSWER FORM**  
(Consultant Condition 3b)

(For Consultant to complete)

1. **TOTAL ORIGAMIS COMPLETED:** \_\_\_\_\_

2. Using the following scale, please rate the quality of the origamis completed according to the diagram provided to the team.

1	2	3	4	5	6	7
Completely Unsatisfactory						Completely Satisfactory

**ORIGAMI ANSWER FORM****Team Code** \_\_\_\_\_ **(HRA/LTA//HC: 4a)****ORIGAMI TEAM EXERCISE**

The team has been provided with a diagram and some short instructions on how to make a particular origami design. The team is to complete as many origamis as it can within 10 minutes. The team will be rated according to the total number of origami completed and the quality of the origami completed.

-----

(For Consultant to complete)

**1. TOTAL ORIGAMIS COMPLETED:** \_\_\_\_\_

**2.** Using the following scale, please rate the quality of the origamis completed according to the diagram provided to the team.

1	2	3	4	5	6	7
Completely Unsatisfactory						Completely Satisfactory

**ORIGAMI ANSWER FORM**

Team Code \_\_\_\_\_ (HRA/HTA/HC: 4b)

**ORIGAMI TEAM EXERCISE**

The team has been provided with a diagram and some short instructions on how to make a particular origami design.

**ORIGAMI ANSWER FORM**  
(Consultant Condition 4b)

(For Consultant to complete)

1. **TOTAL ORIGAMIS COMPLETED:** \_\_\_\_\_

2. Using the following scale, please rate the quality of the origamis completed according to the diagram provided to the team.

1	2	3	4	5	6	7
Completely						Completely
Unsatisfactory						Satisfactory

## Appendix D: Coding Instructions for Consultants Production Task

### Communication Coding Instructions for Consultants

The purpose of coding communication is to determine the varying distributions of utterances of teams when they engage in communication activity. The following list provides an overview of the definitions of the interaction coding system to be used to code team communication activity. It is important that the following list be reviewed in detail, to ensure the overall accuracy of the coding process.

<b>ORIENTATION</b>	<ol style="list-style-type: none"> <li>1. <u>Requests for clarification</u> Questions that are directed at finding out the opinions of other group members regarding goals, objectives, or operating procedures (e.g. "Rob, what are we supposed to be doing today"?)</li> <li>2. <u>Requests for evaluation/justification</u> Questions that are directed at finding out how other group members regard the goals, objectives or operating procedure for the group ("How do you guys feel about going around the table and seeing what each of us picked up"?)</li> <li>3. <u>Clarification</u> Comments that make known an individual's preference about meeting times, or the group's operating procedure (e.g. "I think we should go around the table and see what everyone thinks about this"?)</li> <li>4. <u>Keeping on track</u> Statement directing the group's movement back to its goal path with regard to the group's goals, and objective (e.g. "I thought the reason we met today was to try to figure out an answer to this problem, and not talk about ____"?).</li> <li>5. <u>Simple agreement</u></li> <li>6. <u>Simple disagreement</u></li> <li>7. <u>Miscellaneous</u></li> </ol>
<b>PROBLEM DEFINITION AND ANALYSIS</b>	<ol style="list-style-type: none"> <li>1. <u>Requests for clarification</u> Questions regarding the nature of the problem the group is confronted with (e.g. What did the instructions say about ____"?)</li> <li>2. <u>Clarification</u> Comments that make known an individual's perspective of the task/problem the group is confronted with (e.g. I think the instructions told us to do ____").</li> <li>3. <u>Simple agreement</u></li> <li>4. <u>Extended agreement</u></li> <li>5. <u>Simple disagreement</u></li> <li>6. <u>Extended disagreement</u></li> <li>7. <u>Miscellaneous</u></li> </ol>

<b>CRITERIA DEVELOPMENT</b>	<p>1. <u>Clarification of existing criteria</u></p> <p>Statements that refer to pre-existing constraints that the group must perform under (e.g. "It says that we have to do this to complete the task").</p>
<b>SOLUTION DEVELOPMENT</b>	<p>1. <u>Simple identification</u></p> <p>Statement that identifies an individual's stance or disposition. Makes known an individual's preference for a solution without elaboration (e.g. "I think we ought to go with this alternative")</p> <p>2. <u>Request for elaboration/justification of a proposed solution</u></p> <p>(e.g. "Why did you choose that?")</p> <p>3. <u>Simple agreement with a proposed solution</u></p> <p>Statement that indicates affirmation or concurrence with a proposed solution without elaboration ("That's a great idea").</p> <p>4. <u>Simple disagreement with a proposed solution</u></p> <p>("No, I don't agree with that").</p> <p>5. <u>Consensus building</u></p> <p>("Do we all agree on this then?")</p> <p>6. <u>Miscellaneous</u></p>
<b>SOLUTION EVALUATION</b>	<p>1. <u>Positive qualities</u></p> <p>Statement that identifies an individual's preference and provides a favourable justification for solution ("I think we ought to do this because _____").</p> <p>2. <u>Simple agreement with a stated positive quality</u> (e.g. "That's a good reason").</p> <p>3. <u>Simple disagreement with a stated positive quality</u> (e.g. "That's not a good reason"; "I don't like that decision at all").</p> <p>4. <u>Negative qualities</u></p> <p>Statement that identifies an individual's preference for a solution and provides an unfavourable justification of solution (e.g. "We can't choose this because _____").</p> <p>5. <u>Simple agreement with a stated negative quality</u></p> <p>6. <u>Simple disagreement with a stated negative quality</u></p> <p>7. <u>Miscellaneous</u></p>
<b>MISCELLANEOUS</b>	Utterance concerned with functions other than those previously identified.



## Interaction Coding System (Consultants)

No. of Team Members: \_\_\_\_\_ Team Code: \_\_\_\_\_

### ORIGAMI TASK

<b>ORIENTATION: Utterance concerned with team management. These utterances make known team operating procedures and logistics</b>						
Requests for clarification	Requests for evaluation/justification	Clarification	Keeping on track	Simple agreement	Simple disagreement	Miscellaneous
<b>PROBLEM DEFINITION &amp; ANALYSIS: Utterance concerned with identifying and defining the nature of the team's task/problem</b>						
Requests for clarification	Clarification	Simple agreement	Extended agreement	Simple agreement	Extended disagreement	Miscellaneous
<b>CRITERIA DEVELOPMENT: Utterances concerned with the goals or standards that choices or solutions must meet</b>						
Clarification of existing criteria						
<b>SOLUTION DEVELOPMENT: Utterance concerned with any concrete, particular, specific proposal for action</b>						
Simple identification	Request for elaboration/justification of solution	Simple agreement with solution	Simple disagreement with solution	Consensus building	Miscellaneous	
<b>SOLUTION EVALUATION: Utterances that indicate evaluation of a proposal – for or against a proposal</b>						
Positive qualities	Simple agreement with positive quality	Simple disagreement with positive quality	Negative qualities	Simple agreement with negative quality	Simple disagreement with negative quality	Miscellaneous
<b>MISCELLANEOUS: Utterance concerned with functions other than those previously identified</b>						



### Work Value Diversity (Elizur et al, 1991)

*Please indicate the relative importance of each of the items below to you, using the rating scale provided:*

1. Achievement in work

Very unimportant				Very important
1	2	3	4	5

2. Advancement, changes for promotion

Very unimportant				Very important
1	2	3	4	5

3. Benefits, holidays, sick leave, superannuation, etc

Very unimportant				Very important
1	2	3	4	5

4. Company: to be employed by a company for which you are proud to work

Very unimportant				Very important
1	2	3	4	5

5. Contribution to society

Very unimportant				Very important
1	2	3	4	5

6. Convenient hours of work

Very unimportant				Very important
1	2	3	4	5

7. Co-workers: fellow workers who are pleasant and agreeable

Very unimportant				Very important
1	2	3	4	5

8. Esteem: that you are valued as a person

Very unimportant				Very important
1	2	3	4	5

9. Feedback concerning the results of your work

Very unimportant				Very important
1	2	3	4	5

10. Independence in work

Very unimportant				Very important
1	2	3	4	5

## 11. Influence in the organization

Very unimportant				Very important
1	2	3	4	5

## 12. Influence in work

Very unimportant				Very important
1	2	3	4	5

## 13. Job interest: to do work which is interesting to you

Very unimportant				Very important
1	2	3	4	5

## 14. Job security: permanent job

Very unimportant				Very important
1	2	3	4	5

## 15. Job status

Very unimportant				Very important
1	2	3	4	5

## 16. Meaningful work

Very unimportant				Very important
1	2	3	4	5

## 17. Opportunity for personal growth

Very unimportant				Very important
1	2	3	4	5

## 18. Opportunity to meet people and interact with them

Very unimportant				Very important
1	2	3	4	5

## 19. Pay: the amount of money you receive

Very unimportant				Very important
1	2	3	4	5

## 20. Recognition for doing a good job

Very unimportant				Very important
1	2	3	4	5

## 21. Responsibility

Very unimportant

1

2

3

4

Very important

5

## 22. Supervisor: a fair and considerate boss

Very unimportant

1

2

3

4

Very important

5

## 23. Use of ability and knowledge in your work

Very unimportant

1

2

3

4

Very important

5

## 24. Work conditions: comfortable and clean

Very unimportant

1

2

3

4

Very important

5

### Raven's Progressive Matrices

(Not included here due to copyright)

### Prediscussion Preferences for NASA Moon Task

(Refer to separate protocol)

### THE QUESTIONS BELOW ARE COMPLETED BY THE SUPERVISORS OF TEAMS PARTICIPATING IN THE RESEARCH STUDY PRIOR TO THE COMMENCEMENT OF THE STUDY

Please provide a response to the following statements using the rating scale provided:

This team:

1. completes all activities specified in their task descriptions

Strongly disagree

Strongly agree

1

2

3

4

5

2. fulfills all responsibilities required by their tasks

Strongly disagree

Strongly agree

1

2

3

4

5

3. does not neglect aspects of their tasks that the team is obligated to perform

Strongly disagree

Strongly agree

1

2

3

4

5

4. satisfies all performance requirements of their tasks

Strongly disagree

Strongly agree

1

2

3

4

5

Overall, the quality of the decisions made by this team are:

Completely  
unsatisfactory

Completely  
satisfactory

1

2

3

4

5

## COMMUNICATION MEASURES

### ***TO BE COMPLETED BY TEAM MEMBERS FOLLOWING COMPLETION OF TEAM BUILDING ACTIVITIES***

Using the rating scale provided, please answer the following questions based on your experience of the teams' performance on the Origami/NASA Moon Task:

#### **Ambiguity and Shared Mental Models**

1. The team was provided with a clear explanation of what the task involved  

Strongly disagree				Strongly agree
1	2	3	4	5
  
2. The team knew exactly what was expected of them in this task  

Strongly disagree				Strongly agree
1	2	3	4	5
  
3. Team members spent a lot of time discussing how the task was to be completed  

Strongly disagree				Strongly agree
1	2	3	4	5
  
4. Team members were confident they achieved all objectives of the task  

Strongly disagree				Strongly agree
1	2	3	4	5
  
5. Each team member understood the role of the other team members  

Strongly disagree				Strongly agree
1	2	3	4	5
  
6. The team utilized the capabilities and skills of all team members to complete the task  

Strongly disagree				Strongly agree
1	2	3	4	5
  
7. Team members were clear about how they were going to undertake the task  

Strongly disagree				Strongly agree
1	2	3	4	5
  
8. Team members worked together to develop structures to successfully complete the task  

Strongly disagree				Strongly agree
1	2	3	4	5

**Reflexivity** (Adapted from Schippers et al, in press)

1. As a team we made well-considered decisions for the task performed

Strongly disagree				Strongly agree
1	2	3	4	5

2. We talked about how we were going to achieve the objectives of the task

Strongly disagree				Strongly agree
1	2	3	4	5

3. Problems in decision making were only discussed when they had become critical

Strongly disagree				Strongly agree
1	2	3	4	5

4. Before we commenced, we made sure everyone understood the nature of the task

Strongly disagree				Strongly agree
1	2	3	4	5

5. During the task, we often stopped to determine if the team was on the right track

Strongly disagree				Strongly agree
1	2	3	4	5

6. Team members discussed problems they had with the task

Strongly disagree				Strongly agree
1	2	3	4	5

7. We made sure we kept on track

Strongly disagree				Strongly agree
1	2	3	4	5

8. Problems were looked at from different points of view

Strongly disagree				Strongly agree
1	2	3	4	5

9. We made sure our decisions produced the required outcomes

Strongly disagree				Strongly agree
1	2	3	4	5

10. The team evaluated its actions

Strongly disagree				Strongly agree
1	2	3	4	5



11. We considered the way we communicated with one another

Strongly disagree

1

2

3

4

Strongly agree

5

12. The team discussed how it was going to complete the task

Strongly disagree

1

2

3

4

Strongly agree

5

13. We discussed whether the team was working effectively

Strongly disagree

1

2

3

4

Strongly agree

5

14. The team planned how it was going to complete the task

Strongly disagree

1

2

3

4

Strongly agree

5

15. All team members followed through with the objectives set

Strongly disagree

1

2

3

4

Strongly agree

5

16. All team members supported the decision made

Strongly disagree

1

2

3

4

Strongly agree

5

**Task Conflict**

Please provide a response to the following statements using the rating scale provided:

1. How many disagreements over different ideas were there in your team?

None				A Great Deal
1	2	3	4	5

2. How many differences about the content of decisions did the team have to work through?

None				A Great Deal
1	2	3	4	5

3. How many differences of opinion were there within the group?

None				A Great Deal
1	2	3	4	5

4. How much tension was there in the team during discussions?

None				A Great Deal
1	2	3	4	5

### Task Complexity (manipulation check)

*Please indicate on the following scale the level of difficulty of the tasks performed:*

Unchallenging				Challenging
1	2	3	4	5

*Please indicate on the following scale how challenging the tasks performed were:*

Unchallenging				Challenging
1	2	3	4	5

### Role Ambiguity (manipulation check)

(Adapted from Berkowitz, 1980)

Please provide a response to the following statements using the rating scale provided:

1. How clear were you about your limits of responsibility in the tasks you performed?

Perfectly clear				Not clear at all
1	2	3	4	5

2. Did you feel that you always clearly understood what you had to do for the tasks?

Perfectly clear				Not clear at all
1	2	3	4	5

**Self-Rated Communication Activity**

(Refer to separate sheet)

**Team – Rated Decision Quality (of team building tasks)**

Please provide a response to the following statements using the rating scale provided:

This team:

1. completed the activities specified in the task descriptions

Strongly disagree

Strongly agree

1

2

3

4

5

2. fulfilled all responsibilities required by the tasks

Strongly disagree

Strongly agree

1

2

3

4

5

3. did not neglect aspects of the tasks that the team was obligated to perform

Strongly disagree

Strongly agree

1

2

3

4

5

4. satisfied all the performance requirements of the tasks

Strongly disagree

Strongly agree

1

2

3

4

5

Overall, the quality of the decisions made by this team were:

Completely  
unsatisfactoryCompletely  
satisfactory

1

2

3

4

5

**Prediscussion Preference Check for NASA MOON Task  
(Conditions 1&2: Low Task Complexity)**

You are a member of a spaceship crew. Your spacecraft was originally scheduled to rendezvous with a mother ship on the lighted surface of the moon. Due to an entry failure, however, it was necessary for you and your crew to crash-land some two hundred miles from the mother ship. In landing, much of the equipment was damaged beyond use and several of the crew were injured. Five items of equipment were left intact and undamaged during the crash-landing. Because it is necessary for you to reach the mother ship as quickly as possible if you are to survive, only some of the undamaged equipment may be taken on the two hundred mile trek which lies ahead. At the bottom on this sheet you have been given a list of the five items of equipment that are still in serviceable condition.

Your task is to rank order all five items in terms of their utility and importance in ensuring your survival on the journey to the mother ship. Place a number "1" by the most important item, number "2" by the second most important item, and so on to number "5" for the least most important item. Consider at all times what you know about the moon conditions in making your selections.

\_\_\_\_\_ food concentrate

\_\_\_\_\_ Portable heating unit

\_\_\_\_\_ 2-100 lb. tanks of oxygen

\_\_\_\_\_ Signal flares

\_\_\_\_\_ First-aid kit also containing injection needles

**Prediscussion Preference Check for NASA MOON Task  
(Conditions 3&4: High Task Complexity)**

Please provide a response to the following scenario:

You are a member of a spaceship crew. Your spacecraft was originally scheduled to rendezvous with a mother ship on the lighted surface of the moon. Due to an entry failure, however, it was necessary for you and your crew to crash-land some two hundred miles from the mother ship. In landing, much of the equipment was damaged beyond use and several of the crew were injured. Five items of equipment were left intact and undamaged during the crash-landing. Because it is necessary for you to reach the mother ship as quickly as possible if you are to survive, only some of the undamaged equipment may be taken on the two hundred mile trek which lies ahead. At the bottom on this sheet you have been given a list of the five items of equipment that are still in serviceable condition.

Your task is to rank order all five items in terms of their utility and importance in ensuring your survival on the journey to the mother ship. Place a number "1" by the most important item, number "2" by the second most important item, and so on to number "5" for the least most important item. Consider at all times what you know about the moon conditions in making your selections.

\_\_\_\_\_ 1-case dehydrated pet milk

\_\_\_\_\_ 2 x .45 calibre pistols

\_\_\_\_\_ magnetic compass

\_\_\_\_\_ box of matches

\_\_\_\_\_ portable heating unit