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A Dyadic Composition to Foster Virtual Team Effectiveness: An Experimental Study

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A DYADIC COMPOSITION TO FOSTER VIRTUAL TEAM EFFECTIVENESS: AN EXPERIMENTAL STUDY

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ABSTRACT

A DYADIC COMPOSITION TO FOSTER VIRTUAL TEAM EFFECTIVENESS: AN EXPERIMENTAL STUDY

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The importance of effectiveness for virtual teamwork continues to gain momentum as technology and globalization of work accelerate. The implementation of virtual teams provides one approach to enhance competitiveness, overcoming the disadvantages of space and time differences through collaborative technologies. The influence of structure to virtual team performance has not been clearly established in the literature. The purpose of this research study was to investigate the effectiveness of a dyad structured approach for virtual teams using a quasi-experimental research design.

This research investigated four questions related to the influence of structure on virtual team effectiveness related to task performance, communication frequency, and team satisfaction. Research questions included: (1) How does a dyad structure influence virtual team performance?, (2) What is the impact of a dyad structure on virtual team effectiveness with respect to task outcome?, (3) What is the impact of a dyad structure on virtual team effectiveness with respect to team satisfaction?, and (4) What is the impact of dyadic communication on virtual team effectiveness in terms of reducing overflow communication?

The research approach was a quasi-experiment design to test the effect of a dyad structure, compared to self-structured, design on virtual team performance. A total of one-hundred eleven participants were placed in thirty-eight virtual teams, including dyad

and self-structured assignments. The participants included graduate and undergraduate students from different universities in the US, Israel, Colombia, and the Netherlands. The teams completed a task using a web-based virtual environment, reached a team decision, and reported their satisfaction and perceptions of the experience through a self-reporting web-based survey. Hypotheses on task performance, team satisfaction, and the amount of communication were tested for differences between dyad structured and self-structured virtual teams. Statistical analyses were conducted to assess differences between the dyad and self-structured teams.

The results showed significance differences between the two virtual team structural configurations. Dyadic teams performed better in arriving at the task solution using less communication to finish the task. Dyadic teams were also more satisfied with their task solution than the self-structured teams. However, results indicated that dyadic teams were not satisfied with operating as a dyadic team in this study. The research also demonstrated that team satisfaction was the most significant predictor of virtual team effectiveness. The research document concludes with implications for further research and suggests guidance for improved effectiveness in design and implementation of virtual teams.

To my loving mom, and my late father, both who encouraged me with every decision I made, and supported me until the end.

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This tremendous accomplishment can not be done without help and support of one's family. I would like to thank my mom and my siblings for their continuous emotional support, encouragement, and faith in me. The final and last thank you goes to all my friends both in U.S, and in Turkey who supported and waited patiently for me to finish. I am grateful that they still keep me as a friend even though I could not spend too much time with them while I was in the last stages of my writing.

Thank you all. I would not have done it without you. Now it is time to celebrate!

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CHAPTER I

This chapter introduces the nature of the research problem investigated in this research. It begins with a brief introduction to virtual teams and continues with dyadic teams. The research problem is explained, purpose of the research is introduced, and research questions and hypotheses are presented. The chapter concludes with the organization of this dissertation.

INTRODUCTION

The importance of effectiveness for virtual teamwork continues to gain momentum as technology and globalization of work accelerate. The implementation of virtual teams provides one approach to enhance competitiveness, overcoming the disadvantages of space and time differences through collaborative technologies. Using virtual teams to perform major projects in organizations is becoming more prevalent as the pace and geographical distribution of work increases (Gibson and Cohen, 2003).

Innovations in technology and in organizational approaches are compelling companies to be more competitive and seek the advantages of technology for structuring work teams to be more effective in virtual environments. Large-scale implementation and adoption of virtual teams offer a different way of working, yet the structure, function, and operation of these teams are proving to be significantly challenging for most companies (Nemiro, 2004). Nevertheless, notwithstanding the associated difficulties, the advantages of virtual teams have resulted in their recognition as worthy endeavors. Virtual teams can produce multiple benefits including reduced costs of travel expenses, enabling more timely deliveries of products, services and decisions, help forging new markets that rely

on speed as a performance driver, increased competitiveness in fast-growing global markets, facilitated incorporation of globally based experts into routine operations, and allowance for more flexible work hours for the employees. These advantages offer organizations a major source of competitiveness for the future. Forward focused organizations will be challenged to make the most out of their virtual teams.

Virtual teams are a relatively new concept emerging as a result of increasing sophistication and availability of enabling technologies. Since virtual teams are still in their infancy as a field of study, investigating virtual teams requires us to establish a working definition as a starting point for further development. At this point, as a basic understanding of virtual teams, the following initial definition is offered:

"Virtual teams are groups of people who find themselves separated by distance and/or time, yet have common tasks to perform" (Edwards and Wilson, 2004, pg. 6).

This definition emphasizes groups, geographical separation, and the focus on common tasks as essential elements. Also implicit in this definition is the use of technology as an integrating medium. A significant challenge in virtual team research is to find different approaches of making virtual teams more effective. The literature on virtual teams suggests three major topic areas that appear to address virtual team effectiveness: a) technology/communication, b) team, and c) task. Some of the subsidiary topics studied under these three constructs include but are not limited to the following: leadership (Yoo and Alavi, 2004); creativity (Nemiro, 2004); culture (Gibson and Cohen, 2003); commitment (Powell, 2000), and trust (Jarvenpaa and Leidner, 1998). Furthermore, McGrath and his colleagues have examined task characteristics and time effect related to technology selection (McGrath, 1991; McGrath et al., 2000). They

suggested that media choice is very important for task effectiveness. However, in the examination of virtual team effectiveness, the research has not fully addressed the effects of team structure in relationship to the task performance. Team structure may be a major factor in terms of task effectiveness in global organizations. To address this gap, rigorous exploratory research is suggested to examine the relationship of task-team structure to virtual team performance.

Since virtual teams are still new in practice, new methods and approaches are needed to study them. Today, there is a little question in the literature that, by implementing virtuality in their traditional style of work, companies can overcome the disadvantages of space and time differences (Powell et al., 2004). Although virtual team research has received increased interest in the last decade, the study of team structure related to task effectiveness has received little attention. The goal of this research is to investigate this area.

Nature of the Problem

In this research, dyadic and self-structured teams were investigated to determine the impact of team task structure on team performance where task performance and team satisfaction are the measurement merits for team success. The following section introduces the idea of why the researcher believes dyads have different structure than other teams.

Dyadic Structure

The nature of dyad structure is central to this research. Dyadic relationships exist in every day encounters, and are essential to the functioning of individuals. Dyads can be found in a spectrum of relationships including the personal level such as parent-child,

husband-wife, or in the professional level such as boss-employee, and teacher-student. When two people get together, they form a dyad. Dyads have been examined in different ways in the literature. There have been various studies from the organizational, and communication viewpoints of dyads. However, most of the dyadic studies in the literature are found in the romantic and emotional levels in intense relationships such as marriages. In team structure studies, dyads have been somewhat ignored (Dennis et al., 1991; Nunamaker et al., 1991). In addition, these past studies in dyadic relationships have been limited to face-to-face situations. However, interest in dyadic teams in virtual environments, or virtual dyads, has recently started gaining momentum in the virtual team literature (Kinney, 1992; Espinosa and Carmel 2004). This suggests that the time is ripe for additional research into the nature and impact of dyads in virtual team environments.

In a study that investigated managerial communication patterns analyzing past studies, Panko (1992) observed that forty percent of all meeting time in organizations is spent in dyadic communications. According to Panko (1992), in most group-work studies, dyadic meetings and communications were ignored. However, dyadic communication took almost the half of all communication time. Similar to Panko's results, Lurey (1998) found that in one of the subject companies, most relationships in virtual teams were managed as dyads even though he did not delineate any specific structuration directions. It appears that dyadic communications plays a significant role in organizational structure. The present research considered dyadic teams as an exceptional team structure that may have an essential impact on virtual team effectiveness.

For the purpose of this research, a dyadic team is considered as two person-structured teams working on a particular task. According to Panko and Kinney (1992), a dyad is "a pair relationship that functions as a recognizable organizational unit for a significant period of time" (p.244). In 1950, sociologist Georg Simmel used the term "fragile" to describe the truly unique dyad structure as a differentiation from large teams. What is unique about dyads is that if one member does not cooperate, or withdraws, the structure dies, and group performance suffers. However, on the other hand, an efficient dyad coordination may result in enhanced levels of performance. According to Poole and Billingsley (1989), dyads are less prone to the larger group structure issues with becoming sidetracked. In effect, dyads are more capable than larger groups of focusing on the task.

Dyads Vs. Larger Groups

Panko and Kinney (1992) suggest that an ideal way to examine the topic of dyad structure is to compare dyads with larger groups on different dimensions. Following this suggestion, this research investigated the task effectiveness, communication frequency, and team satisfaction between dyadic virtual teams and four person virtual teams. It has previously been established that dyadic teams operate differently than both individuals and larger groups as well as being structured differently (Poole and Billingsley, 1989). It was also discovered that social context is an important element of structuration in dyadic relationships, and that dyads are more capable of adapting to context regardless than larger team structures. Dyads were found to work in ways that provided continuous open restructuring and interpretation of tasks. In addition restructuring was critical in dyadic interactions. Poole and Billingsley (1989) also linked dyadic teams to the theory of

structuration of Giddens (1986) and attempted to create a theory of dyadic decision-making. Following the early work related to dyads, the present research acknowledges that dyads are unique team structures that suggest different characteristics phenomena than larger teams, not yet fully understood and worthy of further investigation.

In this research, four person teams called unstructured virtual teams, or self-structured virtual teams were used for comparison to the unique dyadic structure. Hackman (2002) argues that teams show better performance without any structuration. This possibility might also be valid for dyadic teams since this assertion has not been tested exclusively in the literature. However, there is no evidence to support that this argument is also applicable for virtual teams. According to Jarvenpaa and Shaw (1998), often virtual teams are self-managed. In this research, the effect of self-structuring was tested using a quasi-experiment design with the self-structured teams as the control in the design. To do so it was assumed that both teams would be self- structured, but dyadic composition would result in better performance. Thus, the stage was set for the research to examine the impact of dyadic structure in virtual team performance.

Another general topic concerning structure that surfaces in the literature is the impact of team size. Team size as a variable of concern is a particular interest in this research. While some small group researchers claim that optimal team size is five people, in the virtual team literature, most repeated group size in experiments involve teams of six to twelve people (Fjermestad and Hiltz 1999). However, Panko (1992) states that this claim has weak support due to publication predispositions favoring the study of larger teams sizes for research. The present research considered four as an appropriate team size due to two primary reasons: 1) In the research literature, four person groups have been

shown to offer almost no superiority to dyadic teams (Panko and Kinney,1992). In other words, if you place two-dyads in a team, there is no supporting research evidence that they will work uniquely as two separate dyads. Therefore, being in a four-person team (two-dyads) will not necessarily provide an advantage over single dyads, and 2) Structuring four-person teams was due to the sensitive relationship between subject size and statistical power. The unit of analysis in this research was the team. Therefore, to make the sample size more powerful, following Reis, et al.(2000) and Shadish, et.al,, (2002), it was preferable to structure four-people teams rather than structuring five or six person teams.

The comparison of two virtual teams is an important distinction of this research. Prior scholarly research conducted on virtual teams has been focused on comparison of virtual team results in contrast to traditional, face-to-face teams. However, existing research literature has already documented successful results of virtual team implementation in contrast to face-to-face teams (Huysman et al., 2003). Therefore, comparison of virtual team results in contrast to face-to-face teams would not sufficiently push the boundaries of virtual team knowledge by exploring new ground necessary to move virtual team research forward. Therefore, the focus of the present research is on the comparison of two virtual teams and the difference that structure might have on their performance.

Research Purpose

The purpose of this research study is to assess the effectiveness of a dyad structured approach for virtual teams using a quasi-experimental research design. The nature of effectiveness, dyad structure, and virtual teams- for purposes of this research

effort- will be established in subsequent sections of this document. In addition, specific details of the quasi-experimental design will also be detailed. However, at this juncture, it is important to note that the quasi-experimental design was selected to conduct testing on the phenomenon of interest (dyad structure in virtual teams) where true experimental control was neither achievable nor necessarily desirable. The quasi-experimental approach guided detailed and rigorous examination of the phenomenon.

Uniquenesses of dyadic teams have been introduced in the previous section. Although dyads and their task performance are subsequently reviewed in detail, this section briefly establishes some essential background on research studies related to dyadic team structure in terms of task productivity. The purpose is not to provide a detailed literature review. On the contrary, this establishes essential knowledge such that the following document will more readily accessible.

Dyadic teams have been previously recognized as improving effectiveness in terms of task productivity. In education studies, dyadic structures are recognized as an important contributor to success of cooperative learning method (George, 1999; Dugal and Eriksen, 2004). This method aims to have students to collaborate in small groups or dyads to help each other learn and teach together (George, 1999). In a cooperative learning structure, one partner becomes the recaller; the other becomes the listener, and it is assumed that they have the same/similar knowledge type. This type of structure corroborates the idea that small groups organized in dyads can improve achievement levels. Dyadic structures have been used in leadership studies, where one person is the leader and the other functions as a member. One of the well-known leadership theories in dyads, vertical dyad linkages, is traced to early nineteen-seventies (Dansereau et al.,

1975). Kinney (1992) investigated the effect of media richness on dyadic teams in terms of communication. Moreover, dyadic structure has been demonstrated conceptually in global virtual teams to reduce costs of coordination (Espinosa and Carmel 2004). Kinney and Panko (1992) also suggested the cost effectiveness of dyadic teams in coordination as well. Valacich et al., (1994) also extended previous work on the Media Richness Theory using dyads to understand task-media relationship. While present research did not look at the cost of coordination and communication richness, it was certainly inspired by the idea of using dyadic teams in virtual collaboration. The enduring theme of dyad team structures enhancing effectiveness was the central focus on this research.

Some earlier research reported that dyads are unique in their higher-level performance, but demonstrate lack of coordination skills (Zigurs, 1988). The recent literature supports that dyads are a significant new trend in team-task structure studies in virtual environments. For example, Ramesh and Dennis (2002) suggested an approach following this trend after investigating coordination and communication process within virtual teams: the object-oriented model for global virtual teams. Espinosa and Carmel (2004) suggested using dyadic groups in the global environment, while Olson and Olson (2000) advocated coupling the work. The common thread between these team-structuring concepts suggests dividing team members into small-sized teams based on task. Since the smaller team size is accepted as two and the concept of team-task structuring is still under exploration, this earlier work provides a useful starting point to test the dyadic team structure impact on virtual team effectiveness through empirical study. Accordingly, the earlier work somewhat suggests that instituting a dyad-structure approach in virtual teams will result in improved performance of a decision-making task solution. This earlier work

has set the foundation for the research to explore this, as yet, unsupported suggestion from the literature. This background has set the stage to examine the impact of dyad task structure on effectiveness in virtual teams through an appropriate quasi-experimental design. Having established this foundation, the specific questions that motivated this research are developed below.

Research Questions

This research seeks the answer to four questions of virtual team effectiveness on task performance, communication frequency, and team satisfaction. This research will investigate the effectiveness of dyad structured approach in virtual environments to answer the following questions:

1) How does a dyad structure influence virtual team performance?

2) What is the impact of a dyad structure on virtual team effectiveness with respect to task outcome?

3) What is the impact of a dyad structure on virtual team effectiveness with respect to team satisfaction?

4) What is the impact of dyadic communication on virtual team effectiveness in terms of reducing the overflow communication?

The following section develops each of the research questions. Referring to our basic virtual team definition, one may presume that virtual team performance relies on available technologies that are bounded by the degree of virtuality. However, one might also suggest that the tasks (type, difficulty level, etc.) executed by team also effects performance. Furthermore, a virtual team that relies on advanced-technology can be evaluated by the teams' performance based on task productivity and individual

satisfaction (Gibson et al., 2003; Potter and Balthazard, 2002; Powell et al., 2004). Many variables, which are not visible all the time, factor into the effectiveness of a virtual team. In a traditional team environment where members can see each other on a regular basis, it is easy to recognize ongoing problems or conflicts related to teamwork (Duarte and Synder,1999). However, when a virtual team has a similar problem, it is harder to identify the problem itself and its source. In some cases, teams do not realize that they have significant problems unless a person leaves the team, or the task output is demonstrably affected (Duarte and Synder, 1999). Responding to this research question will provide insight into the dyad structure influence on virtual team performance.

Different perspectives exist on team satisfaction in the literature. Traditional team literature is focused almost exclusively on satisfaction. Team satisfaction has been linked to different attributes, but most commonly it has been linked to individual satisfaction with the team and satisfaction with the task. In the case of virtual teams, satisfaction mostly evaluated looking at team and task satisfaction, and technology satisfaction. In dyads, satisfaction mostly addressed within partner relationships at socio-emotional level. The satisfaction in dyadic virtual teams has not been investigated extensively. Virtual team literature indicates team performance is highly associated with team satisfaction. Therefore, this research investigates dyadic team satisfaction at team level measuring the level of satisfaction with two merits:1) being in the virtual dyadic teams, and 2) satisfaction with the task outcome.

The communication frequency and amount of communication is another determinant of effectiveness in virtual teams. Olson and Olson (2000) used the concept of coupling to explain frequent communication in virtual teams as an element of their

effectiveness. Olson and Olson's work referred to coupling as a kind of communication required by the work of a virtual team. From their perspective, coupling is tied to the task design. According to their research, tightly coupled work, which requires the work to be highly independent from the task, may not be suitable for virtual teams. Ramesh and Dennis (2002) argued that because tight coupling increases frequency of communication between all members, it might not be useful for a virtual team. As a solution, they offer their object-oriented model, which allows the team members to work in a loosely coupled task environment.

According to Poole and Billingsley (1989), dyads can focus on task representation, and do not sacrifice this focus for social communication, or unrelated topics to the task. Whether they are close or distant to each other, dyad's work focused on what is important. This demonstrates that dyads are more task-orientated than large groups. Large groups have a shorter attention span than dyads according to Poole and Billingsley (1989). While dyads can focus on a common view to finish the task, large groups may have a great deal of different perspectives necessary just to reach a common view. This would result in overflow communication ancillary to the task while dyads would perform their task maintaining the focus of communication on the task. This unique advantage gives dyads greater opportunity in making better decisions. In sum, research suggests that frequent communication in virtual teams may affect the productivity. Dyads can be extremely helpful in providing a framework to address the problem of appropriate focus on communications limited to task achievement (Kinney, 1992).

Having established the research questions, the following section introduces the hypotheses that will be studied in this research.

Research Hypotheses

This research examines dyadic team structure impact on team effectiveness in a virtual environment. It is assumed, as supported by the literature, that dyad-structured teams: 1) reduce unnecessary communication relating to task due to their unique structure, and 2) perform better than their counterparts in four-person self- structured teams. Based on preliminary findings from the literature, four hypotheses have been derived to guide the establishment of the quasi-experimental research design to examine the impact of the dyadic structure on virtual team performance.

The first hypothesis is designed to investigate task outcome effectiveness of dyadic virtual teams. It is proposed, that

Proposition (1): A dyad-structured approach significantly affects task outcome as a performance merit of a virtual team.

It is assumed that the unique structure of dyadic teams keeps them focused on a task more than self-structured teams. The supposition is that the dyad structure will consequently increase the chances of dyadic teams performing in a manner that result in their significantly increased ability to find the correct solution. This hypothesis is stated as:

Hypothesis 1:

There is no statistically significant difference between the dyad-structured approach and the unstructured (self-structured) approach based on the correct task decision produced by virtual teams.

The second hypothesis is designed to investigate whether dyadic virtual teams indeed reduce the amount of communication. It is proposed, that

Proposition (2): A dyad-structured approach significantly reduces the amount of communication.

The literature supports the assertion that since dyads are more task-focused, then they would limit the communication relating the task. If this statement holds true, then dyadic teams can be preferred in organizations to limit unnecessary communications as a way to increase performance. This statement is hypothesized as:

Hypothesis 2:

There is no statistically significant difference between the dyad-structured approach and the unstructured (self-structured) approach within virtual teams based on the amount of communication produced.

The third and fourth hypotheses are designed to investigate whether these work dyads are more satisfied with team's outcomes as compared to their counterparts in self-structured teams. It is proposed, that

Proposition (3): A dyad-structured approach significantly affects team satisfaction as a performance merit of a virtual team.

The literature has supported that dyads are more task-focused and they correspondingly reduce the amount of communication within a team, keeping that team on task related issues. The question is that whether these dyads are satisfied with the task outcomes of the team as well. The third hypothesis investigates dyadic teams' own satisfaction with being in that particular dyad. Correspondingly, the fourth hypothesis investigates dyadic teams' own satisfaction with task outcomes.

Hypothesis 3:

There is no statistically significant difference between the dyad structured approach and the self-structured approach based on overall satisfaction

Hypothesis 3a:

There is no statistically significant difference between the dyad-structured approach and the unstructured (self-structured) approach based on the satisfaction with task outcomes.

Hypothesis 3b:

There is no statistically significant difference between the dyad-structured approach and the unstructured (self-structured) approach based on the satisfaction with being in that particular team.

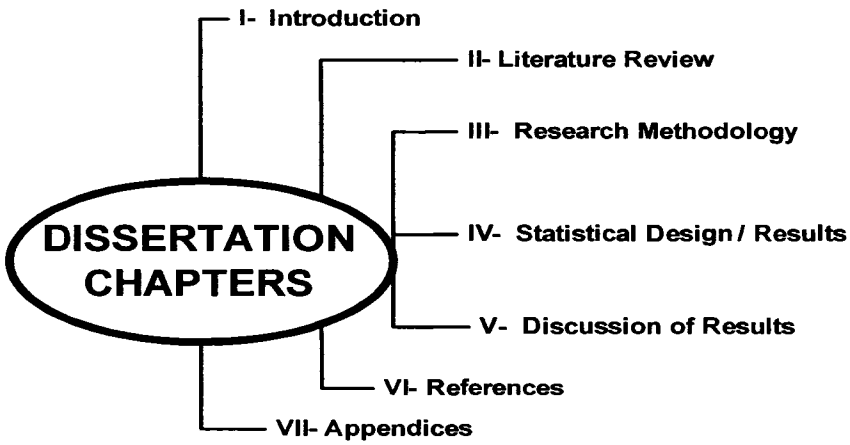
As a summary of proposed hypotheses, the research claim may be captured with the following statement: *Dyadic teams will perform better in task solution, because they reduce unnecessary (not task relating) communication, which increases the complexity to reach solution/consensus. At the termination of project, the dyad structured teams will be as satisfied as their counterparts with the task solution and being in dyadic teams.*

Organization of This Document

Organization of this document is visualized in the figure below. Chapter I has introduced the background, purpose, and specific questions and hypotheses guiding the research. Chapter II provides the foundation for this work via a comprehensive literature review. The chapter delineates the operational definition of variables, discusses virtual team effectiveness and provides a discussion on dyadic virtual teams. It concludes with a summary of current literature related to this research. Chapter III develops the research methodology. The chapter provides detailed information about the research design,

subjects, experiment procedures, data collection, and measurement of research variables. Chapter IV presents the statistical design and results of the data analyses. The following chapter, V, discusses the results based on statistical analysis. In this chapter, the implications for theory, methodology, and practices are examined. Additionally, limitations and future directions for the research are developed. Finally, the dissertation finishes with the selected bibliography. The appendices enclosed contain the details of the experiment materials, pilot experiment results, permissions attained for use of materials and approval of ODU human research review board.

Figure 1. Organization of the Dissertation Chapters



This chapter introduced the research problem, and related hypotheses. It provided brief background information on virtual teams and dyadic teams. Why dyadic teams were chosen to investigate is justified. The research problem was explained, purpose of the research was introduced, and research questions and hypotheses were presented. The chapter concluded with the organization of this dissertation.

CHAPTER II
LITERATURE REVIEW

The literature review provides an essential foundation for constructs used in this research as well as establishing the current state of knowledge with respect to the research domain. The literature is organized in three broad domains to accomplish three primary goals. The first goal is to analyze and critique the current literature on virtual team effectiveness. This is achieved in two parts: a) reviewing the effectiveness literature of virtual teams, and b) reviewing the effectiveness of dyadic teams in virtual team literature. The second goal of this review is to examine the relationships between task and team in the virtual team literature. The third goal of this section is to establish and operationalize the critical variables necessary to support development of the research hypotheses to be tested in the quasi-experimental design.

Definition of Constructs and Operationalization of Variables

This section of the literature review is focused on establishing the constructs and definitions to provide the fundamental grounding of key constructs and operational definitions necessary to support the research effort. The constructs of team, virtual teams, dyadic team, and self-structured team are defined and operationalized for purposes of this research. The section concludes with operationalizing the variables necessary for the testing the research hypotheses in the quasi-experiment.

Team

There are many definitions for the term *team* based on significant commonalities in the literature. A team, simply stated, is a group of people who come together to accomplish a task (Donnelon, 1996). Katzenbach and Smith (1993) argue that a team is composed of several people to achieve common goals and fulfill the common responsibility. Kinlaw (1998) defines work teams as an organizational unit, which was traditionally, formed the basic building block of organizational performance (p.21). Arrow et al (2000) defines groups as "complex, adaptive, dynamic, coordinated, and bounded set of patterned relations among members, tasks, and tools" (p.34). The following definition of team by Cohen and Bailey (1997, p. 241) is used as a reference point to inform the research effort:

"A collection of individuals who are interdependent in their tasks, who share responsibility for outcomes, who see themselves and who are seen by others as an intact social entity embedded in one or more larger social systems (for example, business unit or the corporation), and who manage their relationships across organizational boundaries."

Virtual Team

Despite some general consensus on team definition, there is no single agreed upon definition for *virtual teams.* The term *virtual team* is used very casually in the literature. Any work that is by conducted via advanced technology seems to qualify as *virtual* (Gibson and Cohen 2003). The literature mostly cites virtual teams as teams from similar professional backgrounds who may have never met before, or may have not previously worked together, but come together for a specific purpose. Their geographic locations are

dispersed and they are not co-located. They use computer-mediated technology both synchronous and asynchronous, but mostly without eliminating the initial face-to-face launch (Lipnack and Stamps, 1997; Jarvenpaa and Leidner, 1998; Gibson and Cohen 2003). Cultural diversity and zone-difference/time diversity are added to this common definition if we define *global virtual teams* (Jarvenpaa and Leidner, 1998). Table 1 provides some of the selected virtual team definitions.

Table 1. Selected Examples of Virtual Team (VT) Definitions

Author	***Definition***
Lipnack and Stamps, (1997, p. 6-7)	*VT, like every team, is a team of people who interact through interdependent tasks guided by common purpose. Unlike conventional teams, a VT works across space, time, and organizational boundaries with links strengthened by webs of communication technologies.*
Jarvenpaa and Leidner (1998)	*A VT is an evolutionary form of a network organization enabled by advances in information and communication technology. A global team is to be a temporary, culturally diverse, geographically dispersed, electronically communicating work team.*
Gibson and Cohen (2003, p. 4)	*To be considered virtual to some degree, a team must have the following three attributes.* *- It is a functioning team: a collection of individuals who are independent in their tasks, share responsibility for outcomes, see themselves and are viewed by others as an social unit embedded in one or more social systems, and collectively manage their relationships across organizational boundaries* *- The members of the team are geographically dispersed.* *-The team relies on technology-mediated communications rather than face-to-face interaction to accomplish their tasks.*
Pinsonneault and Caya (2005, pg. 2)	*To be considered as VT;* *- team members are separated by distance* *- team members are forced to rely on technologies to mediate communication and to coordinate work*

In addition to these different definitions, Cohen and Bailey (1997) identify four different types of teams in organizations: (1) work teams, (2) parallel teams, (3) project teams, and (4) management teams. Among these four types of teams, virtual teams fall into the project team category because of their one-time task to be completed within a specified time with the same particular team. Virtual teams can also be considered to function as a semi-autonomous work team. However, work teams usually require long-term commitment on continuous tasks, which make virtual teams somewhat unqualified for the work teams' category (Cohen and Bailey, 1997).

After reviewing the various definitions for virtual teams, Hertel et al. (2005) identified a consensus on virtuality as in following central themes:

a) two or more persons who collaborate interactively to achieve common goals while at least one of the team members works at a different location or organization, or even at a different time.

b) communication and collaboration predominantly based on electronic media.

An ideal virtual team based on these themes uses only electronic media with workers at different geographical locations. However, in reality, most existing virtual teams have some degree of face-to-face communication (Hertel et al., 2005). Given the attention to various definitions and concepts provided above, the following definition is adopted for the purpose of this research effort, which also provides a critical delimitation for this study:

"Virtual teams are small work/project teams that are geographically dispersed and collaborate via computer-mediated technology, predominantly over the Internet, with a potential face-to-face initiation in order to work for a specific purpose and/or specific

piece of work. It is possible that they may or may not have worked together before, and they may or may not see each other again after the work is completed" (Karayaz, 2004, pg.242).

Small work/project teams, for the purpose of this research, are defined as teams that consist of interdependent members mutually interacting, formed for project tasks, and using technology with shared consequences (Arrow et al., 2000). This definition of work teams is such that it does not emphasize large groups of people, since there is an expectation of interdependence and mutual interaction. Consequently, the researcher is able to handle research of the teams effectively, with the upper limit of the size of a small team is considered twenty and the lower limit starting with two people according to Arrow et al (2000). This research used two as the lower limit, and four as the upper limit, consistent with the guidance provided by Arrow, et al., (2000).

Dyadic Virtual Teams

When two people get together, they form a dyad. At its most basic definition, a dyadic team represents two person-teams. From an expansive perspective, in the social psychology field, dyad partners are distinguished by their social exchange and cognitive style (Cheng et al., 2003); in the leadership studies, they are distinguished by their power exchange (Dansereau et al.,1975). Dyads in education research are distinguished by their information and idea exchange (George, 1999; Dugal and Eriksen, 2004). In this research, a dyadic virtual team is defined as "a two person-structured team working virtually on a particular task in a certain period of time". This is consistent with the following definition of a dyad from Panko and Kinney (1992, p. 244): "a pair relationship that functions as a recognizable organizational unit for a significant period of time".

As mentioned earlier, one of the reasons that dyadic teams have been preferred to other structures is that dyads enable greater control of information flow (Hauschildt and Kirchmann, 2001). This characteristic of dyads plays an important role in this research because one of the inspired ideas of using a dyadic form is to reduce overflow communication without decreasing productivity.

Self Structured Virtual Teams

Virtual teams are frequently formed as self-managed according to Jarvenpaa and Shaw (1998). This characteristic of virtual teams makes them qualify to be a self-managing work team or self-structured virtual teams that are predominantly established ad-hoc. Self-managing work teams (Polly and Dyne, 1994) are similar to virtual teams in that each is expected to come together to perform a task over some short period of time (Karayaz, 2005). These self-contained groups are expected to self-organize to complete work where they are responsible for task performance as well as managing the task and group (Polly and Dyne, 1994).

Hackman (2002) argues that a good work structure motivates individual task performance in self-structured teams; however, giving the task to team members to figure out is preferred over dividing and assigning tasks to individuals according to their work. Norms or assumptions emerge from human's knowledge over which neither intelligence nor leadership have much influence on the effectiveness of self-structured teams (Hackman, 2002). He also argues that teams show better performance without any structuration. Thus, there is no evidence that this is true for virtual teams. In this research, this contention of Hackman concerning the structuration effect will be tested using a self-structured team as a control team. Therefore, for this research, self-structuration is a

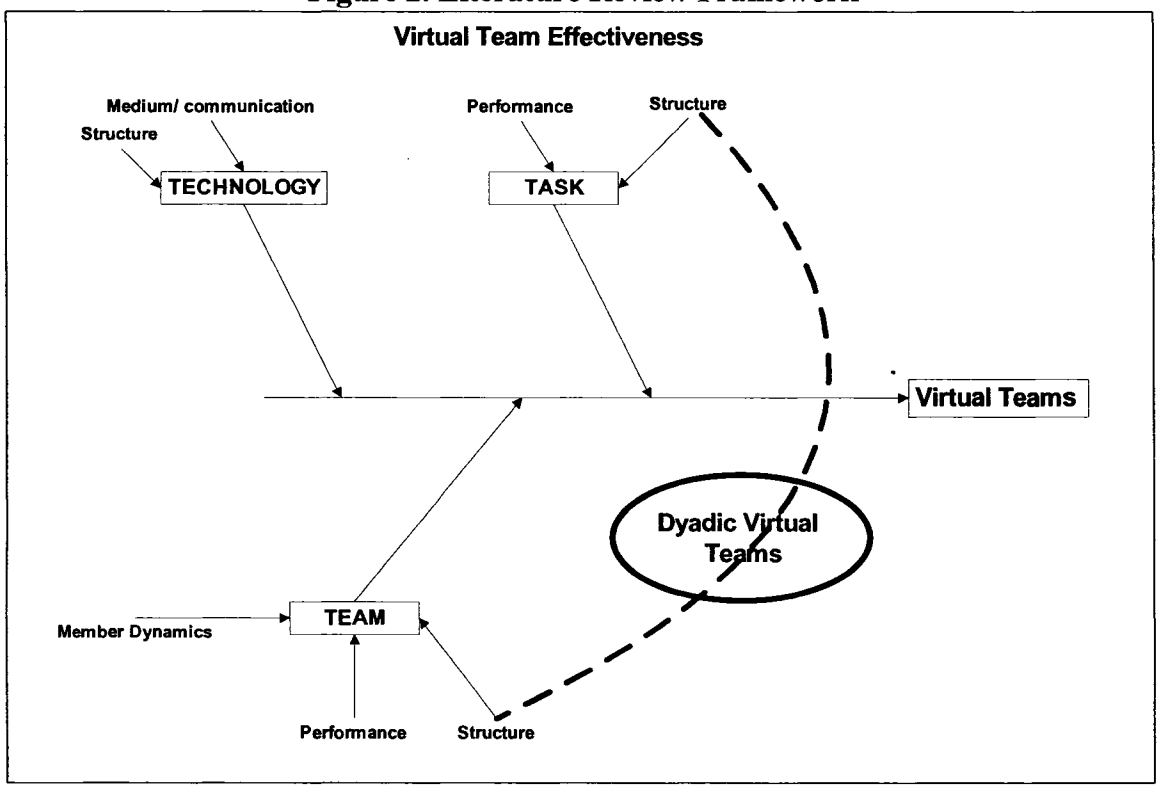
structural approach that refers to the control team in which members are not assigned to any specific task. It is assumed that they will self-organize to accomplish the task consistent with instructions provided.

In the beginning of this chapter, one of the goals identified was to establish and operationalize the critical variables necessary to support development of the research hypotheses to be tested in the quasi-experimental design. This section provided definitions of constructs used in this study. Drawing from the literature team, virtual team, dyadic virtual team, and self-structured team definitions are operationalized. In the following section, the literature review begins in order to accomplish other goals of this section.

Framework to Study Literature

The literature review is introduced in two sections to accomplish the primary goals. The first part, *virtual team effectiveness,* is designed to explore the literature related to virtual team effectiveness. This effort begins with exploration of definitions and explanations of the concepts of virtual teams and effectiveness. The focus is on the exploration of three primary dimensions that relate to effectiveness: a) technology, b) team, and c) task. The second aspect of literature examined deals explicitly with *dyadic virtual teams and structuration and task effectiveness.* This aspect of the review is designed to explore virtual team literature on dyadic teams and their task related performance. Figure 2 shows the relationship among these aspects of the literature review. Another purpose of the literature review is to establish the gap in the body of knowledge that was addressed by this research. The literature review section concludes with a summary of findings.

Figure 2. Literature Review Framework



Virtual Team Effectiveness

Team researchers continue to explore the factors between team effectiveness and team performance. From various definitions, it is apparent that different elements contribute to team effectiveness such as technology, size, time zone difference, member dynamics, and task complexity. In the research on traditional teams, one can find extensive work on team effectiveness. However, due to their nature, virtual teams do not fit precisely into traditional measurements of team effectiveness. However, it is important to elaborate the concept of traditional team effectiveness, which provides a starting point for the examination of virtual team effectiveness. There are several existing frameworks

and theories of team effectiveness that have been applied within the computer-mediated communication studies, such as the Time, Interaction and Performance (TIP) theory (McGrath, 1991), Hackman's Effectiveness Model (1990), Media-Richness Theory (Daft and Hengel,1984) and Adaptive Structuration Theory (Poole and DeSanctis, 1994). These theories were designed to seek different effects of technology, team effectiveness, technology adaptation, and time on team performance. However, the effect of team structure upon effectiveness is neglected in the literature. In addition to these theories, some communication research attempted to link communication technologies and effectiveness as well (Tschan, 2002).

Defining effectiveness is a controversial issue in the team literature, providing a contrast of different perspectives. Several team study researchers have considered traditional team effectiveness in terms of tangible outcomes of a team effort (Tindale et al., 1998). There are different perspectives such as Steiner (1972), who argues that effectiveness can be described in terms of process losses, while Hackman and Morris (1975) argue that effectiveness is determined in the interaction process between group members while they are working on a task. Lipnack and Stamps (1997) focus on whether or not teams meet their goals and objectives based on the nature of task assignment. Among different interpretations, Hackman (1990) created one of the most influential and cited effectiveness criterions. He defines team effectiveness in three ways: 1) productive output (product, service, and decision) that meets the standards of expectations; 2) team ability to work together (team well-being); and 3) team-member satisfaction (as a necessary component for the well-being of individuals). Although this criterion is used

frequently, it may not be qualified for virtual teams due to its lack of consideration for technology related problems.

The research area of virtual teams, to some extent, involves more than one academic field. One can find references to virtual teams under the field of team decision support systems, information systems, human-computer interaction, computer-supported cooperative work, virtual collaborative work, organizational innovation and social sciences. This varied literature has resulted in researchers using different performance measurements and parameters in their studies. The concept of traditional team effectiveness does not fit easily into current thinking about effectiveness of virtual teams. There have been multiple approaches to studying effectiveness of virtual teams. Qureshi and Vogel (2001) stated that these different aspects of research appear to form a gigantic puzzle with each research team focusing on their own particular belief of virtual teams and their own preferred research approach. With this in mind, this section develops a framework to guide review of relevant literature on the subject of virtual team effectiveness. This exploration carries the same burden from the past literature in trying to establish an informed perspective of the determinants of virtual team effectiveness. The purpose of this section is to reduce the vagueness of the relevant literature by categorizing virtual team effectiveness literature under three variables related to team effectiveness: a) technology b) team, and c) task.

Technology

A major part of the literature deals with technology related issues for virtual team effectiveness. Since virtual teams rely on technology as a central component, the consideration of technology as an aspect of virtual team effectiveness is considered an

essential starting point. In addition, technology has a strong relationship to earlier research (McGrath et. al., 1994; DeSanctis and Poole, 1994) concerning virtual team effectiveness.

In this review as the examination of technology related literature for virtual team effectiveness, issues are discussed in three subsequent sections: 1) communication, 2) medium, and 3) structure. Communication here refers to social awareness in virtual teams and theories related to communication efficiency while using technology; medium refers to available technologies used to accomplish work. Lastly, structure, deals with usability of technologies and adaptation problems.

1. Communication

Malhotra and Majchrzak (2005) support the conclusion that earlier research related to virtual team communication focused primarily on e-mail and audio conferencing. This focus inspired by the Media Richness Theory (Daft and Lengel, 1984& 1986). According to this theory, some technology allows more social cues than others and therefore, it is important to understand how and why people choose the media. For example, e-mail communication lacks the social cues that exist for audio conferencing communication. E-mail communications lack the media richness, which may result in social awareness problems. Media richness refers to the medium's capability for sending multiple cues through multiple communication channels, receiving immediate feedback, and supporting a high degree of personalness and use of various languages (Daft and Lengel, 1986; Ferry et al., 2001). Apparently face-to-face is the richest medium (Daft and Lengel, 1986). This theory suggests using rich mediums for communications, especially where the message is complicated. Malhotra and Majchrzak

(2005, p. 11) state that "...sufficient problems in communication remain, leading researchers (McGrath, 1991; Maznevski and Chudoba, 2000;Hinds and Bailey, 2003; Cramton, 2001) to conclude that for tasks requiring many cues, such as negotiation and conflict resolution, face-to-face communication is preferable to using email and audio conferencing".

In a communication study (Kinney, 1992), dyads were evaluated by using different media such as face-to-face, text chat, and audio. Overall, the performance of dyads were not affected by the media choice. This finding may support the contention that dyads may be more robust in working with different communication mediums. The suggestion of Media Richness Theory, applied to dyads, would suggest that dyads would work better with less rich media; however, the type of media was not identified as a performance criterion in dyads. The current technology available to members of virtual teams relies on advanced technologies that far exceed basic e-mail and audio conferencing. These technologies integrated into virtual workspaces enable members to be close to their local companies while engaging global activities (Malhotra and Majchrzak, 2005). The following section examines integrated workspaces and virtual work environments.

McGrath and Hollingshead (1994) believe that the lack of non-verbal cues in a distributed environment may result in an increase of turbulence in the flow of communications. This issue might be reconciled by a regulatory function, for example the use of cues to regulate meetings (Tung & Turban, 1998). There has been support for the assertion that if one can reduce the overflow of communication created by a task, that performance may be increased (Olson and Olson, 2000; Ramesh and Dennis, 2002;

Espinosa and Carmel, 2004). To further explore this concept, related work concerning overflow communication is examined in the subsequent task structure section.

From the approaches to communication examined, it has been suggested that communication flow related to technology is an important part of the effectiveness for virtual teams, but has yet to be fully investigated (Warkentin, 1997). As Daft and Lengel (1986) suggested, it is important to know how and why people choose technology to do particular tasks. The following section examines the current state of available technologies for existing virtual teams. However, the intent is not to provide an exhaustive list with specific names of software, but rather to recognize the breadth of the mechanisms currently available to support virtual teams.

2. Medium

Medium is a concept used to describe intervening technologies that support the virtual work environment. A virtual work environment is an environment in which the work of virtual teams can be accomplished using a variety of different technologies such as e-mail, instant messaging, message groups, audio-video-conferencing, voicemail, fax, telephone, personal blogs, whiteboards, threaded discussion boards and web-based application/documentation sharing programs such as Blackboard, WebCT. These technologies are predominantly Internet based to support stable communications. Technology can be categorized based on temporal distance that can be categorized based on four different zones across place and time, as listed in Table 2 (adapted from Bandera et al., 2006).

Table 2. Time/Place Matrix

	Same Time	**Different Time**
Same Place	Face-to-face interaction	Co-located Asynchronous

	ZONE I	i.e. On-going tasks with different shifts ZONE II
Different Place	Distributed Synchronous i.e. Video-conferencing Audio-conferencing, e-mail ZONE III	Distributed Asynchronous i.e. e-mail, telephone, fax. ZONE IV

One of the noted barriers to virtual team effectiveness consistently identified in the literature is the usability of various implementing technologies as well as adaptation of the technologies to the virtual space (Hengst, et al., 2006; Mark and Poltrock, 2001).

The structure of a virtual space must consider that training of employees may help to improve team satisfaction that creates impressive performance gains (Beranek, and Martz, 2005). According to Susman et al., (2003), companies must realize that it is more important and difficult to integrate a technology into the organization rather than buying the most superior "collaborative" software on the market and expecting it to easily integrate with a team. Therefore, the challenge lies in integrating and adapting technical systems into a social system (Susman, et al., 2003). As Pasmore (1994) stated, "simply buying the latest technology, however, isn't enough; what matters is how the whole system works" (p.74). In sum, the medium to support virtual teams is important, but integration of the medium is also critical to performance of virtual teams. Following this assertion, the subsequent section discusses adaptation and integration of advanced collaborative technologies from the literature.

3. Structure

One of the primary concerns in technology related work is how teams and organizations can adapt to these environments. Qureshi and Vogel (2001) define technological adaptation as the way people handle new technology to achieve shared goals. Gidden's Structuration Theory (1986) explains social interactions and their effects

on group outcomes. Extending structuration theory to apply to advanced technology, DeSanctis and Poole (1994) created Adaptive Structuration Theory (AST). AST aims to alleviate adaptation problems for team members in the organization as information technologies continue to advance (DeSanctis and Poole 1994). They suggest a four-dimension adaptation framework: 1) structural characteristics, 2) technology appropriation, 3) decision processes, and 4) decision outcomes. It is assumed that people's choice on technology will affect decision outcomes (DeSanctis and Poole, 1994). AST proposes that a group's structure, task and appropriation of a specified technology are jointly involved in determining the outcomes of a group's technology use (DeSanctis and Poole, 1994). AST aims to integrate structuration concepts into advanced information technologies, merged with concepts from decision-making field. In effect, structure is suggested to have an influence on the adoption and integration of new technology.

Although AST has been tested for success related to group decision support systems (Steinfeld et al., 2001; Manzevski and Chudoba, 2000), DeSanctis and Poole (1994) identified a concern about using AST to examine group-settings (other than group-decision systems settings) due to possible conflicts of power. Therefore, AST may not be enough by itself to ease adaptation and integration for different types of virtual teams and in different types of virtual settings.

Reinig et al., (1996) showed reward to be an important motivator for adoption problems. They discovered that if employees sense success or appreciation from other members for their work, called affective reward, adoption of new technologies might be accelerated. Besides reward, Yoo and Alavi (2004) studied learning in virtual teams to

identify the role of leadership and training to ease adaptation. According to their research, most learning comes from experience during the task execution. Therefore, they concluded that an initial preparation would not help ease adoption of new technologies.

Another concern noted about technology structuration has to do with usability of the technology (Hengst, et al., 2006). Usability was measured by ease of use and willingness to work with the system again. Easy and friendly design of the system are always welcomed and embraced by end users. Not spending extra time to learn a system is also highly appreciated by team members. When technology is stable, team performance may increase. To enable stable and reliable technology requires consideration of different factors such as bandwidth, quality of connection, and transportability (Qureshi, and Leeuw,2006). In order to prevent unexpected glitches during meetings, a supporting and maintaining activity is recommended. Towsend et al., (1998) discussed the importance of training to ease glitches related technology, concluding that having people trained actually helps acquisition of new skills and knowledge areas related to technology integration. Also, Majchrzak et al., (2000) in a technology adaptation study found that if product components are tightly coupled, then virtual team members from different companies need to work in highly interdependent iterative virtual brainstorming sessions, which were not preferred by team members.

The preceding discussion from the literature reveals that technology related effectiveness has been broadly discussed by scholars; the depth of investigation for issues such as adaptation of technology certainly require additional exploration, since there are no widely accepted solutions to the associated problems for technology integration. However, well designed and prepared virtual teams have been recognized as a critical

component to future success in fast paced, technology based, enterprises (Lipnack and Stamps, 2000).

Team

In 1993, when Eastman Chemical Company received the Malcolm Baldrige National Quality Award, they pointed to a quality philosophy that rested on team alignment (Lipnack and Stamps, 2000). This global company successfully implemented virtuality within the company. Their continuous experience with implementing teams all over the world taught them that teams must know their purpose. The emphasis must be on the specific tasks with clear expectations rather than focusing on mechanics of vehicles such as meetings. This stands as only one of many industry examples, related to virtual team effectiveness, which scholars have studied in the literature. In the following section of the literature review, the construct of team will be discussed in three segments: 1) team structure, 2) team performance and 3) team member characteristics. These three segments within the vast literature and writings on teams, serves to frame the research with respect to the team construct.

1. Team Structure

Stewart and Barrick (2000) define team structure as the team relationship, which determines allocation of tasks, responsibility, and authority. Structure has also been referred to as group process by McGrath (1964). Regarding group process, Brown and Eisenhardt (1995) argued that effective group process increases information within a team. According to Dundis and Benson (2003), current research suggests that team procedural structure can interact with the type of task in both face-to-face and virtual teams. Well-designed team task structure contributes to effectiveness. In contrast to

Stewart and Barrick's team structure definition (2000), other literature studied structure primarily from a perspective of team composition, where composition refers to size and team member skills (Hackman, 1987; Cohen et al. 1996). The present research takes on team structure as its size.

There have been multiple perspectives in the literature concerning the influence of team structure. Although there is not accepted consensus, the findings and ideas are insightful to further research concerning aspects of team structure and the potential for interpretation and application to virtual teams. Frequent and appropriately structured task communication in product development teams has been found, especially cross-cultural teams, to leads to more varied information flow that increases efficiency in team development process (Brown and Eisenhardt, 1995). However, Dougherty (1992) argues against Brown and Eisenhardt's (1995) findings by explaining that a higher level of communication increases the amount of information exchanges, if it is effectively structured. Cohen and her colleagues (1996) concluded that there is not enough evidence concerning how team structure moderates team effectiveness. Conversely, Trower and Moore (1996) found significant evidence in their research that team size, as a team composition value, affects team performance. They tested team sizes between two and twelve in their study and found that, initially, performance increases as team size increases; however, after at a certain size, performance starts decreasing. Therefore, they argued that team size has an inverted U- shape impact on team performance, such that after a certain team size has been reached team performance will actually diminish. Following this research concerning the relationship of size to performance, further

elaboration of the smallest team structural element, the dyad, was selected to examine the related literature.

In this research, dyads are operationalized as "two person-structured teams working virtually on a particular task in a certain period of time". Although two-person groups have been widely studied in traditional team literature (Simmel, 1950; Scott, 1967; Hinde, 1983; Poole and Billingsley, 1989), study of the effect and impact of dyads still attracts research. Recently, a research trend has emerged to carry study of these teams into virtual collaborative environments. The reason for continued interest for dyads is that these are the only groups where task performance is decreased by the withdrawal of one of the parties. Alternatively, this is the only group size for which the task performance can exceed a single person potential if the two team members get along and work together in the dyad (Scott, 1967; Poole and Billingsley, 1989). Consideration of power, social context, and information feedback are important characteristics of interest for the study of dyads in virtual settings. In a dyad, power should be balanced between partners to enable information feedback and to reduce unnecessary communication. If the partners do a good job together, a third person is usually not welcomed (Hinde, 1983).

Relationships have been identified as critical to team structure. For instance, according to Stewart and Barrick (2000), when defining team structure, team relationships are important, because they determine the allocation of tasks, responsibilities, and authority. In dyadic groups, Hinde (1983) explains eight types of relationships: content of interactions, diversity of interactions, qualities of interaction, relative frequency and patterning interaction, reciprocity versus complementarity,

intimacy, interpersonal perception, and commitment. Among these categories, Hinde (1983) suggests the importance of reciprocity versus complementarity, emphasizing integration of viewpoints rather that just acceptance of different viewpoints. Additionally, balance in dyadic relationships is recognized as very critical when a team comes together for a specific task. This is recognized by the suggestion that the individual level of measurement of attitude is not meaningful (Crano and Brewer, 2002). This suggests that, even in dyadic groups, measurement of task evaluation should be considered as attributed to pair-based as opposed to the individual level. In dyadic relations, person A has a specific attitude and person B has a specific attitude as well. Yet, when it comes to evaluation, person A and person B are considered as a pair. One suggested method (Crano and Brewer, 2002) to measure dyads is to pay attention to reciprocity asking following questions: Are they equal in work balance? Are they equal in social relationship? According to Crano and Brewer (2002), social science literature provides direct and derived measurements for teams and dyads: "...a principal challenge comes from assessments of teams that are derived from measures taken from individuals" (p.313).

A recent study investigated group size and communication modes in computer supported collaborative work environments (Masoodian and Apperley, 1996). It found that changing group size from two to three members had little effect on measured factors. However, the change did influence social communication. Further research on four-person team structure indicates a high incidence of disagreement. Masoodian and Apperley (1996) discovered in their research that four-person groups recorded more successes. One reason behind this success may be, as a consequence of structuring within

the group of four, a tendency for the group to become a pair of interactive dyads (Scott, 1967). However, Panko and Kinney (1992) ruled out this possibility when they demonstrated that two-dyads placed in a single team are barely more effective than single dyads.

Katzenbach and Smith (1993) suggest that teams from five to eight members are most effective. After eight members, performance is deemed to decrease because there are too many interactions and too much information to be integrated. In virtual teams, Edwards and Wilson (2004) suggest that newly formed virtual teams should consist of eight or less people so each person's voice can be heard. By screening literature on virtual teams between 1970 and 1998, Fjermestad and Hiltz (1999) also find that most repeated group size in experiments is between six and twelve members. From Panko's (1992) perspective, stating an optimal team size is a weak claim because the optimal team size is mostly determined due to concern of publication issues by scholars. Therefore, the literature is insufficient to authoratively identify the appropriate team size for study, particularly within the virtual team domain.

As noted from above discussion, the literature has not consistent on a uniform perspective for team structure or team size. However, it has been recognized that structuration is important in information flow (Dougherty, 1992). It has also been noted that small teams are relatively more successful (Scott, 1967; Masoodian and Apperley 1996) than larger teams, clearly establishing the influence on team size in relationship to performance – although no definitative guide for team size has been established or accepted. As being the smallest team size, the dyadic structure is a critical structural form with respect to team structural composition. In conclusion, there is a lack of research

concerning the function of the dyad structure in virtual teams. Further development and investigation of the dyad structure in virtual teams has clearly been established as an area in need of further exploration.

2. Team Performance

Team performance is generally measured in terms of what a team produces. Conceivably, some specific criteria related to the evaluation of performance may change the results of a study. For example, Hacker and Lang (2000) measured performance against a schedule, customer expectations, and overall team health in virtual teams. They concluded that team member accountability and support from local management were critical for the performance. Although team performance can be somewhat nebulous, this section, for the purposes of the current research, examines the area of team performance.

One criterion to establish the level of team performance is the teams' decision quality. For instance, in an empirical study, Huang et al. (2002) discussed the effect of team support systems on team building. They measured goal setting as a performance criteria. Their findings suggested that it is important to set the goals at the beginning of the team effort, so that virtual teams can produce more quality decisions.

One theory related to team performance, Time, Interaction and Performance (TIP) theory (McGrath, 1991), is one of the most frequently cited theories in small group research. This theory suggests that a team with no history has to engage with four modes when they are working on a complex challenging problem with advanced technology in an elusive environment. These four modes to boost performance are identified as 1) inception and acceptance of project, 2) problem solving, 3) conflict resolution, and 4) project execution (McGrath, 1991). The theory describes work groups as time-based,

multi-functional, and multi-modal social systems. The importance of this theory, and its acceptance, lies in the establishment of the team as a social system, subject to increasing performance based on ability to function effectively in different modes. Also supported by McGrath's research was the concept that member-support and group well-being relate directly to relationship development. The TIP theory also explains how technology affects performance positively when there is enough time to learn it. In later related efforts, McGrath and colleagues did conduct several experiments to support this claim by comparing face-to-face teams to virtual teams. As a result of their work, they concluded that face-to-face teams performed better than virtual teams in the first half of the experiment; however, subsequent measurements of performance showed that there were no performance differences between these two teams (McGrath and Hollingshead, 1994). This research demonstrated the importance of time as a factor in team performance, based on the learning processes achieved over time within the virtual groups.

An expanded review of the current literature for virtual teams has been outlined by Powell et al., (2004). They analyzed forty-three articles published between 1991 and 2002, and found interesting results on the virtual team research as well as for the directions for further research. In their review, what they found most notable for effectiveness criteria were *performance* and *satisfaction*.

The majority of the virtual team literature states that there is no performance divergence between traditional and virtual teams where the performance criteria was a benchmarked comparison with face-to-face teams (Powell, et al., 2004). McDonough et al., (2001) discovered in their research that virtual teams were not expected to outperform collocated teams in some organizations. This belief may exist due to previous studies

focused on benchmarking virtual teams with face-to-face teams, producing a bias that face-to-face teams represented a limit to virtual team performance. In addition, this contrast with the earlier discussion concerning performance measurement is an indicator of virtual team effectiveness.

The literature for virtual team effectiveness is unclear, especially concerning performance measurements. Since performance categories are very broad, researchers have focused on different aspects of these variables, applying different research approaches to determine effectiveness. Nevertheless, using multiple variables to evaluate the effectiveness of the team may lead the researcher into a dilemma that manifest itself as an inability to distinguish which variables actually determine effectiveness. Besides, the idea of the uniqueness of each virtual team does not necessarily support face-to-face benchmarking as an establishment of effectiveness of virtual team performance (Qureshi and Vogel, 2001; Powell et al., 2004). More recently, different variables have been studied in order to measure the level of team effectiveness (Lee et al.1999; McDonough III, et al., 2001;Steinfeld, et al., 2001; Potter and Balthazard, 2002; Gibson and Cohen, 2003). An initial evaluation of the literature reveals that most of the research studied team effectiveness through the measurement of team performance (Kuo, 2004). As we can note from the exhibit below, team performance criteria rely almost entirely on team satisfaction as an indicator.

Primarily, reliance on team satisfaction can be explained due to a lack of a unified approach. Table 3 below is an example from selected studies to demonstrate the multiple perspectives of variables that have been used in effectiveness studies. The

exhibit shows the dimensions of effectiveness used in these studies and also measurement variables these studies undertook as well.

Table 3. Selected studies from effectiveness literature

Authors	Dimensions of Effectiveness	Measurement Variables
Warkentin,et al, 1997	Communication process, information exchange	Perception of team cohesiveness Perception of Team Interaction Process Satisfaction with Decision Making and Outcomes
Hacker and Lang, 2000	Individual Commitment Management support	Quality of Work Satisfaction with Decision Making and Outcomes
Huang et al., 2002	Team building Team support systems	Collaboration Climate Individual Commitment Perceived Decision Quality Number of Decisions Generated Team cohesion
Potter and Balthazard, 2002	Human interaction	Personal Attraction (Extraversion)
Prasad and Akhilesh, 2002	Work characteristics Strategic objectives Situational constraints	Exploratory research
Gonzales, 2003	Group behavioral performance	Task Cohesion Quality of Work Collective Efficiency Interpersonal attraction
Souren,et al,2004	Conflict management and heterogeneity	Perceived Decision Quality Perceived Participation Satisfaction with Decision Making and Outcomes Individual Agreement Level Personal Attraction (Extraversion)
Balthazard et al.,2004	Human interaction	Perception of Team Interaction Process Personal Attraction (Extraversion)
Powel et.al, 2004	Literature review	Individual Satisfaction Performance

To date, some membership characteristics and/or dynamics are assumed to have a large impact on effectiveness. Characteristics such as trust, leadership, commitment, and

creativity have received considerable attention from the researchers. These member characteristics relating to performance are reviewed in the following section.

3. Team member dynamics

Potter and Balthazard (2002) examined group interactions in virtual teams. Similar to concerns noted above, they were concerned about using traditional team performance measures in virtual teams. Based on their research, they concluded that extraversion was also a performance driver in virtual teams and was critical on effectiveness. A recent study investigated extraversion in dyadic teams (both virtual and face-to face) to choose the medium for virtuality (Topi, et al., 2002). In contrast to the previous study, this research found introvert dyads were more dominant in virtual teams. On the line with previous research, extrovert dyads were found to be more satisfied in virtual teams. A notable outcome of this research was to demonstrate that face-to-face dyadic teams were more satisfied than virtual dyads, and finished their assigned task faster.

Previous concerns mentioned about using face-to-face teams as a benchmark comparison for virtual teams is prevalent in virtual team development research. In that sense, the literature reveals that to examine team outcomes and team cohesion researchers used mostly surveys to conduct measurement of these factors (Burke and Aytes,1998; Maznevski and Chudoba,2001). However, it is not clearly known whether these measures were verified by other means (Balthazard et al., 2004).

With respect to the current research, there are two important considerations derived from the present discussion. First, the research focus is on structure as a determinant of success and satisfaction within virtual teams. Therefore, there is no

benchmark of comparison that exists in the literature. Although, face-to-face teams provide useful background, the direct implication for comparison of virtual teams has not been established, particularly with respect to the current context for research. Second, the existing research is clearly focused on individual aspects of virtual team effectiveness rather than taking an integrative approach, which focuses on the virtual team unit performance.

One individual characteristic, trust, has been identified as being very important for virtual team success. Suchan and Hayzak (2001) established that trust requires shared purpose, goals, commitment and loyalty. In contrast to most models that assume trust develops gradually over time, Meyerson, Weick and Kramer (1996) argued "swift" trust is necessary for temporary systems. Jarvenpaa and Leidner (1998) studied trust and concluded that in virtual teams, high trust must be replaced with "swift trust" in order to achieve success. This finding brings attention to the time constraint of projects. As most projects have very tight deadlines, team members do not have time to build the trust over time. They feel compelled to trust team members regardless of short time periods assigned to perform projects (McGrath, 1991; Jarvenpaa and Leidner,1998).

Leadership is another important characteristic that contributes to virtual team effectiveness and is recognized widely in the literature (Bell and Kozlowski, 2002). Lurey and Raisinghani (2001) found that team leaders need to establish positive team processes, develop supportive team member relations, create team-based reward systems, and select only those team members who are qualified to do the work. In reviewing literature concerning teams, leadership is certainly a topic with a plethora of research.

Consistently, the literature of virtual teams also recognizes the importance of leadership as a determinant of effectiveness (Bell and Kozlowski, 2002).

Hinds and Bailey (2003) studied conflict in distributed teams. They found conflict to be disruptive to performance, occurring primarily due to distance and technology reliance (Hinds and Bailey, 2003). They identified three types of conflict from the literature: task, affective, and process conflict. In their words, "...task conflict refers to disagreements focused on work content" (Hinds and Bailey, 2003, p.616). Affective conflict (sometimes referred to as relationship or emotional conflict) refers to team disagreements. Lastly, process conflict refers to disagreements over the "...team's approach to the task, its methods, and its group processes" (Hinds and Bailey, 2003, p.616). Hinds and Bailey (2003) suggest that task conflict is a good conflict and one that may affect team performance positively; however, conflicts centered on methods or group processes are detrimental to effectiveness. Other related research indicates that consensus formation and conflict resolution are especially difficult in time-limited virtual contexts (e.g. George et al., 1990). In essence, conflict has been recognized as an important aspect related to team performance.

The task which teams are asked to perform has been found to be one of the principal moderators of group behavior and effectiveness (Hackman and Morris, 1975; McGrath, 1984). The following section examines "task" as it has been articulated in the virtual team literature.

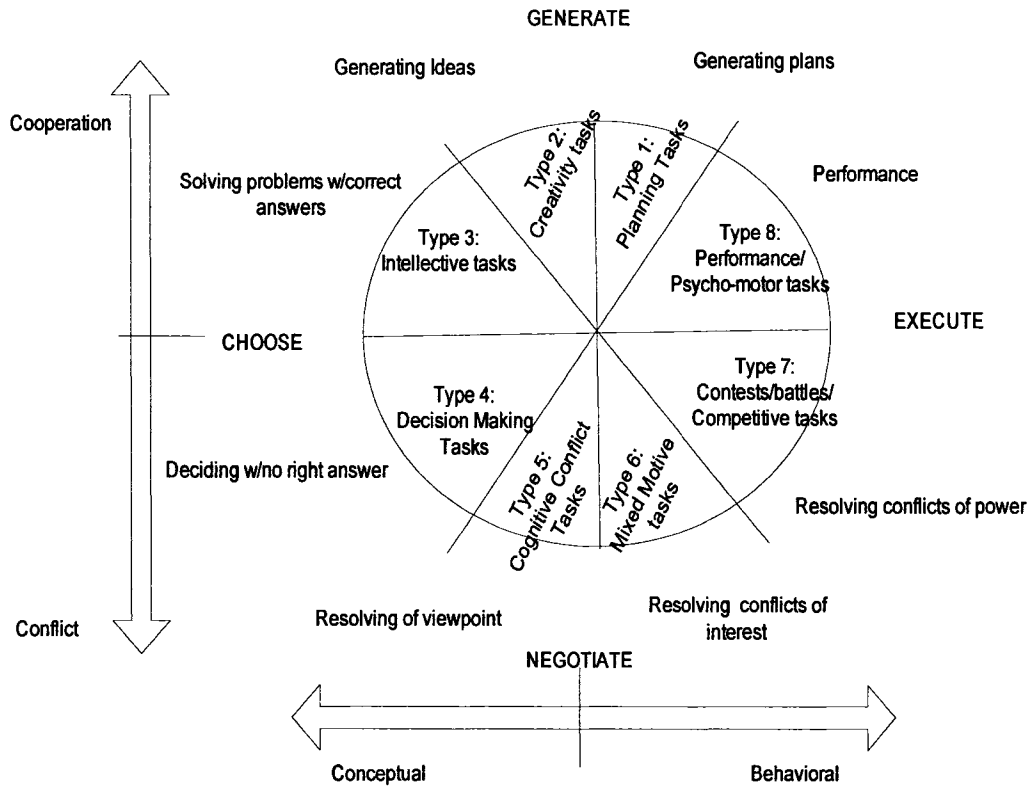
Task

Lipnack and Stamps (1997) suggested that the task could be considered as the purpose of virtual teams. The team literature provides evidence of the importance of task.

Since teams engage in many different tasks, a number of task typologies have been presented in the literature in an effort to better define and understand the critical role of tasks (Mennecke and Wheeler, 1993). The literature is rich concerning task classification (Hackman and Morris, 1975; McGrath, 1984, Hackman 1987). In one explication of task, Steiner (1972) suggested that task information flow could be identified as parallel, pooled, sequential or reciprocal forms. Furthermore, Steiner (1972) added that the pattern of task information flow between people also plays a viable role in the structuring of the task. Apparently, communication channels are utilized to ease this information flow. For instance, if communication is restricted between certain members, the actual flow of communications will be restricted (McGrath, 1964).

The most detailed research concerning task classification was performed by McGrath (1984) who integrated prior related work for into a framework. McGrath (1984) called this classification framework *task circumplex*. This framework integrated the work of Hackman and Morris (1975 and 1978), Laughlin (1980), Shaw (1973), and Davis (1980) for classifying group tasks (cited in Mennecke and Wheeler, 1993).This task classification can be seen in Figure 3, which is adapted from McGrath (1984). The task types that have been used to study virtual teams fall primarily into type II (creative), III (intellective), and IV (decision-making) in the literature (DeSanctis et.al, 1989; Mennecke and Wheeler, 1993; Hollingshead, et al.,1993; McGrath and Hollingshead,1994; Dennis and Wixom,2002).

Figure3. McGrath's Task Circumplex



In this literature review, task is analyzed according to two main themes form the literature. Those are 1) outcome/performance, and 2) structure which are detailed in the following section.

1. Outcome/performance

Teams exist for a task-oriented purpose (Lipnack and Stamps, 1997; Hackman, 1990 and 2002) and team structure must relate to the team task(s) (Hackman, 2002; McGrath, 1984; Arrow, et al., 2000). While all small groups carry out tasks to some degree (as well as make decisions and support social interactions), the task is the focus for teams and this perspective has been supported by the previously mentioned authors. In addition, Cohen and Bailey (1997) identify satisfaction, as well as task structure, as a determinant of team performance. Task outcome is primarily defined with respect to its quality (Cohen et al.,

1996). Task quality here refers to the degree to which expectations are satisfied. Maximum task performance is achieved when teams are operated satisfactorily (i.e., from a managerial perspective, determined by the quality of task outcome). In addition, the task outcome can be dependants of team members' skills as well (Cohen et al., 1996). On the other hand, Qureshi and Vogel (2001) point out that outcome of individual efforts to produce a task is not the critical determinant for task outcome. They advocate that individuals must possess mixed task skills rather then having expertise in one area. Thus, having mixed skills can help them to acquire new skills as well as developing and utilizing their knowledge appropriate to the task situation. They further suggest that this is the approach organizations should consider when they are building virtual teams. In effect, Qureshi and Vogel (2001) support the argument that there is a trend towards more aggregated small units of work.

2. Structure

Lam (1997) defines task structure as "... the overall configuration of the problem space that underlies the task (p.195)". Task structure, thus, provides a procedural orientation for how members in the group make decisions, and perform outcomes. According to Steiner (1972), a set of strategies, rules, and procedures are used to structure the task. McGrath and Hollingshead (1994) suggest, "group interaction and performance is greatly affected by the type and difficulty of the tasks that the group is performing (p.66)". Similarly, Lam (1997) discovered that task type has received more attention in the literature than task structure. However, he argues that task structure is more important than the task type. In their review, Hertel et al., (2004) divides task design into two categories, *type* and *interdependence.* According to Gibson (1999), tasks

in design are analyzed mostly based on task uncertainty and task interdependence. Gibson (1999) also argues that high uncertainty tasks may lead to ineffective team processes, because the team does not know how to proceed toward a solution. On the other hand, task interdependence hinges on structural features of tasks (Gibson 1999). Clear instructions and materials define the level of interdependency which demonstrates member interaction when the task is executed. If the level of interdependency is low, infrequent communications and less knowledge sharing occurs. If this is the case, performance is affected based on how individuals align to the task they perform (Gibson, 1999). In examination of task and structure relationship, Kent and Hasbrouck (2003) offer structural elements that can affect the team-task process in classrooms. They found that a number of structural variables such as common approach, clear mission, and team planning are related to team performance. They concluded that those variables could be manipulated by the instructor positively to affect classroom team performance. Clearly, the literature asserts the relationship of task structure to team performance.

Olson and Olson (2000) suggest a coupling approach for the foundation of task structure and for frequent communication. Coupling is a form of communication required by the work (Olson and Olson, 2000). As they claim, coupling relates to the concept of decomposability of systems in organizational theory. They continue to argue that tightly coupled tasks do not work with remote teams. In their research, they concluded that tightly coupled work is harder to achieve across remote locations. Therefore, the design of tightly coupled work may become problematic in virtual domains. From their examinations of major industrial companies such as Boeing, they found that tightly coupled work was achieved much more productively in co-located teams, where they had

to reorganize the work assignments to fit geographically. Thus, the literature is suggestive of assignment of tasks to be loosely structured and straightforward in long distance dependencies.

The literature is supportive of tightly coupled work requiring an extensive amount of communication among members. Consistent with this assertion, Tschan (2002) claimed that extensive communication might decrease productivity in virtual teams. Ramesh and Dennis (2002) suggest an object-oriented model that assumes by standardizing processes, inputs, or outputs it is possible to reduce communication between team members. Their suggestion shows the need for different methods of organizing and coordinating work, especially in virtual teams (Ramesh and Dennis, 2002). In contrast, Olson's effort (2000) on tightly coupled work is described as the traditional integrated virtual team approach by Ramesh and Dennis (2002). Tightly coupled work endeavors link team members through information rich media. One weakness, Ramesh and Dennis (2002) argue, is that tight coupling may lead to problems when work and workers are tightly coupled to other's work and workers. It becomes increasingly difficult for the work to be performed independently because changes must be coordinated among all elements of the system. This finding not only supports the need for dyadic teams, but it also supports the notion that strong coupling suggests that the members of the team are highly interdependent with respect to tasks (Olson and Olson,2000). Therefore, a consistent thread in the literature is the relationship between tight coupling and the need for autonomy in task performance – particularly as there are implications for virtual team task structure.

The object-oriented team idea, however, favors decoupling team members through semantically rich media. Loosely coupled work, naturally, has fewer dependencies and thus is able to utilize fewer communication channels to achieve the interaction necessary for task performance. The object-oriented team model avoids overly tight coupling by having a) standardized or well-defined processes, b) exchange information (inputs and outputs) with other objects through well-defined semantically rich interfaces, and c) produce a decreased flow of information (Ramesh and Dennis, 2002). Again, the importance of the degree of coupling in relation to task structure and performance is a common thread in the literature.

Qureshi and Vogel (2001) state that there is a move towards smaller work units, and more decentralized units in today's organization structures. As an example, the network form of organizational structure is cited as an important emerging form that exemplifies the decentralization theme (Qureshi and Vogel, 2001). They conclude that the aim of networked organizations, with respect to work accomplishment, is to enable distributed teams to work together and to provide a common space for team communications by Qureshi and Vogel (2001). Again, the literature is supportive of smaller units to more effectively organize work efforts, particularly for distributed teams.

Summary of Part I

This part of the literature review has focused on reviewing the effectiveness literature for virtual teams. Several conclusions and themes of continuity have emerged arise from this part of the literature review. First, traditional teamwork is not more effective than virtual teamwork. Although there are some superior results with face-to-face teams in contrast to virtual teams, there is insufficient evidence to substantiate such a

claim that virtual teams are less productive than face-to-face teams. Second, there is no unified effectiveness model/framework that has been accepted to describe virtual teams. While the body of knowledge for virtual teams is growing, empirical results have not yet achieved sufficient volume to move virtual team effectiveness beyond the embryonic stages of theory, method, or practice. However, the literature is consistent in suggesting that *virtual teams can be as successful as traditional teams, provided that* a) the design of team is structured properly; b) the task is explained and structured well; and c) a face-to-face kick off initiation is planned at the beginning of the task. The following discussion captures examines the major treads and shortcomings in the literature related to virtual team effectiveness.

Although virtual team effectiveness research is expanding rapidly, the field has not yet definitively identified the moderators of effectiveness. Thus, researchers are left with limited definitively supported findings, a plethora of variables and characteristic attributes suggested for effectiveness, as well as some apparent contradictions. Consistent with the conclusions of Stewart and Barrick (2000), the present literature review suggests that relatively little is known about whether there is an optimal team-task structure that moderates performance. The literature could not definitively establish, beyond suggestion that a clearly defined (tested) relationship between team and task structure exists. In effect, team performance was suggested to depend on many variables that may occur during the task execution – none of which have been universally accepted or endorsed by the community of scholars. However, it is acknowledged that the structure of work affects performance in positive manner.

In the first part of literature review, three topical categories related to virtual team effectiveness were examined. These categories included technology, team, and task. The following summary results are addressed to correspond to each of the three categories. Additionally, the performance measures review of the literature on virtual teams is summarized.

Technology. Previous work in technology focused primarily on technology adoption problems. This technology related literature examined concerns about whether teams could adjust and thrive with advanced technology, as well as how technology choice affects team performance. The early work related to technology helped to advance the field by testing traditional team effectiveness theories, especially in task-technology fit as well as task-media fit. Technology has been considered an important piece of the team effectiveness puzzle and is certainly more stable than earlier days of virtual teams. However, as virtual teams continue to evolve, there are many remaining gaps to address concerning adaptation problems, such as cyber security issues. In addition, the literature was found to be lacking with respect to communication flow relating to technology has. A significant supported theme in the literature was that dyads were determined to be an effective structure to work with any technology regardless of media richness.

Team. Previous work that studied team dynamics has primarily been focused at the individual level. While trust, leadership, and individual satisfaction have been studied extensively, and found to be critical to success, other areas, including conflict, team commitment, cohesion, creativity, and team development have also been researched extensively. However, some topics that are assumed to have an impact on effectiveness,

such as flexibility and innovation, have not been measured empirically. The following discussion summarizes the important aspects of team from the literature review.

One of the challenges cited in the literature for virtual teams relates to the impact of coordination and communication with respect to virtual team performance. Technological barriers to communication have been studied extensively to understand how people choose the mediums for communication. A key point of agreement appears to be that lack of understanding due to communication is an obstacle to success in virtual teams. A focal point of active research has been directed at finding different approaches to improve communication effectiveness. Coordination, on the other hand, has been identified as a threat to success in global teams where time is not synchronous and cultures are divergent. Several perspectives concerning the impact of communication and coordination have been cited. As an exemplar, in their object-oriented model, Ramesh and Dennis (2002) suggest that by standardizing the processes, inputs or outputs, so we can reduce unnecessary communication between team members. In effect, despite a somewhat scant accounting in the literature for virtual teams, communication and coordination are recognized as important aspects for team performance and effectiveness.

The literature has been silent with respect to the influence of the team-task structure relationship on virtual team performance. One important finding after reviewing the literature on team dynamics was that socio-emotional factors influence the performance in a positive manner. A point of critical note is that no empirical study exclusively looked at the relationship between team structure (in terms of size) as a control variable in design and its potential effects on task performance (Powell, et al.,

2004). Therefore, there is a significant gap in the literature concerning the relationship between team structure and effectiveness, particularly with respect to virtual teams.

Task. Earlier work on task studies identified the importance of task selection. There were many studies cited concerning task importance. However, these studies were primarily focused on how the task fits into virtual environments. Traditionally, "working together" was one of the elements assumed to be necessary for effectiveness (Hackman, 1990). However, this assumption may not be valid for virtual teams. The type of task may challenge this assumption in virtual teams, and has not been adequately addressed in the literature. The project type, which can be considered as related to task, is another area that researchers have not adequately explored for virtual teams. The lack of research literature concerning virtual teams may suggest an extrapolation of traditional team research. However, from a research perspective, this extrapolation assumption is not sufficient.

Recently, there has been a trend toward more aggregated small units of work to perform tasks (Qureshi and Vogel, 2001). Olson's effort (2000) on tightly coupled work, previously discussed, introduced the traditional integrated virtual team approach. Since dyads are well suited to the trend to smaller divisions of work, literature supports that unnecessary communication flow is reduced. Espinosa and Carmel (2004) demonstrated this idea to reduce the coordination costs in global teams by simply dividing tasks between dyads. In their sequential workflow dependency model on coordination costs, which is an extension of coordination theory of Malone (1999), Espinosa and Carmel (2004) demonstrated improved effectiveness using single dyads as "task requestor, and task producer". Building upon the limited literature and new trend concerning smaller

work division, research to investigate of effectiveness of smaller work units (dyads-structured approach) in virtual team settings is certainly an area ripe for further development.

It has been established in this review that task structure provides a procedural orientation for how members in the group make decisions and achieve outcomes. According to Steiner (1972), a set of strategies, rules, procedures are used to structure a task. Thus, the literature supports the need for additional investigation into the impact of the dyad structure through a disciplined procedure to organize the task.

Dyadic Virtual Teams: Communication, Structuration and Task Effectiveness

In this section, the focus of the review is concentrated on the examination of communication, structuration, and task effectiveness related to dyadic virtual teams. Although the topics are certainly important to the emerging knowledge base concerning virtual team design and execution, the literature accounting is scant. The literature has primarily discussed dyads in socio-emotional and cognitive levels (Panko, and Kinney, 1992). This research has focused on work dyads, but not beyond the two-person social structures that also function as typical work units as well. As introduced earlier, the socio-emotional and cognitive explorations dominate most of the organizational communication (Panko, 1992) study. Unfortunately, as work units, dyadic teams are germane to different areas in organizations such as effective communication, team size, team task on effectiveness and do not have a unified perspective among researchers. This section of the literature aims to give a brief summary on work dyads as a critical element of the current research.

Most of the organizational dyadic studies are focused on coordination and communication within virtual teams. Dyads are somewhat ignored in most of the team studies, because of the small size, and restricted communication channels. When they are studied, their influence-seeking behaviors tend to be overlooked (Barry and Fulmer, 2004). Different variables have been used to understand dyadic teams such as reciprocity, power, dominance, attractiveness, equality (Hinde, 1983; Crano and Brewer, 2002). These variables are suited to the study of social dyads with intense relationships; but, it is has not been fully tested and understood whether dyadic structure influences task outcomes in team settings, muchless virtual team settings.

Task productivity in relationship to communication has been studied in the literature. In a communication study investigating cycles to measure task productivity, Tschan (1995) found that in three-person teams, quality of recurrent communication cycles affects team performance in a positive way (cited in Tschan, 2002). Subsequently, Tschan (2002) did replicate the earlier study using dyadic teams and found out that the earlier proposition does hold true for dyads where task requirements rather than individual characteristics was emphasized. However, again this study was of dyads, but not in a virtual team setting. Although the study was not in virtual teams, the potential of having direct relationship between task structure and communication cycle in dyadic teams cannot be discounted in following research concerning dyadic structures, regardless as to whether the teams are face-to-face or virtual.

Task importance relating to team structure can be found in studies conducted by McGrath and his colleagues in 1992 and 1994 (McGrath and Berdahl, cited in Tindale, et al., 1998). These longitudinal studies explored the group process, task performance and

participant reaction as functions of the group's membership composition, its communication, technology and the specific task types. One contribution that emerged from these studies was to establish the relationship between group structure and task. They concluded that "good fit" is required between group structure and task to understand the dynamics of a working group. However, again this research was not narrowed either to dyadic structures or to virtual team environments. The application of these findings to dyad structures and virtual teams might be instructive, but has certainly not been established in the literature. Focusing specifically on dyads, Valacich et al.(1994), extended previous work on Media Richness Theory in dyads. This laboratory experiment showed that computer-communicated dyads were adequately rich for solving intellectual tasks. This demonstrated that intellectual tasks are a "good fit" for virtual dyads and lends support for further research concerning the dyad structure as pertinent to performance of virtual teams. The importance of task selection in virtual teams has also been analyzed by the previously literature (Mennecke and Wheeler, 1993).

Work dyads are used in global virtual teams to cope with coordination obstacles (Espinosa and Carmel, 2004). Considering team-task structure, Hackman (2002) states that structure is in itself neither good nor bad for teamwork. However, the kinds of structures that are created are important. From his perspective, structuring a team requires some architectural skills. It is important to discern between what is critical and what is not critical for designing a team structuration. Hackman (2002) argues that good work design that is devised in a straightforward manner motivates individual task performance. He does not favor dividing and assigning tasks to individuals; he suggests rather that the task be given to team members to figure out, because assumptions, or norms, emerge

from human's knowledge over which neither intelligence nor leadership have much control (Hackman, 2002) as mentioned previously. In conclusion, Hackman (2002) argues that teams show better performance without any structuration, but rather self-organize. However, there is no evidence that this is true for virtual teams either.

This section closes with an acknowledgement of the scarcity of research literature concerning the issues of communication and structuration (particularly dyadic structures) in virtual teams. Although there has been research done concerning the impact of structure and communication in dyad teams, there has not be extension to virtual teams through research. A major criticism of the literature is an implicit assumption that there can be a direct extrapolation of the findings of face-to-face team inferences directly to virtual teams. In addition, the paucity of research concerning virtual team's further places in doubt conclusions based on prior team performance research.

Summary of part II

In the second part of the literature review, dyads as work groups, communication and task effectiveness in these teams were reviewed. The following section details the findings and current state of the literature concerning these topics.

It is the nature, at the most basic level, for teams to work together. However, this does not necessary mean that they will yield the best effort and performance while trying to work together, regardless of appropriate structure. Since there are different attributes and characteristics that may have influence on team structures (such as work, power, communication, norms, and composition), one method to reduce ambiguity is to reduce overflow communication through effective coordination. This conclusion was amplified

by Hertel (2005), who argues that modular structure of tasks may be feasible in order to reduce coordination requirements.

It is currently unclear with respect to the relationship between the degree of formality (structuring) and team effectiveness. DeSanctis and Poole (1994) argued in favor of decreased use of formalized rules and procedures. Conversely, it has also been argued that increased communication flow may reduce team effectiveness. Yet, no empirical study explicitly tested the impact of structuration on task outcome or team structure as a moderator of virtual team effectiveness, especially in dyads. Moreover, the structuration concept in the literature has not gone beyond considerations for technology adoption and communication structures. In research experiments conducted to date, the trend appears that scholars allow teams to organize their work in a way they preferred, not isolating structural form as a focus of study. The result has been a notable absence of research literature examining the impact of structure, particularly dyadic structure, on virtual team effectiveness.

A number of studies have been conducted concerning traditional teams on dyads and their effects on performance. However, again the notable absence of these studies in the virtual team literature. Dugal and Eriksen (2004) investigated dyads (non-virtual team setting) in cooperative learning settings similar to George (1999)'s work. As mentioned earlier, Dansereau et al., (1975) used the power of dyadic forms in leadership research. Besides education, and leadership studies, dyads are also used frequently in R&D projects to increase innovation. One of the reasons that dyadic teams are preferred to other structures is that dyads enable greater control of information flow and managing information flow is very important to successful innovations (Hauschildt and Kirchmann,

2001). In his dissertation study, Lurey (1998) found that in one of the subject companies, most relationships are handled as dyads as opposed to integrated team formats, even though he did not delineate any specific structuration directions. Moreover, Espinosa and Carmel (2004) demonstrated the cost effectiveness of using dyadic global teams. Notwithstanding the recognized importance and implications for the dyad structure, as well as virtual teaming, the research literature is silent on studies in this domain. What is left is reliance on extrapolation of research that was neither conceived nor carried out with a focus on dyads in virtual teams.

Structure of virtual teams has been identified as an important aspect of effectiveness in the virtual team environment. For instance, Hertel et al.,(2004) found out that highly interdependent task structures may be efficient at the establishment stage of virtual teams. The suggested explanation was that one of the purposes for structuring a team, as identified from the literature, is to reduce overflow communication between members (Hertel, 2005). It was further suggested that having people with similar backgrounds in a team would not reduce the overflow communication. On the contrary, similar backgrounds might increase the communication. Again, there is not supporting research concerning the influence of the dyadic structure in reducing overflow communication. Neither is there research in the literature concerning the relationship of task structure to team effectiveness in virtual environments where dyadic structure has been imposed.

Summary of Prior Literature

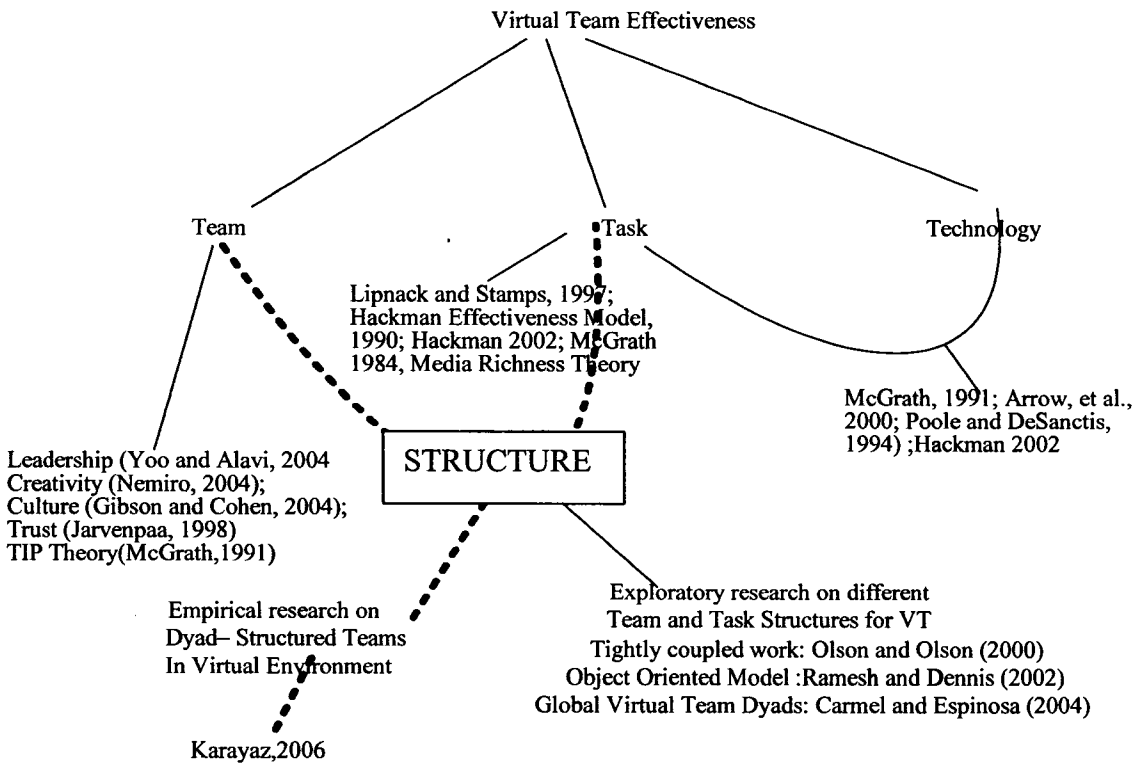
A top-level summary of the literature might be that concluded by Powell, et. al. (2004), there is no univariate approach to handle effectiveness although varied performance

constructs have been used on virtual teams. The study of virtual teams is in a dynamic and embryonic state of development. Technology continues to advance and accelerate rapidly. In addition, the study of virtual teams appears to be primarily antidotal in nature, substituting research-based findings for the expedience of assumptions and practical experience. Nevertheless, the literature has established the importance of team satisfaction, task performance, and communication frequency as critical aspects of team performance. In this review, we discovered that work groups are getting smaller (Qureshi and Vogel, 2001) to cope with increasing complexities of work and the strain of communications. The dyad has been established as the smallest structural element in teams, virtual or otherwise. Another important conclusion from the literature was the speculation that if there can be a reduction in the overflow of communication created by task, performance may be increased (Olson and Olson, 2000; Ramesh and Dennis, 2002; Espinosa and Carmel, 2004).

To conclude, a well-structured design is recognized as a candidate with significant potential for affecting virtual team effectiveness. As the research and body of knowledge continue to grow in this field, it is essential to understand the impact of structural alternatives as means to improve effectiveness. In particular, an extreme of the structural assignment is the dyadic structural configuration for virtual teams. Original research has not been accomplished to expound on the impact of the dyadic structure on virtual team performance. The literature supports the idea that team structure has a definite influence on performance and outcomes, although not explicitly in virtual collaborative environments. With pressures of team, organization to occur rapidly, some teams may not have an extended period of time to develop effective structure due to a shortened life

cycle. As Arrow, et. al (2000) suggested, teams with a longer life-cycle might have enough freedom and wisdom to structure their group in effective ways. They continue, however, the more likely case is that most teams start working immediately, with corresponding time pressures. In those instances, structuration of a team may be considered as an investment of time, but ultimately it is an important effort with significant consequences concerning performance. The literature supports the concept that, since the main idea in team structures is to support work towards the completion of tasks in the most effective and efficient ways, teams that are appropriately structured deemed to process tasks more successfully. However, we must also conclude from the literature that there is a lack of support for knowledge claims concerning the impact of structure, particularly dyadic, in enhancing effectiveness of teams in a virtual collaborative setting. Therefore, this research represents a rigorous effort to fill a critical gap in the body of knowledge: Empirical research on the influence of dyad structured teams in virtual environments. Based on the review of recent literature, the gap by the dotted line in figure 4 shows the relationship of this study as contributing to an existing void in the current state of knowledge for virtual team research.

Figure 4. Research Gap



CHAPTER III
RESEARCH METHODOLOGY

This chapter explains the research methodology used in this study. Over the two weeks of data collection for the quasi-experiment, one-hundred and eleven participants in thirty-eight teams worked virtually. They completed a task using a web-based virtual environment, reached a team decision, and reported their satisfaction, as well as experience with the experiment. A quasi-experiment design was used to carry out the experiments. Before the actual experiment, a pilot experiment was conducted. The design, procedures, and survey that were pilot-tested supported refinements to the actual design used to guide the study. The results of the pilot study can be found in Appendix A. The following section discusses the experimental design, subjects, procedures, measurement, and data analysis methods. A detailed section on validation of instruments is included in this chapter.

Introduction

This research takes a quantitative research approach and combines experimental research with empirical data collection and analysis drawn from experiments. A quasi-experimental design was chosen to carry out experiments. The primary reason for choosing the quasi-experimental method was to investigate the causal relationship between team and task structure with respect to task effectiveness. The secondary reason quasi-experimental design was selected was consistent with the research methodology guidance provided by Shadish, Cook and Campbell (2002). This guidance suggested appropriateness of quasi-experimental design due to non-practicability of locating a large number of voluntarily participating units who would be randomly assigned to groups.

In general, quasi-experiments comprise a class of empirical studies that lack two of the usual features of field experiments: a) the lack of full control, and b) absence of randomization. They may be defined as "experiments that have treatments, outcome measures, and experimental units, but do not use random assignment to create the comparisons from which treatment-caused change is inferred" (Cook and Campbell, 1979, p. 6). Quasi-experimental design structure involves one or more treatments, measures taken after a treatment, and, usually, more than one unit receiving each treatment.

Different design options exist in quasi-experiments, but are mostly classified in two categories; 1) designs that either lack a control group, or lack pretest observations on outcome, and 2) designs that use both control groups and pretest. Both designs have been used in and accepted in many applications over time (Shadish, Cook and Campbell, 2002). Quasi-experimental designs that either lack a control group or lack pretest observations on outcome have been used very widely due to "...practical necessities imposed by funding, ethics, or logical constraints" (Shadish, Cook and Campbell, 2002., p.104).

The literature also reports that there are many quasi-experiments conducted using designs that combine many design elements. If the design has somewhat less strength, then what is desirable for a true experiment, due to circumstances such as ethics or population, statistical control is used to provide support and plausibility in experiments. A recent technique for "casual-modeling", such as structural equation modeling (SEM) is an example of incorporating the power of statistics in quasi-experiments. One must note that the quasi-experimental approach is advocated as a complement, not a substitute, to

the deductive approach to research (Caporaso, 1973). Finally, "...quasi-experiments are nothing more than combinations of such elements selected to suit particular circumstances of research" (Shadish, Campbell, and Cook, 2002, p.156). The responsibility and accountability for appropriate use and design of quasi-experiments rests solely with the researcher.

The following section discusses the design of quasi-experimental design used in this research study.

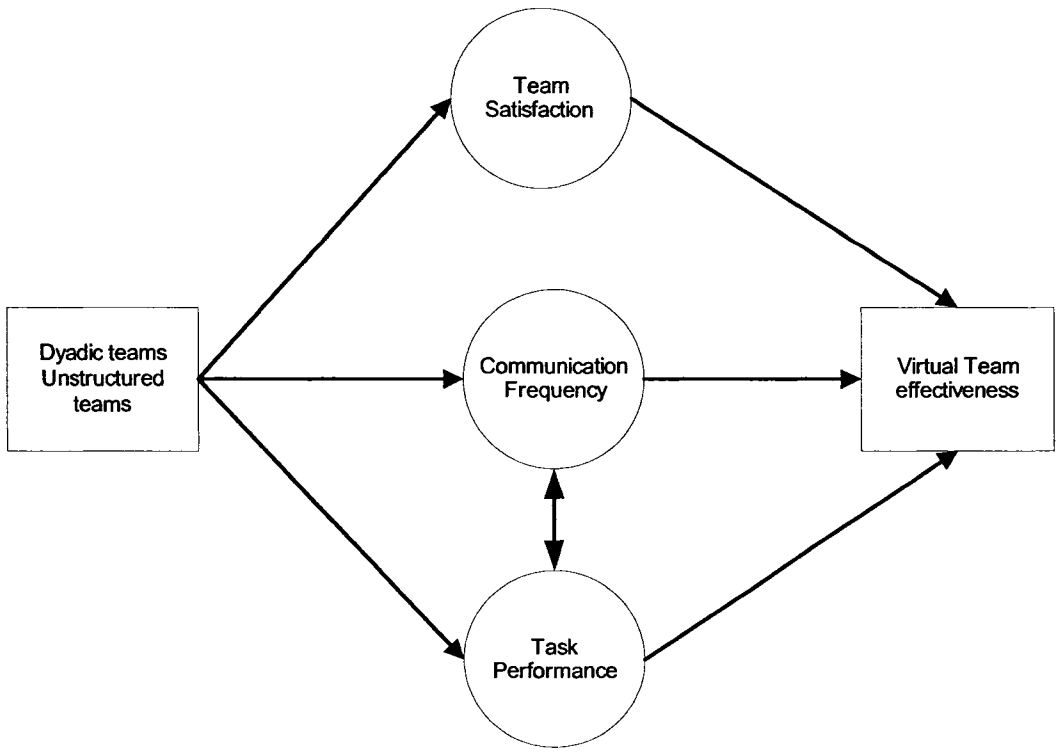
Design of Quasi-Experiment

Drawing from the literature, it has been established that team structure may affect team performance both directly and indirectly. A few variables that can be considered measurable as part of the structure of a group include variables such as team size, goal clarity, specific norms, task control and a formal leadership (Gladstein, 1984). For the current research, the main focus was on team size as the independent team structure variable, more specifically on dyads. Task structure, on the other hand, is defined as the overall configuration of the space such as set of strategies, rules, and procedures that may include control, goal, clarity, and type of the task such as complexity (Lam,1997; Gladstein, 1984; Steiner,1972). Drawing from various definitions, the present research used a clear set of rules for the experiment and clear description of the task to be assigned to the groups participating in the quasi-experiment. The experimental process was explained in detail for participating team members. In addition, a decision-making agenda was given teams to structure the task in this research (Appendix E). The agenda would not only help teams to structure the task, but also would serve as a way of starting task discussions. However, the agenda was not strictly enforced, but strongly

recommended. The reason it was not strictly enforced stemmed from the observation during the pilot experiment: the agenda was provided and no direct effects on outcome were identified. Therefore, the agenda was given as an advisory consideration for teams to organize their ideas.

This research focused investigation on the effects of team/task structure on team effectiveness in terms of task performance, team satisfaction, and the communication frequency. Communication frequency is assumed to be a moderator variable, and to have a direct effect on the effectiveness, where task structure is assumed to have indirect effect on outcomes. The following figure visualizes the experiment design:

Figure 5. Design of the Experiments



A preliminary version of this design was tested in pilot experiment and adjusted accordingly. Detail information on pilot experiment can be found in Appendix A.

Subjects

The subjects for this experiment were all volunteers. Initially, one-hundred twenty-seven volunteers signed up for the experiment. One-hundred fourteen participants started the experiment, and one hundred eleven of them completed. One of the members of a dyadic team dropped during the experiment; therefore, this team's data was not included in the statistical analysis. Initially, it was intended to have dyads compared to four-person teams, however, due to drops; three three-person teams emerged as the unit for the non-dyad team structure. The following table shows the assignments in numbers:

Table 4. Subject Data

Team Type	Number of Teams	Number of Total Participants
Dyadic teams	19 teams (initially was 20 teams, but in the process one person dropped, so number of teams analyzed was 19)	**38**
Self-structured teams 4 person-teams	16 four-person teams	**64**
3 person teams	3 three-person teams (Initially 19 four-person teams created, but three people dropped during the process, so three-person teams emerged).	**9**
TOTAL	**38**	**111**

A web page was created to solicit participation for the experiment, and provide linkage to the virtual team space. Volunteers were sought using professional societies' student listings, placing flyers around the Old Dominion University (ODU) main campus, using ODU's electronic announcements for students, and collaborating with professors

who were teaching summer classes at the Department of Engineering Management and Systems Engineering at ODU. Although participation was voluntary, students had various extra credits in professors' discretion. A monetary incentive ($100, $80, $60) was given by the researcher for the best three performing teams to encourage participation. Through a signed consent form, all participants were asked to complete a team assignment form in order to determine their virtual team experience, gender, place of birth, work experience, class standing, and major.

The majority of participants were graduate students (62.5 % of whole population) whom work in different fields. Average age was thirty years old. Forty of the participants were female and seventy-one of the participants were male. More than a third of the participants (thirty-six percent) were in an engineering field. A bit over twelve-percent of the participants reported as working in the Operations/IS field. The business/management field had slightly more than seven percent. However, looking at the field they want to work after graduation; business/ management scored the second highest category following engineering with twenty-one percent. Overall, twenty-four percent of participants reported that they either do "not work" or "other". The other category was not distinguished from the answers to determine a specific category. The results of the pre-experiment survey show that seventy-four percent of participants were currently working when they joined the experiment.

Participants were assigned to teams using purposive sampling, a method recommended for quasi-experiments where randomness is lacking (Shadish, et al., 2002). One of the problems with quasi-experiments is generalizability of causal inferences due to lack of randomness. Purposive sampling is advantageous in that it minimizes selection-

sampling error. The idea behind purposive sampling is to find typical instances within the group, and placed them purposefully into groups such that initially all groups would be equal. This method was chosen to increase the statistical power of the design, and to help control proportions assigned groups. In this research, all participants were first placed into groups based on matching characteristics (identified below), then assigned separately for each group. Following two paragraphs explains assignment process in detail.

After analyzing pre-experiment team assignment forms, it was determined that there were two instances in the data: virtual team experience, and class standing. The first assignment variable was whether participants had any prior virtual team experiment. The majority of the participants reported no previous virtual team experience (seventy-three percent). Therefore, those who had some experience of virtual teaming were placed into teams purposefully such that, all teams except one, had one member who had previously experienced in virtual teaming.

Another characteristic found was their class standing. Thirty-seven percent of the participant's were undergraduate students, and over sixty-two percent were graduate students. The researcher ensured that every team had at least one undergraduate and one graduate student, as well as having one member experienced in virtual teaming. Four global members signed initially. However, one dropped prior to the commencement of the experiment. These three global members, from Israel, Colombia, and The Netherlands, were randomly placed into teams; however, none of dyadic teams had global members.

Virtual Collaborative Team Space

Prior to elaboration on the virtual environment supporting the research, an important point is necessary to has to be noted at this point. This research, unlike the earlier studies concerning virtual teams, compares two virtual teams in a quasi-experiment. To date, prior to this research, comparison using virtual dyadic teams versus virtual four-person groups has not been done. The most distinguishing aspect of this experiment was using only the virtual collaborative environment to communicate and coordinate to perform the task. This was accomplished such that face-to-face interaction was not permitted during the experiment. All communication/ coordination were limited within the virtual collaborative team environment. Therefore, the experiment was conducted totally virtually.

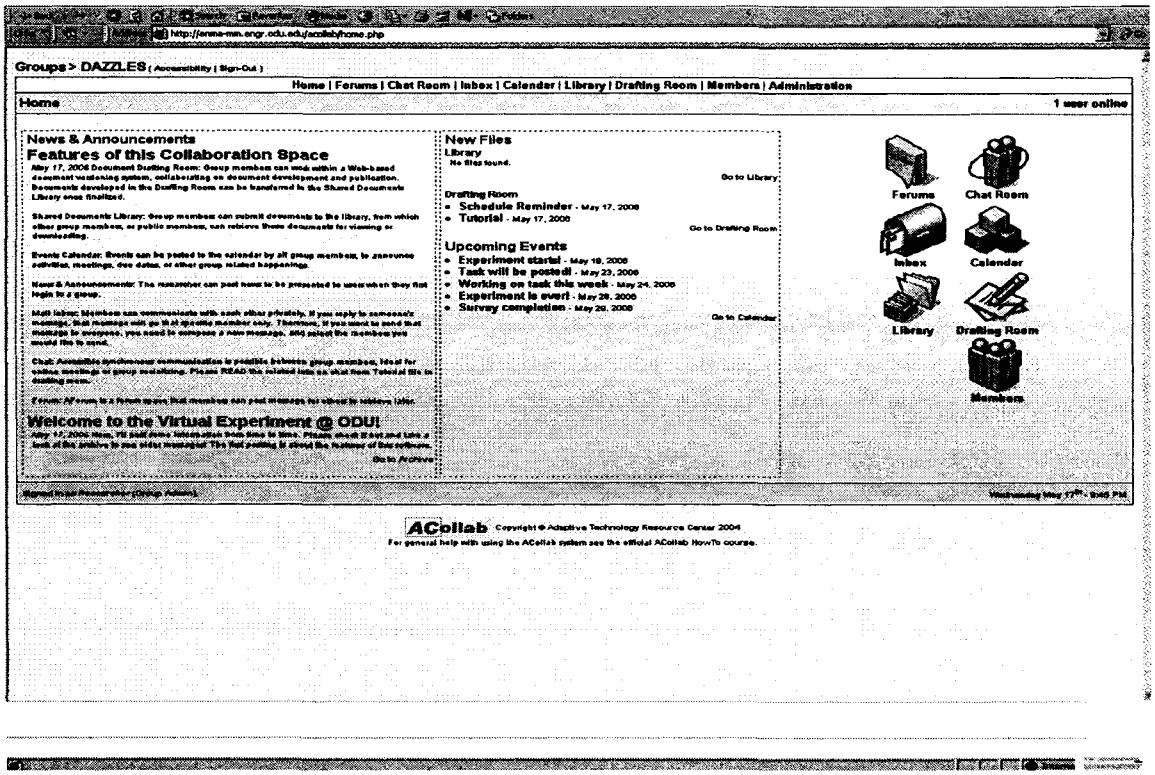
A web-based password protected virtual environment, Acollab©, (2006) was used to facilitate the experiment. Acollab© is a powerful open-source software that works as an integrated part of a learning management system. However, in this experiment, Acollab© was used as a standalone application, and set it up on a server at ODU. All technical maintenance was done by the researcher. The researcher acted as the system administrator as well as the group administrator in team rooms to identify and correct computer application problems. To do so, the researcher observed the experiment continuously, issues were resolved, and the server was maintained successfully during performance of the experiment. Consequently, there were no data corruptions due to technical problems during performance of the experiment.

Acollab© has variety of features that makes this application a robust virtual collaboration space. Features such as document drafting room, shared document library,

events calendar, news & announcements, mail inbox, chat, forum, membership index to see other members in the team make this software an effective technology to support virtual team collaboration for purposes of research. The figure 6 below is a print screen from the application where the features can be seen.

In the post experiment survey, ninety-seven percent of experimenters in dyads reported they have had access to all technology they need to perform the task. Similarly, approximately ninety-six percent of unstructured teams reported the technology accessibility. This shows that Acollab© was a robust application for this experiment.

Figure 6. Print Screen from Acollab©



Experiment Task

The literature supported that task has been shown to be one of the moderators of team success in the literature (Mennecke and Wheeler, 1993). Lipnack and Stamps

(1997) suggest that the assigned task be considered as the central focus or purpose of teams. This suggestion confirms the importance of task in group structure. Again, Lipnack and Stamps (1997) suggest that virtual teams are more effective in decision-making tasks than face-to-face teams. In design for the experiment, it was important to distinguish first, suitable task types for virtual teams. A number of authors have developed different task taxonomies to attempt to provide a framework in research and theory building (McGrath, 1984; Hackman and Morris, 1975; Hackman, 1987) as already appraised in the literature section. This study, following McGrath's task circumplex, used a decision-making/intelligent type of task with correct decision answer.

The experiment task was taken from the information systems literature, and modified with permission. Originally, this task was used to examine information exchange in group decision making (Dennis,1996). Although this task was tested and verified, the original task was modified accordingly to fit into this the research design. The original and modifications are provided in Appendix E and Appendix F respectively. The initial version of the task was tested in the pilot experiment, and some changes made based on the pilot results.

The task was to select an applicant to a university. There were three fictitious candidates whom were initially turned down in the selection process. The participants were asked to accept one applicant, and rank the other two. The information was given about the task as follows:

> Scholastic Aptitude Test (SAT) (both verbal, and math), Grade Point Average (GPA) on academic courses, advanced placement courses, quality of high school, required courses for admission missing from each candidates background, GPA

over all courses, letters of recommendation, motivation to attend to university, extracurricular activities, degree program intended to study, commitment to degree, place of residence, size of residence, parent's alumni status, parent's education and jobs, and gender

The first seven variables were sufficient to make a decision (Dennis, 1996). Nonetheless, the rest of the information was kept so the teams could have richer discussions in coming to a decision.

Experiment Procedures

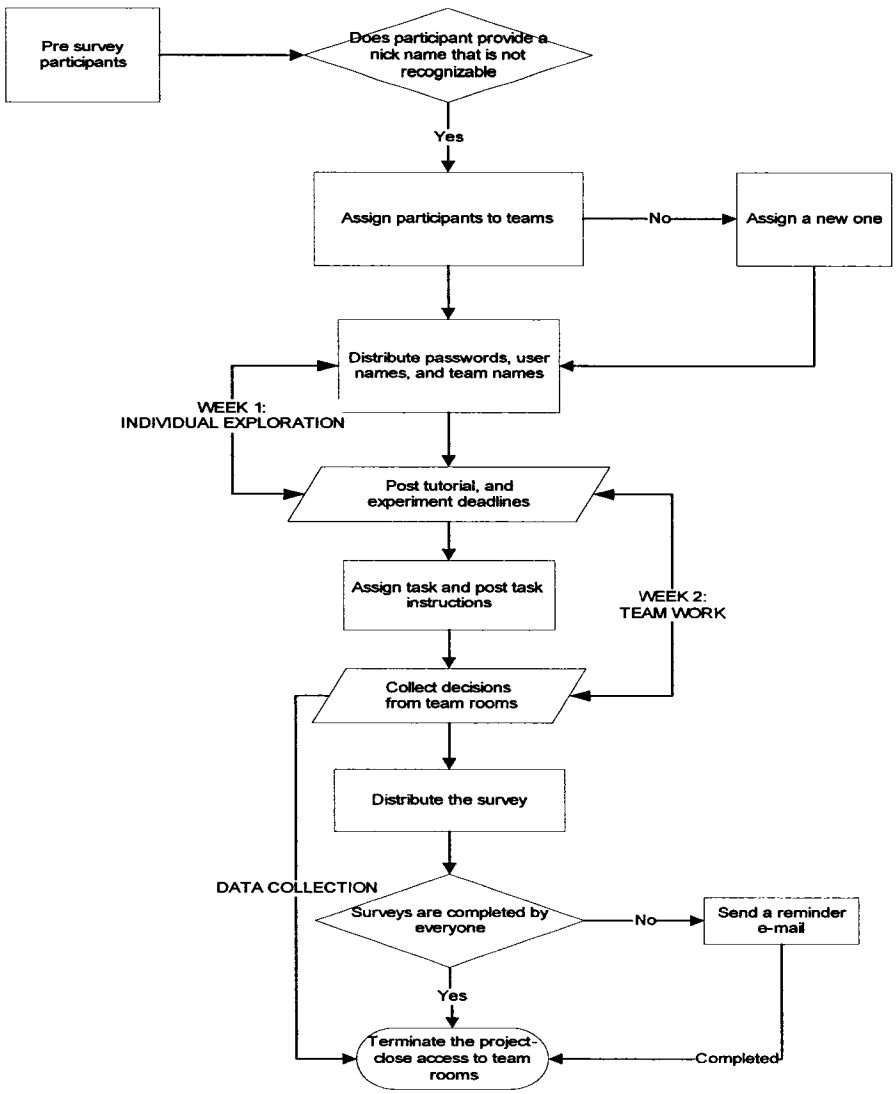
The experiment was conducted over a two-week period. After pre-surveyed data was analyzed, the participants were assigned to teams as mentioned previously. Figure 7 shows followed steps in the experiment procedure. Following section elaborates the effort.

1. Assigning user names: If a participant mentioned a nick name/screen name on the team assignment survey, which they were asked to do so, the researcher used this name with caution. If the screen name was revealing their identity in some way, such as replica of student e-mail accounts at ODU i.e. xxx007, the researcher changed the screen name to make it less obvious for recognition.

2. Assigning teams/exploring the team space: At the beginning of the first week of the experiment, all individuals received their password, user name, and team names. They were given instructions on how to access to their team space, with necessary information on each step for successful completion of the experiment. A calendar showing experiment deadlines was posted on each team space. A tutorial was also posted into the team space at the same time usernames were sent out. The first week was considered as

an individual effort to prepare for active participation in the experiment. The participants were asked to log in, check the features of the software, complete the tutorial, and start communicating with their teammates to accomplish the task. This week gave participants enough time to learn the technology and getting ready to communicate with team members.

Figure 7. Experiment Steps



3. Assigning task: At the beginning of the second week, the experiment task was posted into the team space with the corresponding instructions. A decision-making agenda was

part of the instructions. The agenda was presented as a suggestion to the teams to organize the task. Following or use of the agenda was left to the discretion of the team. All participants were informed of posting by e-mail. They were given a week to finish the task. Although time was not a criterion in measuring task outcome in this experiment, teams were instructed that they would not need to spend more than an hour to complete the assigned task. This week was considered to be a virtual team effort.

The way they went about solving the task, and tools they used to solve the task, and the time they spent the task varied from team to team. Some teams used the forum function exclusively, some teams preferred to use the e-mailing function and some used combination of e-mail, forum and chat. The drafting room was also used frequently to post their ideas to have other members to see. Very few teams used the calendar to post any event.

5. Survey distribution: At the end of the second week, as they were instructed, teams posted their results into the team space. After all teams posted their results, a self-reporting survey was sent to individuals via e-mail. The e-mail provided a link to a web-based survey to measure the satisfaction about their team experience and team task solution.

6. Communication during the experiment: Other than using team space, all other means of communication between team members was forbidden during the experiment. Since the team space would be the only communication place, participants were instructed to log in the team space at least once a day. Checking team space frequently and participating actively was emphasized strongly in e-mails to avoid having frustrations, since this was the only way to communicate/collaborate with team members.

Acollab© has an alert feature to make participants aware of postings in their team space, which sends an e-mail to team members when someone posted something to forum, drafting room, or events calendar. However, for two reasons, this function was not set up. First, the alert function works only with the forum, events calendar, and drafting room. This would limit the usage of other features such as e-mailing and chat, encouraging participants to use only the functions with automatic alert, potentially dissuading use and checking of their team space frequently. Second, to protect anonymity and confidentiality, giving of e-mail addresses would have potentially breeched confidentiality of participants. To make the alert function work, real e-mail addresses would be required to be entered into the system. These addresses would have been seen by other members. Once private e-mails were known, they might have ended up using only e-mails without checking their team space. This would have rendered measuring communication frequency impractical for this research. These actions consequently resulted in participants checking their team space frequently.

The researcher kept participants' private e-mails to herself, and used them when there was a posting necessary by the researcher. These messages were simply generic messages such as "task is posted", "you have a posting in your team space" "there is an activity in your team space, please check back more frequently". Another generic message was e-mailed out two times before the deadline, serving as a reminder about task posting deadline. One reminder was sent out right after the task was posted, and another sent out when there were only a few days left to finish the experiment. This message also repeated the information where to post the task. Other than these messages, the researcher did contact the subjects only if it was necessary. For instance, there were two extreme

cases that necessitated researcher contact with groups. The first instance occurred when one of the members from a dyadic team did not show up until last moment. The other team member of the dyad actively tried to reach the team member without success and complained about the situation. This prompted an e-mail from the researcher to the non-participating member requesting that they either join actively or drop the experiment. Eventually, this member re-engaged, however, the other team member was not satisfied and dropped their participation in the experiment. Another similar case occurred in a four-person team. One member did not participate during the entire experiment. The other three members reported to this researcher, and the researcher tried, without success, to contact with this member. Therefore, this member was dropped from the experiment by the researcher, and other team members were instructed to continue without the fourth team member. Besides these cases, the researcher used the "news & announcements" function in team spaces to communicate teams and convey necessary information.

Research Variables and Measurement

The objective of this study was to compare two virtual teams by manipulating the team/task structure. The research then investigated whether the difference in team/task structure influenced effectiveness of the team. Three constructs are derived from the literature to measure virtual team effectiveness in this research: a) task performance, b) team satisfaction, and c) communication frequency. These variables and their measurement are described below.

The unit of analysis was at the team level for this study. Task performance and communication frequency were analyzed at the team level while team satisfaction was analyzed individually, and aggregated to the group level. Consisting with previous group

studies, reliability of aggregated scores within-group (inter rater agreement) tested using *intraclass correlation efficient* (Hardin, et al., 2006). The following section discusses only data collection and reliability of measures used in the study. The primary statistical methodology used for data analysis is introduced in the following chapter. This development includes discussion of results. The following section provides a brief explanation concerning the statistical design used in this research.

Statistical design in this research relies on Multivariate Analysis Techniques. Multivariate Analysis Techniques broadly refers to various relevant statistical models that simultaneously analyze multiple measurements (Hair, 1995). It provides the researcher the opportunity to analyze in detail the variance between variables. This is especially useful in quasi experiments to explain causal relationships when there are independent, dependent, and mediator variables measured in different components of each (Shadish, et al., 2002). The specifics of the design and individual Multivariate Analysis Techniques used for discussed in detail in the next chapter. The following section focuses on the development of constructs with respect to data collection.

Task Performance

This construct was represented by the task quality produced by a team that includes two sets of variables: the correct task solution, and correct ranking of applicants for the admission process. The data was electronically retrieved from each team's task decision files. All teams posted their decision files (i.e., word, excel) as instructed into team space, including their justification on why they selected and ordered particular applicants. The researcher downloaded these files and transferred them into a format where all team's results could be coded. Two levels of coding were created for this

construct. Teams that selected the right applicant, and ranked the other two correctly, received a performance coding of one. The rest of the teams received a performance coding of zero. Thus, task performance was capable of objective measurement for the experimental results.

Team Satisfaction

Satisfaction was measured by asking each individual to report their satisfaction in a post-experiment survey. The foundation of survey items were based on two previously developed surveys from the literature: *Team Outcome Effectiveness Survey* Gibson et al. (2003) and *Virtual Team Survey* (Lurey, 1998). Although these two surveys were already validated with different techniques, the reliability of modified survey used in this research was face-validated and pilot tested prior to use in the research. Post-pilot analysis showed that Cronbach's (1951) coefficient alpha was α=0.883. This is considered to be a reliable level in the literature.

Survey Instrument

The survey consisted of four main parts: a) tools and technology; b) communication/coordination process; c) level of satisfaction of the member; and d) overall performance of the team. The surveys are included in Appendices B and C. Wording of the two surveys was slightly modified to fit the specifics related to the different team type (dyad and non-dyad). For instance, in dyadic teams, word "partner" used rather then word "team member". A five-item Likert type scale from strongly disagree to strongly agree was predominantly used with ratings. The following paragraphs elaborate on specifics of the survey items.

Both teams were asked to report if they had previous experience in teams or virtual teams. Additionally, dyadic teams were asked if they had ever worked in a dyadic team prior to the research. Tools and technology questioning was the same for all teams. Teams were questioned as to whether tools and technology used were sufficient to perform the required task. If they did not agree that tools and technology were adequate to perform the task, they were asked to explain what was missing. They were also asked to rank the most frequent features they used in the virtual team space. This was asked to capture whether there were abnormalities between electronic logs and reported answers.

The *communication/coordination process* part consisted of four questions. Participants were asked to report the satisfaction with communication mode, effectiveness of coordination, coordination difficulties, and satisfaction with the interaction. From this set of questions, attribution of communication/coordination process was established.

The *level of team satisfaction* part consisted of total ten self-reporting questions ranging from the quality of task they produced, effectiveness of the team, whether they enjoyed being in this team, to whether they would join another virtual team in the future. They asked to report their satisfaction with team outcome as well as task solution. While it was not a central focus of this research, a question about leadership was also asked to disclose whether or not there was a formal leadership that emerged during the experiment.

In the *performance reporting* part of the survey, participants were asked if the information exchange occurred in a timely manner; to what extent their participation effected the decision; if they agreed that all members participated substantially. If

participants did not agree on the equality of participation, they were asked to rank the contribution of members. However, if they agreed that members participated equally, they would not be requested to complete the ranking question. Participant opinions were also collected concerning if they could, in retrospect, identify ways that would have made their team more efficient and productive.

These data gathered from the survey were first analyzed at the individual level, and then aggregated to the team level. This aggregated data provided the base for team's own satisfaction. Out of this analysis of survey data, team satisfaction was established for both dyadic as well as self-structured teams.

After analyzing the results of the pilot experiment, several items were refined based on variances for answers and apparent redundancy in several questions. Post experiment analysis did not use these items from the survey. Related items were grouped to create high level construct data. This items and their reliability were explained in the statistical analysis section. The following table depicts the reliability of surveys for the main experiment.

Table 5. Reliabilities of survey instrument

Survey	Cronbach's (α)
Dyadic Survey	0.804
Self-structured survey	0.771

These reliabilities, based on Cronbach's (α), are acceptable for statistical analysis and interpretation of data.

Communication Frequency

Communication frequency was measured using the recorded electronic logs as well as a ranking question in the survey. The reported electronic logs included e-mails, chat room-size, forum messages, calendar events and draft number of files to discuss the task in the team folder. The number of e-mail messages sent, number of forum messages posted, and the draft files in the drafting room were counted. The chat transcripts were saved as html files, and the size of the file was quantified based on kilobytes used as the part of the communication log data. The ranking of the usage of different tools was also collected by questioning in the post-experiment survey. The combination of these data provided a reliable measure of communication frequency. The amount of communication data were important to establish whether or not an overflow of communication occurred. This combined data was analyzed using correlation between each application used to facilitate communication.

As mentioned previously, these three constructs were analyzed at the team level using Multivariate Analysis Techniques. The following section summarizes this chapter.

Chapter Summary

The goal of this chapter was to explain the research methodology. The chapter began with an introduction to quasi-experimental design. The quasi-experiment design used in this research was introduced. The descriptive data about participants including the method for assignment of subjects, and demographics were presented. The experiment task was discussed in detail. A screenshot from virtual collaborative environment was provided and application feature were presented. The experiment execution steps were visualized in a flowchart diagram. These steps were explained in detail, from assigning

teams to collecting surveys. The measurement of three research constructs was discussed in turn:1) task performance, 2) team satisfaction, and 3) communication frequency. Detailed information about survey items was also included to the discussion. The following chapter discusses the data collection, data examination, statistical design and techniques used in this research, and report the results of analysis.

CHAPTER IV
STATISTICAL DESIGN AND RESULTS

This chapter discusses the statistical design and the results of the statistical analyses. As established earlier, three constructs were considered measurable in this research; task performance, team satisfaction, and communication quantity. These three constructs were examined for statistical differences between dyad and self-structured teams. The following section explains the data collection for these constructs as well as discussing the statistical analyses performed, their rationale, and the results stemming from the analyses. All statistical analysis was performed using SPSS 14.0 for Windows. The last section of this chapter discusses hypotheses testing, and presents the results.

STATISTICAL DESIGN

This research tested four hypotheses, which were presented earlier. It would be beneficial to relate them again in this section to explain the statistical models that was used in the study. For review purposes, the four hypotheses tested were:

Hypothesis 1:

There is no statistically significant difference between the dyad-structured approach and the unstructured (self-structured) approach based on the correct task decision produced by virtual teams.

Hypothesis 2:

There is no statistically significant difference between the dyad-structured approach and the unstructured (self-structured) approach within virtual teams based on the amount of communication produced.

Hypothesis 3:

There is no statistically significant difference between the dyad structured approach and the self-structured approach based on overall satisfaction

Hypothesis 3a:

There is no statistically significant difference between the dyad-structured approach and the unstructured (self-structured) approach based on the satisfaction with task outcomes.

Hypothesis 3b:

There is no statistically significant difference between the dyad-structured approach and the unstructured (self-structured) approach based on the satisfaction with being in that particular team.

The statistical analysis was designed to compare two virtual team structures on. Since this is a contrasted-group design experiment, three constructs task performance, team satisfaction, and communication frequency were compared between the two virtual team structures for differences. In other words, it was investigated whether dyadic structured teams performed better.

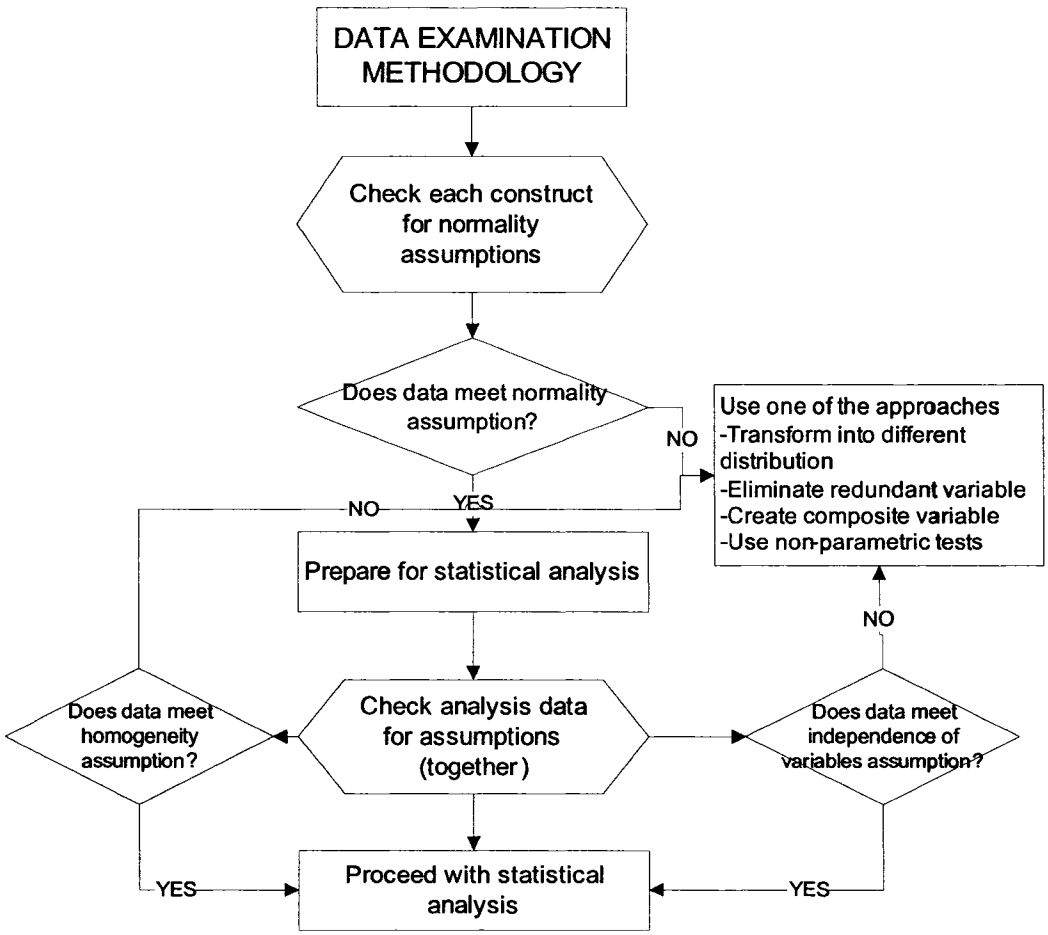
The main statistical methodology relied on several multivariate analysis techniques in this research. In the following sections, these techniques are elaborated. The following section explains the treatment of data. The primary purpose of this section is to establish that the data assumptions necessary to perform statistical tests are in fact met by the research design and data.

Data Examination

This section provides the results from statistical analysis of the data in support of the hypotheses testing. It was important to establish that the necessary statistical assumptions could be met before running the statistical analyses. Some of the critical assumptions of multivariate analysis techniques used for the data analysis included the normality of distribution, homogeneity of variance, and independence of observations (Nunnally, 1975; Hair, et al., 1995) that were analyzed in this research.

The normality of data refers to fitting a normal distribution, and if the difference between variables are sufficient to make statistical significance. The homogeneity of variance relates to variances within groups, and can be detected using Levene's test (Hair et al., 1995). Independence of variables assumption refers to uncorrelated responses from each respondent. The normality assumption was analyzed individually for each construct. Nunnally (1975) states that compulsive concern about the normal distribution would be wrong in practice. If there are anomalies about normality, this is reported. Anomalies can be corrected using one of the approaches; a) to transform the data into a different distribution, which is not recommended due to difficulty of interpretation of results, b) to meet the normality assumption, eliminating redundant items unless significant impact does exist for inter item reliability, c) create composite variables to establish one or two data sets using data reduction techniques, or d) to use non-parametric tests which do not require normality assumptions (Nunnally, 1985 ; Hair et al.1995). After analyzing normality, research hypotheses were tested with meeting other necessary assumptions. The following section summarizes data examination effort for each construct. The figure 8 below visualizes the effort.

Figure 8. Data Examination Methodology



Task Performance

Task performance data were collected for each team based on the task results. All teams posted their decision files (i.e., Microsoft® Word, Microsoft® Excel) into the team space, including their justification on why they accepted a particular applicant. The researcher downloaded these files and transferred them into a format where all team results could be coded. Two levels of coding (0-1) were used for this construct as previously mentioned. Six out of nineteen dyadic teams reached the correct solution, as

opposed to four self-structured teams. Descriptive statistics were applied to check for normality (Table 6).

Table 6. Descriptive Statistics

Team Type		N	Mean	Std. Deviation	Variance	Skewness	
		Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error
Self	Task	19	.21	.419	.175	1.545	.524
Dyad	Task	19	.32	.478	.228	.862	.524

Non normality and skewness were expected from this data, since the correct solution was not expected to be found by a high number of groups completing the task. For this type data, an accepted rule of thumb for skewness statistics/std. error reported as less than 2.5 (p=0.01 level) indicates that skewness is acceptable (Leech, 2005). Therefore, the skewness in dyads is acceptable based on this rule. The self-structured team skewness slightly exceeds the accepted value, but it will be accepted for purposes of this research since this data was coded using a dummy variable (0-1), and non-metric data are not required to meet normality assumption necessarily (Hair, et al., 1995) as long as the two teams are equal in size (Hopkins, 2000). Therefore, a basic statistical means comparison is appropriate for significance testing of this data. It is concluded that there is no legitimate reason to transform this data. The normality assumption necessary for statistical analysis is met.

Team Satisfaction

Team satisfaction data was collected with a self-reporting web-based survey for both teams, using Inquisite 7.0 software. This data was collected at the individual level. Therefore, as a first step, individually reported data were aggregated to support team

statistics. Individual scores were aggregated averaging scores between team members to the team level. Reliability of aggregated scores (inter rater agreement) testing was conducted using *intraclass correlation coefficient.* This coefficient, has been previously recommended for dyadic teams (Kashy and Kenny, 2000; Crano and Brewer, 2002) to establish the reliability of associated variables. The intraclass correlation coefficient score closes to 1 to show the positive agreement. On average measures for this research, aggregation reliability measured by the intraclass correlation coefficient was 0.862 for absolute agreement, and on consistency was 0.889. Both of these values indicate a reliable level of consistency within items.

Next, data was examined to determine whether there was a case of abnormality. If the substantive research issues were addressed, and nothing overlooked, then less is more in variables (Cohen 1975; Nunnally, 1975). According to Nunnally (1975), it is acceptable to discard unnecessary information following the experiment. Therefore, not all of the questions from the survey were used in data analysis. The complete survey questions can be found in Appendices B and C, the following section focuses on data reduction for unnecessary items.

Two-types of centralized questions, including several subquestions, existed to measure team satisfaction. These questions included those that addressed; a) satisfaction with being in the team, and b) satisfaction with task outcomes. In order to eliminate unnecessary variables and redundancy, data was first scanned for normality assumptions. Initial examination showed that there were indeed few items that violated the normality assumption (refer Table 7 below). Based on examination of data, it was believed that some measures might need to be grouped for analysis. In order to explore the data, a data

reduction technique, *exploratory factor analysis* was performed (Nunnally, 1985; Hair et al.1995). The purpose of the factor analysis was exploratory in this case, attempting to determine factors to group variables into two constructs, not to test internal consistency. Consequently, factor analysis provided the empirical basis the potential of creating two composite variables for satisfaction (Hair, et al., 1995). The following table shows the satisfaction related questions in the dyadic survey prior to the factor analysis being conducted. It must be noted that same questions were asked to self-structured teams (changing the words from partner to team members).

Table 7. Satisfaction Survey Questions

Construct	Measure
Satisfaction	• I worried about my team's performance * • The team was effective in reaching its goals • I was very satisfied with the quality of team's solution • Approximately how many hours did you spend in this project to solve the task? • Task information exchange within team was timely • How would you rate your partner's contribution in this task • To what extent did the final decision reflect your inputs • The team was efficient • The team was productive • I enjoyed our dyadic interaction during this project • I felt my input was valued by my partner* • There was respect between partners* • Time was dedicated to developing social relations during this experiment* • Overall, I enjoyed being a member of this dyadic team. • In the future, I would be interested in participating in another virtual team

* Represents the violation of normality assumption.

Using SPSS 14.0, principal axis factoring using Varimax rotation was conducted to assess the underlying structure of the data. No specific guidelines exist to pick a particular rotation technique according to Hair et al., (1995); the reason for Varimax rotation picked in this research was because it would make the final factors as uncorrelated as possible, therefore ensuring that information from one factor will be independent from other factors (Leech et al., 2005). Varimax gives clearer separation on factors (Hair et al., p.110). For the extraction method, eigenvalues (a measure of explained variance) over 1 were selected for elimination (Hair, et al., 1995; Morgan and Griego, 1998).

Assumptions related to sampling adequacy and appropriateness of factor analysis was tested respectively using Kaiser-Meyer-Olkin (KMO) and Bartlett's test (Hair et al., 1995, Morgan and Griego, 1998). Both indicated significant levels. KMO was scored as 0.792 and explained there were sufficient items for each factor to be predicted. This test is considered adequate when the score is above 0.70 (Leech et al., 2005; Hair et al., 1995). Bartlett's test of sphericity was used to determine appropriateness of factor analysis. The test was significant ($p<0.001$) indicating that items were correlated enough for a sound base to perform factor analysis (Hair et al., 1995).

In practice, factor loadings greater than ± 0.30 meet the minimal level, if the loadings are greater than ± 0.50, they are considered significant (Hair et al., 1995; Leech et al., 2005). Based on the factor loadings, items were grouped in two main constructs previously identified as a) satisfaction with being in the team, and b) satisfaction with task outcomes. Overall reliability of new items were retested using Cronbach's (1951) coefficient alpha before proceed with the data analysis (Table 8).

Table 8. Reliabilities of team satisfaction construct

	Dyadic	Self Structured
satisfaction with task outcomes	α	α
• The team was effective in reaching its goals • I was very satisfied with the quality of team's solution • Task information exchange within team was timely • The team was efficient • The team was productive	0.818	0. 919
satisfaction with being in that team		
• I felt my input was valued by my teammates(partner) • There was respect between teammates (partners) • I enjoyed our (dyadic) interaction during this project • Overall, I enjoyed being a member of this team • In the future, I would be interested in participating in another virtual team	0.872	0.755

These items were run together to determine group level for reliability, resulting in an alpha 0.759 of for dyadic teams, and 0.839 for self-structured teams. Based on the analysis, it was concluded that these two sets of questions formed a reliable measurement of the associated constructs.

These two constructs were analyzed normality as a final step. Two summated scale created as taking average of the variables in each scale: task satisfaction and team satisfaction. The following table shows the mean, median, mode summary. The results indicated three descriptive statistics were very close to each other, which showed the normality assumption was met.

Table 9. Descriptive statistics of team and task satisfaction constructs

TeamType		Team Satisfaction	Task Satisfaction
Self	Mean	4.2589	4.0663

	Median	4.2600	4.0200
	Mode	3.72(a)	3.88(a)
Dyadic	Mean	4.1947	4.2789
	Median	4.2000	4.4000
	Mode	4.20	4.70

a Multiple modes exist. The smallest value is shown

Communication Frequency

Communication frequency data was collected at the both the individual and team levels. At the individual level participants were asked to rank their usage of Acollab© features. Also, at the team level, communication frequency was established by reviewing the recorded electronic logs. Individual rankings were averaged to establish the team level and cross checked with electronic logs. The majority of the results were consistent between the self-reporting rankings and electronic logs. There were two inconsistencies within recorded logs and self reporting. For instance, a team ranked the chat as their number one tool in the experiment where there were no chat transcripts and logs. These two instances were corrected manually for the coding process referencing the electronic logs.

Two sources of communication data, electronic logs and survey results were used for analysis. First, a correlation analysis conducted within these two sources. According to Nunnally (1975), when a correlation between variables exceeds 0.50, they can be considered highly correlated. Only calendar survey and calendar electronic logs results did not show a high correlation. Therefore, survey and electronic logs results of the calendar were eliminated from the data analysis. Electronic logs of e-mail and forums were counted and summed into one variable for each of the categories. Chat usage data was recorded based on the size of chat boxes (kilobytes) as well as survey reporting. This process created two communication variables for each source: 1) electronic logs of forum

and e-mail; survey rankings of forum and e-mail 2) electronic logs of chat usage, and survey rankings of chat usage. Following this process, these values were transformed into one communication variable using a coefficient (coefficient of variation). This coefficient was calculated computing standard deviation of team's usage for each application divided by the mean usage of each team (Jarvenpaa, Rao, and Huber, 1988). The coefficient helped to adjust differences across two sources used for communication.

This section analyzed three constructs based on normality assumptions of the data required by statistical analysis. Having analyzed three constructs individually gave us chance to improve the data used in hypotheses testing, and some initial clues about the results. The following section is devoted hypothesis testing, and the results.

Hypothesis Testing and Results

In experimental research, it is useful to test hypotheses concerning the variance of in-group responses on two or more metric dependent variables (Hair, et al., 1995). Several statistics were employed for significance testing: analysis of variance, analysis of covariance, and correlations. Analysis of variance (ANOVA) is useful making multiple comparisons between groups, and gives you additional information over basic inferential statistics (Nunnally, 1975; Hair, 1995; Leech et. al., 2005). Some assumptions must be met for application of ANOVA, as it must be in all statistical tests. The ANOVA assumes that the observations are independent, and the dependent variable is normally distributed for each group. To analyze the assumptions, Levene's statistics were used for each application of this analysis (Hair et al., 1995). Covariance in ANOVA (ANCOVA) was helpful exploring task and communication relationships reciprocally. ANCOVA can be used to remove effects of uncontrolled variables if they exist. Hypotheses were individually analyzed, their significance identified.

Hypothesis 1

The first hypothesis was designed to investigate task outcome of dyadic virtual teams. It was hypothesized that there is no significant difference between virtual team structures with respect to task performance. Thus, the research tested if dyadic teams performed better in task solution. In this case, the dyadic virtual team structure did reach the correct decision with a greater frequency than the self-structured teams, outperforming the self-structured teams by 10.5%. The results can be found in Table 10.

Table 10. Comparison of Task Performance

Self-Structured Teams		Frequency	Percent
Valid	0	15	78.9
	1(correct score)	4	21.1
	Total	19	100.0
Dyadic Teams		Frequency	Percent
Valid	0	13	68.4
	1(correct score)	6	31.6
	Total	19	100.0

Analysis of variance was employed to establish the level of statistical significance for the difference. Levene's test of equality of variances was exceeding (0.05) that indicated homogeneity of variances assumption was justified (0.155) for the analysis. However, no significant difference between means emerged from this analysis. Although, initial observation showed that dyads did better in their task decision with 10.5% difference, ANOVA failed to show any statistical significance (Table 11).

Table 11. ANOVA of Task Performance

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.105	1	.105	.522	0.475

Within Groups	7.263	36	.202		
Total	7.368	37			

Therefore, the hypothesis was not supported. From observed results, one would interpret this as dyads performed better; however, there is not statistically significant evidence to support the hypothesis. A possibility that may explain failure to establish significance is the small sample size. Overall, there seems to be a trend towards dyadic teams doing better. We now direct attention to the testing of the second hypothesis for the research.

Hypothesis 2

The second hypothesis states that there is no significant difference between virtual team structures in terms of the amount of communication produced (communication frequency). Levene's test found slight significant variances in homogeneity ($0.01 < 0.05$). According to Leech et al. (2005), this is not an important problem using SPSS, since it uses a regression approach to perform calculations. Therefore, it was determined that the analysis could proceed with ANOVA to compare means. Table 12 shows descriptive statistics for communication based on team type.

Table 12. Descriptive statistics of Communication Frequency

	N	Mean	Std. Deviation
Self structured	19	1.2272	.34889
Dyadic	19	.8526	.17589
Total	38	1.0399	.33211

The calculation of this variable was previously explained. The variable, communication frequency, was transformed into one variable, which scores between 0.53 and 1.71 based on the standard deviation of team's usage for each application divided by the mean usage of each team. Therefore, direct comparison by the mean difference would be appropriate

for this variable at the first step. By doing so, the communication variable itself showed significant difference between two teams where dyadic teams had 37.46 % less communication average. This result seems to support the hypothesis. Moreover, Table 13 shows statistically significant ANOVA results ($p<0.05$) to support the hypothesis.

Table 13. ANOVA table for Communication Frequency

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.333	1	1.333	17.466	<0.001
Within Groups	2.748	36	.076		
Total	4.081	37			

It was suggested that that dyads were more task-focused, consequently reducing the amount of communication within the team, and thus keeping communication focused on task-related issues. This was analyzed using analyses of covariance between task decision and communication, where team type was dependent, communication was covariant. The reason communication was labeled as covariant was because it was predicted that the dyadic two-way interaction effect in this research would be evident through teams and task decision. The dyadic structure might therefore have a significant effect on teams. Table 14 reports the results.

Table 14. Test of Between-Subjects Effect

Dependent Variable: TeamType

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3.286	2	1.643	9.253	0.001	.346
Intercept	19.886	1	19.886	112.003	<0.001	.762
Communication	3.150	1	3.150	17.743	<0.001	.336
Task	.182	1	.182	1.028	0.318	.029
Error	6.214	35	.178			
Total	95.000	38				
Corrected Total	9.500	37				

R Squared = .346 (Adjusted R Squared = .309)

The covariate of communication is significant, but covariate of task is found not significant (p =0.318). Table 16 shows that the significant part of the contribution comes from communication as opposed to task performance. The effect of communication on team type is considered large looking at R^2 ($\sqrt{0.346} = 0.59$) and eta^2 ($\sqrt{0.336} = 0.57$). These numbers represent a large effect according to Cohen (1975). Analysis was reversed keeping communication as dependent variable to see how team type and task impact the communication. Table 15 reports these results.

Table 15. Test of Between-Subjects Effect

Dependent Variable: Communication

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1.376(a)	2	.688	8.900	0.001	.337
Intercept	9.359	1	9.359	121.089	<0.001	.776
Team Type	1.371	1	1.371	17.743	<0.001	.336
Task	.043	1	.043	.552	0.462	.016
Error	2.705	35	.077			
Total	45.176	38				
Corrected Total	4.081	37				

a R Squared = .337 (Adjusted R Squared = .299)

The results are consistent with the assertion that team type affects communication. Team type indeed affected the communication ($p < 0.05$); but effect of team type on communication does not depend on task performance. In fact, further analysis showed that interaction between task performance and team type provides weak evidence for a relationship to communication (p =0.418). This was actually expected due to insignificant results of the first hypotheses (difference in task decision). Since it was expected that dyads would focus more on task rather than social relationships in the team, the expectation was a resulting reduction in the amount of communication necessary to

complete a task. It has already been established that the communication amount of dyads is significantly less than self-structured teams. However, to gather more evidence on communication restricted to task rather than social relations to support this assertion, two questions were asked in the post-survey;

Question 1: Time was dedicated to developing social relations during this experiment (strongly disagree-1 to strongly agree-5)

From the results of the frequency table below, a specific conclusion can not be made. Only a small number of the participants thought that time was dedicated to social relationships (reporting for strongly disagree and agree). However, overall, 50 % both teams agreed that they did not spend time for social interaction during completion of the task assignment. Dyadic teams did not score more on "disagree" to this question, further, as might have been expected to support a conclusion that dyadic teams are more focused on task rather than social relationships.

Table 16.Question related to social relationships

Dyadic Teams		Percent	Self-structured Teams	Percent
	Strongly Disagree	23.7	Strongly Disagree	11.4
	Disagree	26.3	Disagree	38.6
	Neutral	34.2	Neutral	27.1
	Agree	13.2	Agree	20.0
	Strongly Agree	2.6	Strongly Agree	2.9
	Total	100.0	Total	100.0

Another question was asked to determine how long the groups spent on the assigned task. This would give some evidence how focused they would be working on the task.

Question 2: Approximately how many hours did you spend in this project to solve the task?

In sum, 42.19 % of dyadic teams reported between 0-2 hours, and 39.5 % between 2-4 hours. In self-structured teams for same amount of hours, this rate was 28.6 %, and 50% respectively. Although almost half of the dyads finished in 2 hours showing less communication in focusing on task, and consequently scored better solutions than other teams, these results are not conclusive to provide evidence of dyadic team performance.

Table 17: Hours spent in this project to solve the task

Dyadic teams		Percent	Self-Structured Teams	Percent
Valid	0-2 hours	42.1	0-2 hours	28.6
	2-4 hours	39.5	2-4 hours	50.0
	4-6 hours	18.4	4-6 hours	8.6
	Total	100	6-8 hours	10.0
			8-10 hours	2.8
			Total	100.0

In summary, communication frequency was found to be a significant factor depending on team type. Further analysis showed that it also contributed to the effectiveness more than task performance. It was also supported that team type had an effect on communication frequency. Therefore, this hypothesis was supported statistically.

Hypothesis 3 and Hypothesis 4

These two hypotheses investigated both dyadic and self-structured teams' satisfaction with outcomes. Analysis of the team satisfaction construct was established from post experiment questions and consisted of two variables for each team: a) satisfaction with task outcomes, and b) satisfaction with being in that team. The establishment of these variables was previously explained. First, descriptive statistics were calculated. Then, a

comparison made using univariate analysis of variance. The following tables (18 and 19) show the results of these two analyses respectively.

Table 18. Descriptive Statistics

	Task Satisfaction	Team Satisfaction
Mean	4.1726	4.2268
Std. Deviation	.47857	.37159
Variance	.229	.138

Table 19. Test of Between Subjects Table

Dependent Variable: Team Type

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	8.500(a)	26	.327	3.596	.015
Intercept	69.664	1	69.664	766.305	.000
Task Satisfaction	8.500	26	.327	3.596	.015
Error	1.000	11	.091		
Total	95.000	38			
Corrected Total	9.500	37			

a R Squared = .895 (Adjusted R Squared = .646)

Dependent Variable: Team Type

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	7.450(a)	25	.298	1.744	.157
Intercept	55.131	1	55.131	322.718	.000
Team Satisfaction	7.450	25	.298	1.744	.157
Error	2.050	12	.171		
Total	95.000	38			
Corrected Total	9.500	37			

a R Squared = .784 (Adjusted R Squared = .335)

The results indicate there is no statistically significant difference for *team satisfaction*, which represents the satisfaction on being in that team, between teams. However, there is a significant difference on *task satisfaction,* which represent the satisfaction on task outcome between teams (p =0.015). Thus, there is an evidence to conclude that dyadic teams are more satisfied with the task solution then self-structured teams, although, there is no evidence that they were more satisfied being in a dyadic team as opposed to being in a self-structured team. Although an overall satisfaction (p=0.061, α=0.05) produced slightly significant effect (Table 20) , especially taking into account eta^2 and R^2 effects, the mixed effects of two separate variables lead us to think there may be no strong evidence to accept null hypothesis in this case. To investigate this further, a correlation table was constructed to examine if these variables were highly correlated.

Table 20. ANOVA table for overall satisfaction

Dependent Variable: TeamType

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	9.000	31	.290	3.484	0.061	.947
Intercept	71.388	1	71.388	856.655	<0.001	.993
Satisfaction	9.000	31	.290	3.484	0.061	.947
Error	.500	6	.083			
Total	95.000	38				
Corrected Total	9.500	37				

R Squared = .947 (Adjusted R Squared = .675)

As suspected, a high correlation was found between task and team satisfaction (0.623 at the 0.001 significance level) in Table 21. This may indicate that these variables should be composed or eliminated from the analysis. The overall satisfaction variable tested

previously (Table 20) was in fact the composite of these two variables. Therefore, now the satisfaction ANOVA results (p=0.061, α=0.05) would make sense, and can be considered reliable. Nevertheless, the hypothesis is still not accepted (0.061>0.05), because dyadic structured teams did not have a higher level of satisfaction in overall.

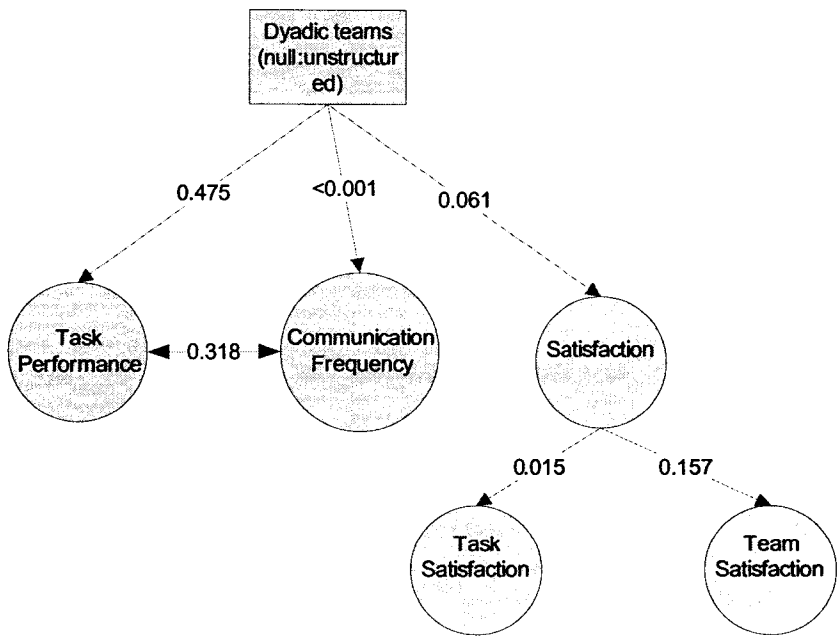
Table 21. Satisfaction Correlation

		Task Satisfaction	Team Satisfaction
TaskSatisfaction	Pearson Correlation	1	0.623(**)
	Sig. (2-tailed)		0.001
TeamSatisfaction	Pearson Correlation	.623(**)	1
	Sig. (2-tailed)	.000	

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

To sum all results, Figure 9 below depicts the hypotheses testing results.

Figure 9. Analysis Results



Summary Results

In this research, it was hypothesized that dyadic virtual teams would perform better in task decision with less communication and be more satisfied with outcomes than self-structured virtual teams. The following table summarizes the results of the hypotheses testing:

Table 22. Hypotheses Testing Results

Hypothesis	Significance	Results
1.There is no statistically significant difference between the dyad-structured approach and the self-structured approach based on the correct task decision produced by virtual teams.	Statistical significant was not emerged from the analysis (p=0.475) between teams. However, frequency analysis showed dyadic teams was 10.5 % better than self-structured teams.	Not supported
2. There is no statistically significant difference between the dyad-structured approach and the self-structured approach within virtual teams based on the amount of communication produced.	Statistically significant (p<0.001)	Supported
3.There is no statistically significant difference between the dyad structured approach and the self-structured approach based on satisfaction	*Overall satisfaction was not significant (p = 0.061)*	*Not supported*
3a. There is no statistically significant difference between the dyad structured approach and the self-structured approach based on the task outcomes.	*Task satisfaction was significant (p=0.015).*	*Supported*
3b.There is no statistically significant difference between the dyad-structured approach and the self-structured approach based on the team satisfaction.	*Team satisfaction was not found to be significantly different (p=0.157).*	*Not supported*

Chapter Summary

This chapter focused on statistical analysis and its results. The research hypotheses were tested, and results summarized in Table 22. The results indicated that dyadic teams

slightly performed better than unstructured teams with less amount of communication. The satisfaction (combining team and task satisfaction) was not found significant in overall. When satisfaction was analyzed separately in terms of team and task satisfaction, task satisfaction was found significantly different between teams. However, opposite to expectations, dyadic teams were not satisfied by being in a dyadic team. The interpretation of the results and potential explanations on why dyads were not satisfied by being in dyadic teams are discussed in the following chapter.

CHAPTER V

CONCLUSIONS AND IMPLICATIONS

This chapter provides a discussion of the research findings presented in Chapter 4 as well as interpretations of experiment results. In addition, limitations and delimitations of the research are explored for their implications, particularly with respect to the contributions to the body of knowledge. Finally, future research directions that might amplify and extend this research are provided.

Discussion of Results

The purpose of this research was to examine how dyadic teams perform in virtual environments. Four research questions were addressed by testing hypotheses in the experimental study. These questions included:

1) How does a dyad structure influence virtual team performance?

2) What is the impact of a dyad structure on virtual team effectiveness with respect to task outcome?

3) What is the impact of a dyad structure on virtual team effectiveness with respect to team satisfaction?

4) What is the impact of dyadic communication n on virtual team effectiveness in terms of reducing the overflow communication?

These questions subsequently led to four hypotheses for testing. The thrust of these hypotheses concentrated on examination of two central areas. First, that dyadic structured teams would perform better than self-structured teams because they are capable of reducing overflow communication because of focusing more on task. Second, that dyadic structured teams would be as satisfied as self-structured teams with respect to being a member of the team as well as the task performance results.

Both team types, dyadic and self-structured, in this study worked in a self-organizing mode to accomplish their task within the bounds of the research. They were both expected to organize, communicate, coordinate and reach a solution within the given period. In this sense, both team types operated successfully. However, dyadic teams were able to do better under conditions specified by the research design.

The statistical analysis indicated that dyadic teams performed slightly better in task decision as well as finishing the task with less communication while being more satisfied with their task solution. A significant relationship was found between communication frequency and team type. However, communication frequency did not have a significant effect on task performance. What was not expected was that dyadic teams were not satisfied with being in a dyadic team, although overall satisfaction (being a team member and task outcome) was marginally significant.

A regression model was conducted as an analysis of interest. The regression model results suggested that combination of team type, communication frequency, and satisfaction provides a significant predictor of virtual team effectiveness. In this model, virtual team experience was additionally tested to determine whether there was a significant effect related to effectiveness. Virtual team experience was not found as a significant indicator of virtual team effectiveness. Surprisingly, satisfaction had the larger coefficient in the regression model as an explanation of team effectiveness. This result was consisted with the literature. In a previous investigation of team control structure in virtual teams, Piccoli (2004) reported similar results. While satisfaction is important, overall performance is critical according to Powell (2002). The following section is organized to explore findings based on research questions.

Task performance

The experiment results indicated that dyadic teams performed better than four-person teams. This conclusion was established from the results of task performance (correct decision). However, significant results did not emerge from statistical analysis. This was contrary to initial expectations. The statistical results led us to conclude that there is weak evidence to claim that dyads are better in task decision. Notwithstanding the better performance of the dyad structured teams, statistical significance was not achieved. One rationale to explain this result may require looking at the team size. Although the number of correct decisions was more in dyadic teams, comparing the six correct decisions from dyadic teams with the four correct decisions from self-structured teams was not a sufficient difference necessary to establish the statistical argument of significance. Although it was encouraging to see that the dyadic structured teams did in fact come to the correct decision with greater frequency, the fact remains that the statistically significant difference was not supported.

Further consideration for the task decision results suggests that there might be many reasons why there were no statistical differences between these two team structures. Motivation related to student participation can be one reason to explain the results. This was a short-term project with a decision making task. Some of the students may not have engaged in the experiment with the same level of seriousness as that of a functioning "real world" virtual team. This is irrespective of the monetary incentive and potential class credit for participation. Therefore, the motivation of participants was necessarily beyond the direct control and impact of the research design, which might have influenced the outcomes of the experiment.

The nature of the task may also offer some insight as the results are explored. Despite the results, task should not be ruled out to explain virtual team effectiveness. Although this research did not support the influence of task on virtual team effectiveness, the preponderance of literature and the existing body of knowledge suggest that the task types may be somewhat important in virtual teams. Tasks from the literature that have been used to study virtual teams are primarily creative, intellective, and decision-making (DeSanctis et. al, 1989; Mennecke and Wheeler, 1993; Hollingshead, et al., 1993; McGrath and Hollingshead, 1994; Dennis and Wixom, 2002). For this research, a decision making task with a verified correct decision was chosen for its suitability in virtual teams. However, this may not be the best type of task for dyadic teams when the results are interpretative in nature. In fact, in the future another experiment based on different tasks might be conducted to examine the differences, where virtual dyads are being used. Although examination of the task type was beyond the boundaries of this research, it could have influenced the research results and should be considered in future related research endeavors.

Satisfaction: Task outcomes and Team Satisfaction

One of the important findings from this research was that dyadic teams were satisfied with the task outcome, but they were not satisfied with being a member of a dyadic team. Satisfaction is a long-studied issue in teams and has been the source of debate in the literature concerning the impact on team performance. While some researchers have linked dissatisfaction to team size (Cohen et al., 1996, Trower and Moore, 1996), it has also been linked it to the task type --i.e. complexity, clarity (Gladstein, 1984; Lam, 1997). Findings of this research added one more perspective to

this debate. Virtual dyads may perform better in task decision and be satisfied with the team results, however, they may not be satisfied being a team member in a dyad structure. This may seem a contradictory statement in nature but several possible explanations are examined below.

Demoralization may be one reason for dissatisfaction with virtual team dyads. Two person dyads are very fragile as established earlier in this document. If one of the partners leaves, or does not correspondence with the other partner, dyads are easily breakable. For example, in one team, when demoralization occurred, a member dropped from the experiment. Apparently, lack of correspondence reflects negatively on team outcomes such as frustration. Feelings of frustration can be linked to social relationships in a team (Panteli and Fineman, 2005). This could put work in jeopardy, because it can be associated to intentional non-involvement. Thus, based on the fragility of the dyad structure, the potential for dissatisfaction may be increased.

Furthermore, consistent with the literature (Piccoli, 2004), one could look at coordination difficulties to examine the underlying reasons for dissatisfaction with the dyad structure. The teams were asked to report their difficulties in coordination between team commitment, schedule conflicts due to team member's workloads, time zone differences, insufficient task planning, and other reasons. In dyadic teams, 4.88% of members agreed that they have schedule conflicts due to busy workloads and 4.88% of members reported commitment problems. This meant approximately 9.8 % of dyads had problems in coordination. This explains a part of the satisfaction disagreement in dyads.

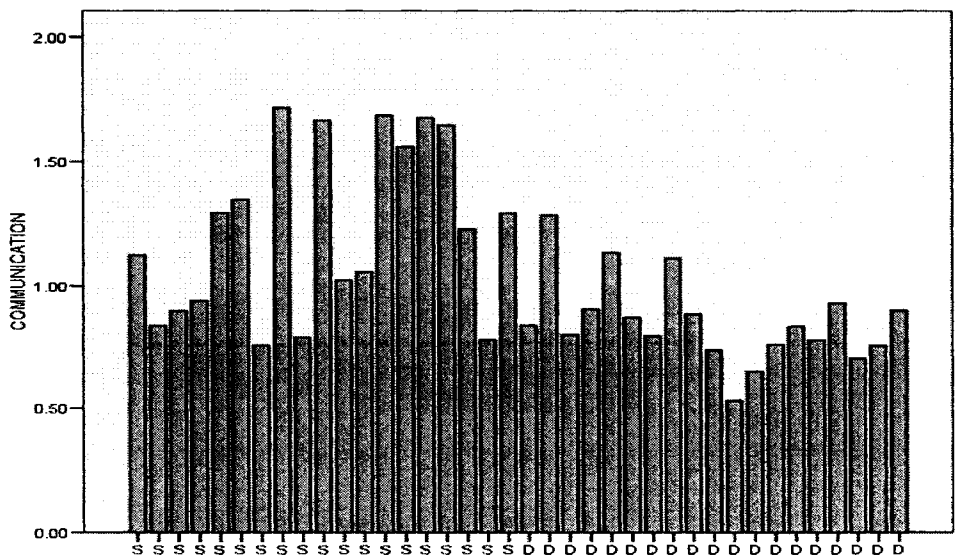
Based on findings, when there is a coordination problem, it was expected that dyads would not be satisfied being a member of a dyadic team. Furthermore, effective

communication and coordination leads to more satisfaction in virtual teams (Powell et al., 2004). In this research, the results indicated both team structure types (dyad and self-structured) were highly satisfied with communication, but not with coordination. Therefore, further research is needed to explore the nature and impact of coordination problems, specifically with respect to commitment issues in virtual dyads.

Dyadic communication

The results indicate that dyadic teams achieved better results with less communication. Communication frequency was found to be a significant factor depending on team type. Findings also supported that team type has an effect on communication frequency. One may argue that the number of team members may have a direct relationship with the communication frequency (i.e. smaller the team size, the fewer the communication interactions). However, this is not necessarily true. There were dyadic teams had more communications than four-person teams in this research (see the figure below-S represents Self structured, D represents Dyadic team).

Figure 10. Communication amount in teams



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wever, it is a difficult task to determine how communication frequency directly links to team effectiveness. Drawing from the literature, this research expected to find evidence relating task outcomes and communication frequency. However, insufficient evidence was found to support the relationship between task outcome and communication frequency. The significant evidence supported the relationship between team type and communication frequency. This finding has direct implications for global managers due to: 1) finding that reduction in the total amount of communication using dyadic teams can be accomplished without sacrificing the work results, and 2) consequently, there is the potential to decrease costs associated with excessive communication.

Exploring the implications further, there are potential advantages to be gained in the utilization of dyadic teams in virtual environments. If dyadic structured teams are as effective as non-dyad structured teams, and perhaps other team structures, with fewer communication requirements, it follows that less communication reduces resource requirements (time, technology). Therefore, more effective structuring might result in successful teams with fewer communication resource requirements. This points out the benefits for cost effectiveness in global organizations stemming from a different structural form. Espinosa and Carmel (2002) realized the benefit of dyads, and already established a conceptual cost effectiveness model amplifying their utility. Extended research efforts might surely provide further exploration of this premise, and perhaps test a cost effectiveness model in an experiment using dyads.

Analysis of interest: Task structure

An interesting result emerged from self-structure teams. A total of 7.41 % of the members of self-structured teams thought that they were insufficient in task planning whereas no dyad team member responded similarly. This finding gives us some important insights with respect to the team task structure. It was expected that dyadic teams are uniquely structured teams that are more focused, and more organized in their work. The lack of sufficient task planning in self-structured teams, in contrast to dyadic teams, may indicate a support for this claim. This finding also might also be supportive in explanation of the better task performance in dyads, even though the statistical significance was not supported directly from the experiment.

Analysis of Interest: A Prediction Model

The purpose of this section is to extend analysis to create a regression model that explains virtual team effectiveness based on the research data. In the hypotheses testing, significance of three constructs on how they relate to the team type were examined. A regression model was created to provide a foundation, and begin forging implications for virtual team effectiveness. In other words, a regression model was developed to understand which combination of variables serves better to explain virtual team effectiveness based on the present research data. To do so, a hierarchical multiple regression analysis was performed. A multiple regression model combining these three constructs and adding a latent variable was developed to further establish the relationship of variables to explain how well a regression model could predict the virtual team effectiveness. The benefits of this model is twofold: 1) The model crosschecked the significance of construct-relationships that emerged for the initial analysis of variables,

and 2) The model included some latent variables that were not included in hypothesis testing, but suspected to have a potentially significant relationship on virtual team effectiveness as examined in this research.

Virtual team effectiveness values were determined by task performance and using two self-reporting survey items on effectiveness: 1) the team was effective, and 2) the team was efficient. In previously performed factor analysis, these two survey items factored into the team satisfaction construct when the team type effect was analyzed. Therefore, to preclude confounding effects, the remainder of the satisfaction items were entered as one block variable called *satisfaction1* in the model, excluding the two confounding measures. The reliabilities of this new construct were retested, and results can be found in the following table.

Table 23. Questions and Reliabilities of the new satisfaction construct

	Dyadic	**Self Structured**
Satisfaction 1	α	α
• The team was effective in reaching its goals • I was very satisfied with the quality of team's solution • The team was effective reaching in its goals • Task information exchange within team was timely • I felt my input was valued by my teammates(partner) • There was respect between teammates (partners) • I enjoyed our (dyadic) interaction during this project • Overall, I enjoyed being a member of this team • In the future, I would be interested in participating in another virtual team	0.870	0. 881

Multiple regression analysis was conducted to determine best combination of the indicators. The researcher also suspected that previous virtual team experience might contribute to the effectiveness. In sum, a four-level hierarchical multiple linear regression analysis was conducted. Variables were entered one by one to show the effects of newly added variables on the regression. The least unknown was entered last as a rule of thumb (Powell, 2002). The results are reported in the following table.

Table 24. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.063(a)	.004	-.024	1.32807	.004	.143	1	36	.707
2	.158(b)	.025	-.031	1.33262	.021	.754	1	35	.391
3	.566(c)	.321	.261	1.12873	.296	14.787	1	34	.001
4	.567(d)	.322	.240	1.14456	.001	.066	1	33	.799

a Predictors: (Constant), TeamType
b Predictors: (Constant), TeamType, Communication
c Predictors: (Constant), TeamType, Communication, Satisfaction1
d Predictors: (Constant), TeamType, Communication, Satisfaction1, VTExperience

From Table 25, it can be seen that team type by itself did not appear to be a significant indicator of effectiveness. When communication frequency was added to the regression, a significant increase was observed in R squared. Adding the communication frequency construct to the model did change the R value significantly. In Model 4, a latent variable, virtual experience, was added to the equation to see whether this was a significant indicator. The model indicates it was not a significant indicator in this model. The overall model could explain that 56.7 % from the combination of variables. This result indicates that the model is fairly good at explaining variance. When the ANOVA table was

examined, it was determined that only the Model 3 combination showed a significant explanation for effectiveness.

If Model 3 was taken as a base model for effectiveness, the model could predict 56.6 % of the effectiveness from team type, communication frequency, and satisfaction. Investigating regression coefficients demonstrated that only satisfaction was contributing to the model very significantly (Beta=0.554 in model 3, refer to table 26 below).

Table 25. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.253	1	.253	.143	.707(a)
	Residual	63.496	36	1.764		
	Total	63.749	37			
2	Regression	1.593	2	.796	.448	.642(b)
	Residual	62.156	35	1.776		
	Total	63.749	37			
3	Regression	20.431	3	6.810	5.346	.004(c)
	Residual	43.317	34	1.274		
	Total	63.749	37			
4	Regression	20.518	4	5.129	3.916	.010(d)
	Residual	43.231	33	1.310		
	Total	63.749	37			

a Predictors: (Constant), TeamType
b Predictors: (Constant), TeamType, Communication
c Predictors: (Constant), TeamType, Communication, Satisfaction1
d Predictors: (Constant), TeamType, Communication, Satisfaction1, VTExperience
e Dependent Variable: Effectiveness

Table 26. Regression coefficients of the Model 3

Model 3	**Beta Coefficients**
Team Type	0.042
Communication	0.076
Satisfaction	0.554

The guidelines to determine whether the model's effect size is small, medium or large, are determined by consulting Cohen's (1975) guidance on R square. The R squared value

was 32.1 %, which indicates the amount of variance in virtual team effectiveness was explained by the model. That effect size is almost medium (small=0.10, medium=0.36, large=0.51), and indicates that model may not have the sensitive effect of predicting all values for effectiveness, yet still it is a reasonably sound and a promising model to make predictions.

Limitations: Validity Challenges

As with most quasi-experiments, there are some limitations for this study that must be considered in projecting the findings beyond the boundaries of the research. This work does have limitations to validity, which must be taken into account as the research results are interpreted, or projected, beyond the boundaries established by the research design. However, the following steps were taken to reduce threats to validity and minimize their potential for skewing the interpretation of results.

The limited sample size was certainly a concern in this research. 38 teams (111 participants) finished the experiment. Although this number was enough to conduct the experiment, caution must be used in extrapolating the results to larger and more general populations. In addition, due to sample size restrictions, advanced exploratory statistical techniques such as structural equation modeling could not be used in analysis to recover causal relationships. Also, related to sample size, the statistical power was of concern as well. Analysis was carried out with a higher significance level, α stretched to 0.10 in some analysis, rendering power insufficient to detect the influences of small effects. Given the sample size of 19 for each team structure type, a statistical program was employed to calculate the effect of sample size on the power of the statistics used. When α was established at a 0.10 level, the statistical power was 87.61% as opposed to 78.06 %

for α at 0.05 to detect only large effects. Therefore, engaging future research using larger sample sizes should be capable of confirming the external validity of the research findings established for this research.

Another threat to validity, which must be taken into account for the interpretation of results, was the test sample consisting of students as subjects. A mixed body of students, including both graduate and undergraduate students, participated in this study. As reported previously, the majority of students were enrolled in graduate programs. This characteristic of the population is considered as an advantage with respect to being able to generalize the results. Most graduate students work while they are completing their advanced degree. Additionally, the average years of working experience was 8.4 years overall, and 2.2 years in management. This gave the study a real word feeling based on the level of participants, although they were students, with respect to experience beyond the student level. If it is true that most virtual teams gather ad-hoc (Jarvenpaa, et al., 1998), based on demand, then this experiment is somewhat representative of a real world application in terms of short-term project teams forming on an as needed basis (Piccoli et al., 2004).

With respect to technology, most universities utilize the Internet, and computer-mediated technologies to assist with learning. Therefore, the use of students from a university setting was considered as an advantage in this study, as students were accustomed to the use of technology to support conduct of work/school. Even though the majority of participants had no virtual teaming experience prior to the experiment, it was assumed that they were familiar with use of web-based activities. This was due, in part, to use of such educational tools such as the Blackboard Academic Suite ™ as well as

similar applications in courses at most universities, including Old Dominion University, from which the majority of participants were enrolled. Despite this technology advantage, in order to have participants prepared and learn basics of the software, a tutorial was posted in the virtual team space in the first week of the experiment. This feature was introduced to reduce technology related errors for participants who might have not been comfortable with the technology. The survey results indicated that the technology was not an impact on the execution of the research design. Therefore, the threat associated with technology familiarity/adjustment was minimized by the research design.

Another limitation for the research results is focused on sample selection. As mentioned before, an objective was to have the team constituency balanced. The placement into teams was purposeful to achieve this objective. The goal was to create zero-history groups, especially in dyads, consistent with research literature references calling for zero-history teams as an advantage for research (Kinney, 1992). However, the researcher was not in a position to detect if there was any history between team members. Participants used nicknames. Also, to hide the identity of participants, the e-mail function was disabled in the software, so they could not access to other members' e-mail addresses. This meant that teams would only use the e-mail from within the software. In addition, purposeful team assignment was undertaken to balance students as much as possible within teams. This purposeful assignment was also undertaken to help reduce error to a minimum for another possible threat: the imitation of treatments. In the context of this study, imitation of treatments was most likely as a threat to internal validity. Teams might have revealed the information of treatments to one another, thus cross contaminating teams and calling results into question. To avoid this threat, competitive

incentives were instituted (extra course credits and a monetary award) and advertised for the best three team performances. The intent was to create a competitive incentive such that the task and all related information would be treated as confidential between teams. Thus, the research design instituted controls to limit the threat of imitation of treatments.

Another concern of the research was the cooperation of subjects in interactions and treatment. This research required subjects to participate actively the experiment. It was stipulated that they had to check their virtual team space at least once in a day in order to follow discussions and to participate. Although this seemed rudimentary, in actuality proved somewhat difficult. Due to busy schedules, review of the data indicated that not every member made sufficient commitment. Some participants did not check in frequently, and this discouraged their other team members. This was indicated in the results of the survey taken at the conclusion of the experiment. The results showed that some members complained about their teammates to the researcher moderating the experiment. Although the researcher did not manipulate these situations, if there was an obvious issue, a system message was sent to the member who was not participating. The message was a generic one, such as "there are some activities in your team space. Your team members may have been trying to reach you. Please check your team space more frequently." This helped the team to reorganize to finish the task, but questioned the commitment of team members in these instances. Although this was not the norm during the experiment, nevertheless, it was required in several instances.

It was also recognized that the characteristics associated with the various team member roles were the core drivers of the informal structuration of the virtual teams. Therefore, a limitation that of concern in this study had to do with the informal

structuring of teams beyond the two tested structures. There is always a possibility that the team may develop informal structures due to different interests and progress of the members. This informal group structure can fulfill the social needs that may be missing in restricted structures, and was certainly beyond the control or monitoring of the experiment based on the research design. In this research, no attempt was made to have teams engage in social or informal relationships, such as suggesting or implementing some icebreakers. A survey question was asked to examine whether teams devoted time to social relationships. Responses indicated that 50 % of both team type structures agreed that they did not spend time for socialization. This may be problematic in some teams if the characteristic of the individual demands for some level of social attention. As one global member stated,

> "There were no social interactions besides the task. This was somewhat disappointing....."

In effect, although there were threats to validity in this research, as with any research, they were controlled to the greatest extent possible by the research design. There is a degree of confidence in the results, given limitations, that they can be projected to other similar contexts. Additionally, there were several areas for further research, both confirmatory as well as extension, which might be undertaken in response to the results of this effort.

Delimitations

As with any research, there were several delimitations for this effort. Although they might have been interesting, delimited areas were beyond the boundaries and scope of this effort. In this study, geographical distance and advanced technology reliance were

considered as the main characteristics to distinguish a virtual team and virtual environment. One of the research delimitations, geographical distance, is difficult to determine in this research effort. However, being in different geographical locations satisfied the degree of dispersion expected for this study. Although there were a few participants from outside of the U.S., issues such as time zone differentials, and cultural influences were considered beyond the scope of this analysis. These two characteristics, time and culture, are considered as essential characteristics of qualification as a global virtual team, which was not the subject of study for this research.

An additional delimitation of the research was the restriction to text based asynchronous and synchronous media in this experiment (i.e. chat, e-mail, and forum). This delimitation was primarily a function of the tools available to both participants and support for the research. Therefore, other forms of technology, which might be available to virtual teams, such as video-conferencing, were not available in this research. Only those interface forms available through the selected software (Acollab®) were utilized.

Delimitations were an important aspect of narrowing the research such that it could be conducted with confidence, while still responding to the research questions. This does not imply that areas of delimitation are not worthy of future research efforts. However, the delimited areas were simply beyond the scope of this effort. We now shift directions to explore other areas for future research suggested by this effort.

Future Research Directions

Several paths of future research can be suggested from this effort. The focus of this research centered on virtual work dyads in virtual teams. The investigation focused on whether the dyad structured virtual teams were more productive in terms of task

performance, team satisfaction, and communication frequency in relationship to self-structured virtual teams. Although the focus of the research was met, there did emerge several other areas that might offer fruitful future research explorations. One particular area of future interest, as suggested by some of the survey results, was exploration of the social aspects of the dyad in virtual environments. This would require capturing a "dyadic world" where partners affect each other socially. This could be done comparing dyads to dyads rather than to larger groups. It is not well known what effect or implications might exist for the social component of virtual teams, particularly with respect to the influence of the dyad structure.

The research results indicated that dyads were not as satisfied with their teams in contrast to the larger virtual groups. However, the dyad structured teams still performed better than the larger groups. This result should be the focus of further examination of satisfaction in dyad structured virtual teams. An experiment that examines the satisfaction in virtual teams, based on structural configuration, should be conducted. Consideration of multiple potential measures for team satisfaction, such as "commitment", and "liking each other" may provide for an interesting exploration in dyad structured virtual teams.

Another interesting topic, related to satisfaction in virtual work, that could be investigated is the sound of silence or sense of presence. This concept in virtual teams is evident when virtual team members do not respond to their team members (Panteli and Fineman, 2005). As evidenced in some of the team interaction during this research, the lack of response or engagement can be very frustrating and confusing in a virtual environment where cues are very limited. This was identified as a possible explanation of some instances of dissatisfaction in dyadic teams that occurred in this research. The

dyads, in several cases were dissatisfied, but the majority of dyadic teams reported they were enjoyed being a member of this team (agree=46.15%, strongly agree= 30.77%). In addition, 71.8% of dyadic members reported that they would be interested again participating another virtual team experiment. Therefore, additional research might prove fruitful in further understanding the role and constituents of satisfaction in virtual teams, as well as how structuring of teams might influence satisfaction. Although team performance is important, satisfaction (as has been linked to performance in the team literature) bears further exploration for virtual teams. We cannot be certain to what degree satisfaction, as established from the team literature, might be different for virtual teams.

An additional area of potential future research is leadership in virtual teams, and how that might be different/same as existing team research might suggest. This research effort did provide some examination of leadership. Based on initial speculations for the response to leadership questions in the survey, investigation may also be helpful to understand leadership influence on satisfaction in dyadic teams. There are extensive theories in face-to-face dyads (i.e vertical dyad linkage, Dansereau et al.,1975), which can be explored in virtual teams. Although it was not the central focus of this research, the participants were asked to report the existence of leadership in the team. The following table shows frequencies of the responses to leadership questions:

Table 27. Leadership

Leadership	**Dyadic Teams**	**Self-structured Teams**
An informal leadership existed	64.1%	64.29%
A formal leadership existed	30.77%	7.14%

No leadership existed	5.13%	28.57%

While both team structures reported similarly with respect to the existence of leadership, dyadic teams reported there was also formal leadership, with almost 31% responding positively. This high rate suggests that additional research in leadership of virtual teams might be a beneficial, particularly since self-structured teams did not think they had a formal leader. Again, looking for emergence of formal leadership in virtual teams may be linked to the imposition of the dyad structure. Certainly, this area is ripe for additional research to answer several of the questions exposed during the experiment and interpretation of findings.

The research has identified several areas for future consideration. As the body of knowledge for virtual teams is still in an embryonic state, additional research is warranted. It would be haphazard to expect that the results from the traditional literature of teams would have a one-to-one correspondence to virtual teams. In many cases, this blind assumption might in fact cause more harm than good. Instead, the design, operation, and analysis of virtual teams must not be overly bound by the traditional team research and writings. In effect, taking virtual teams as a distinctly different form may ultimately result in better performance. Proceeding in the domain of virtual teams must be pursued with caution, particularly where there is a body of evidence that is readily accessible, but may be fraught with assumptions that are inconsistent with the emerging domain of virtual teams.

Implications

This study investigated whether a dyad structured virtual team performs as well as a self-structured virtual team on a given task. The present research suggested effectiveness factors based on the model hypothesized for dyadic virtual teams. Organizations that plan to arrange their work around dyads can take some insights from this study. Those tasked with the design, analysis, deployment, maintenance, or evaluation of virtual teams might also gain insight from the findings of this research.

The most significant finding in this research was an apparent dissatisfaction with the dyadic team structure. Due to limited physical connection in virtual teams, satisfaction may become an issue. Although dyads have been used and their effectiveness demonstrated in traditional team research (Poole and Billingsley, 1989; Kinney, 1992; George, 1999; Lee et al., 1999), satisfaction in virtual dyads deserves increased attention. Notwithstanding a lack of research in virtual team satisfaction, related to structure (dyad), those responsible for virtual teams in practice might be advised to ensure that satisfaction is actively taken into account. Satisfaction is an area that shows promise for further research in virtual dyads. Several other areas of further research were identified from the results of the research, including, commitment, team silence, and leadership. These areas, although we might speculate on their importance stemming from the traditional team research literature, are in need of further exploration for virtual teams.

This study has provided contributions and implications on both the theoretical and practical levels. From the theoretical standpoint, extending the literature, the research contributed to the body of knowledge concerning virtual team effectiveness. There are extensive studies in traditional small team research literature (McGrath, 1991; Arrow et.

al, 2000; Hackman, 1990; Beyerlein et al., 2000 and 2001). Yet, to our knowledge, empirical studies related to virtual dyadic teams are very limited (Kinney, 1992; Olson and Olson, 2000; Dundis and Benson, 2003; Espinosa and Carmel, 2004). Consequently, the empirical approach demonstrated the effectiveness of using dyadic structured virtual teams.

The results are, to some degree, generalizable beyond the boundaries of the research. There are implications for organizations, managers, and researchers stemming from this research. This research targeted graduate and undergraduate students who had not necessarily faced to virtual environments in their academic endeavors. The mixed populations of students was composed primarily of working professional graduate students. With an average of 8.4 years of work experience for participants, this project can be seen as a short-term work project with characteristics in common with real world applications. The flexibility of web based participation made work very transportable in this research. The participants were able to join anywhere in world, which also corroborates a typical virtual work in an organizational setting. Therefore, the implications of the research should not be taken lightly for either the academic research or managerial communities.

In the interpretation of the research for implications, one caveat is identified. In real world organizations, the results of the work have more impact on workers than was the case for this research effort. The stakes in this research were rather limited. Actual virtual team performance will certainly be a contributing factor to organizational success. Obviously, the stakes are much higher for organizations than could be designed into this research examination. In this research, self-structured teams relied primarily on others

because there was no formal leadership appointed. This result may likely be different in actual organizations, where the managerial function and structure of a virtual team may be appointed. The implication is that virtual teams will most certainly be a fact of life in a global world. As such, the implications stemming from this research are important in understanding phenomena related to virtual team structure, performance, communication, and satisfaction.

This research also makes another major contribution to the body of knowledge by comparing two virtual teams. To date, studies tended to compare virtual teams with face-to-face teams to measure differences in effectiveness. However, little empirical work has been done to compare purely virtual teams to examine the differences (Timmerman and Scott, 2006). Therefore, the results of this study provide an important contribution and step in furthering the embryonic state of our understanding of virtual teams. Although there is a call for further research, there are several important implications that can be derived for practitioners. Below we identify several implications for those tasked to design, manage, deploy, maintain, or evaluate virtual teams.

From a practical standpoint, engineering managers can benefit from results of this study in a way that they can apply the results to create supportive and more effective environments for virtual teams. Virtual teams are increasingly becoming a fact of life in a global, technologically interconnected world. Engineering managers will assume roles related to effective leadership and integration of these teams into their organizations. It is critical for managers to understanding enabling conditions of virtual team success to reduce failure rates. This study investigated several of these success conditions by analyzing virtual teams empirically. In particular, for those who work for multinational

companies, the results provide some guidance for establishing cost-effective virtual teams using a dyadic structure. In particular, this research indicated that organizing work around dyadic teams could give companies significant advantages. One such advantage is to reduce the costs associated with communication, without sacrificing performance, by structuring in dyads for task accomplishment. Dyads might use fewer resources in communication in contrast to larger groups, providing more focus on the assigned task rather than periphery events or activities. This is a significant insight for managers concerned with performance in virtual environments.

From this research experience, and researcher's observations, the following five suggestions are made for engineering managers to consider as they deal in the world of virtual teams:

1. *Setting conditions for effective coordination* – It is imperative that coordination be designed as an up-front activity. Leaving this activity to totally organize itself may result in less than desirable performance levels, potentially resulting in unnecessary conflict.

2. *Appoint a formal leader* – leadership in a virtual team may certainly emerge. However, taking the leadership function seriously, and making the appointment, may spare unnecessary expenditure of resources, increase satisfaction, and increase the probability of success for virtual teams.

3. *Providing conditions for satisfaction* – Satisfaction must be taken into account for virtual teams. Investment into understanding virtual team satisfaction and instituting initiatives/actions may prove fruitful in fostering higher levels of virtual team performance.

4. *Setting clear goals at the beginning of the project* – In effect, this is about ensuring that the virtual team has sufficient focus to be effective. Structure will do little for effectiveness if managers do not establish clear expectations with respect to goals for the virtual team.

5. *Providing time for team building activities* – Face to face teams generally, due to their interaction, have an advantage in establishing social connections essential to effectively working together. Mangers of virtual teams must also ensure that virtual teams be given the opportunity to develop and maintain social interaction.

> Perhaps the use of teambuilding, separate and apart from task work, should be engaged to provide the opportunity for socialization of the virtual team.

In sum, this research not only addresses a gap in the body of knowledge by examining virtual dyadic team structure under experimental conditions, but it also establishes the utility of dyadic teams in virtual environments. This research also closes a gap in the empirical studies related virtual teams by comparing two-virtual teams. Additionally, the implications for managers of virtual teams have been developed from the research results.

The results of this study indicated that dyadic structured teams could perform better than self-structured teams. This finding opens the door for more structuration studies in virtual teams to further understand phenomena associated with their effectiveness. A significant implication was the need for increased attention in practice, as well as further research related to satisfaction in virtual dyads.

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APPENDICES

Appendix A: Pilot Experiment

This research undertook a pilot study to assess the effectiveness of design elements. Since a pilot study is the rehearsal conducted prior to the main experiment, all experiment related preparation must be done as it would be done in actual experiment. However, before anything was started, Institutional Review Board (IRB) approval was secured. The IRB approval can be found in Appendix D. For the purpose of this research, the pilot experiment covered the following steps:

- Developing virtual workspace which the experiment would use
- Identifying pilot subjects
- Pre-surveying and matching subjects
- Conducting the experiment
- Testing the survey instrument and data collection methodology
- Refine the design as necessary

The primary goal of the pilot study was to test the efficacy of the design and surveys through application consistent with the intended conduct of the research. Technology was also tested to identify and correct emergent issues.

For the pilot design, most of the subjects were recruited from students in the Department of Engineering Management and Systems Engineering at Old Dominion University. Eleven of twelve participants were pursuing their PhD degree. There were three people external to ODU. By the time pilot experiment was conducted, four of the

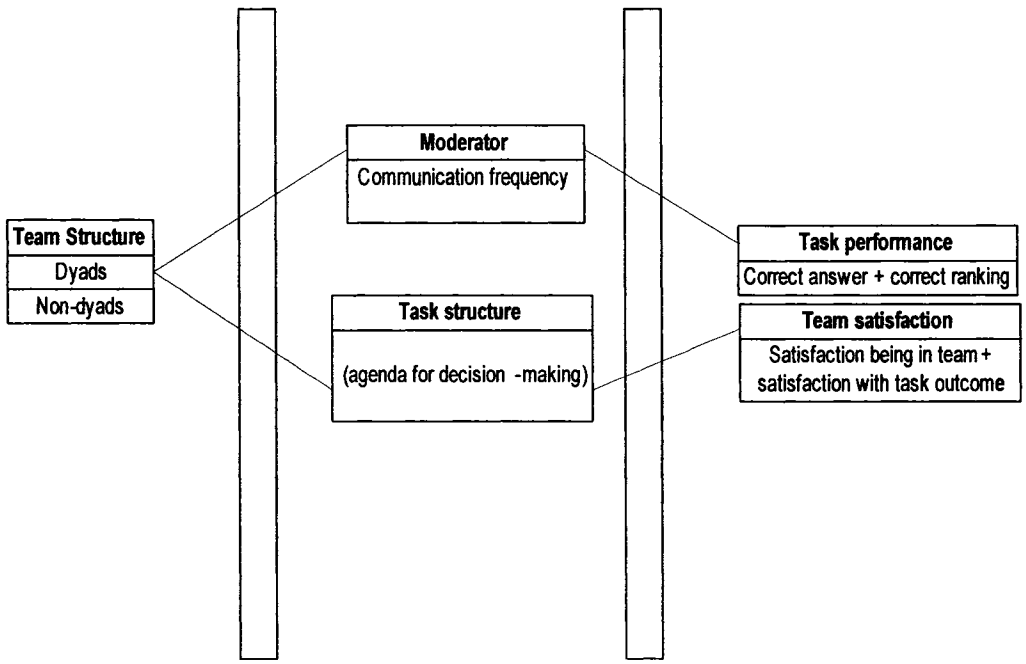
participants were geographically outside of the main campus. This ensured the researcher that technology was tested for supporting hardware beyond the bounds of the university. Thirteen volunteers were divided into five teams as follows:

Table 28. Design of the Pilot Experiment

Team	Number of Teams	Team Size
Dyadic	3 -total 3 teams	6 -total 6 participants
Self-structured	1 1 -total 2 teams	4 3 -total 7 participants

The pilot experiment design is depicted in the following figure.

Table 29. Design of the Pilot Experiment



As seen from the model, a task structure manipulation was pilot-tested. In the pilot experiment, half of the groups from each team structure (dyadic and self-structured) were given a decision-making agenda to structure the task. The observed results and an item from the survey indicated that none of the groups followed the agenda provided as a guide, although they talked about it in chat transcripts. Consequently, a structured task agenda for decision-making had no significant impact on the results of the experiment. Despite the indication in the pilot experiment that the agenda was not used, it was kept in the main experiment to offer potential help to organize the task because sample size from the pilot experiment was too small to conclude decisively that the agenda would not be used during the experiment. However, based on utilization in the pilot experiment, the agenda would no longer considered as a manipulation variable for the actual experiment. Instead, it was considered as a process variable that might influence team effectiveness indirectly.

At the earlier stage of the pilot experiment, a few necessary modifications were identified and appropriate changes to the experiment and research design initiated. For instance, the chat function did not work for the first week of the experiment, and the drafting room gave coding errors when someone uploaded a file. These problems were fixed in the first week of the experiment. Also, in the e-mail box within Acollab©, an inconvenience was discovered. When someone replied to a message this would sent to only that person, not to all team members. To send the message all members, one must have copied the message and pasted it in a new e-mail using new message to everybody. This was a function of the software and could not be fixed in a short time. Therefore,

extra caution was taken in the main experiment. The researcher emphasized this in the experiment steps, in e-mails, and in a posted announcement to make sure this technology limitation was known and seen by all participants. Other than these minor limitations, the virtual team space was found to be very user-friendly. The ability to connect the team space from anywhere, via the web-based interface, gave participants flexibility.

The pilot experiment lasted in two weeks. In the first week, teams were assigned to teams. Individual access to the virtual environment was given via username/password. In the second week, the task was posted in the team space. The original task was an undergraduate admission case for a Georgia-based university. It consisted of information of three fictitious applicants whom were turned down initially by the admission committee. The goal was to find the best candidate to accept for admission. Initially, the task was tested in the pilot experiment based on a Virginia-based university (modified based on becoming more geographically pertinent). Two of four groups engaged in considerable discussion concerning whether or not the state citizenship was important to the school where applicants applied. One team had a deadlock; they offered a tie between correct decision and second optimal decision. To avoid this dilemma in the main experiment, and considering overseas participants, this part of the task was adjusted for the main experiment to be "a fictional state". Since the main key decision variables [SAT (both verbal, and math), GPA on academic courses, advanced placement courses, quality of high school, courses missing from the university's admission curriculum, GPA over all courses, letters of recommendations] had nothing to do with the state, this dilemma was not observed in the main experiment.

During the pilot experiment, one of the dyadic team members turned out to be very busy, limiting their participation. The active member invited the busy member for chat, for discussion, but the other member never replied. The researcher had to contact this individual but there was no teamwork that occurred within this group during the pilot. Eventually, this team did not reach a conclusion by the pilot end, resulting in a frustrating experience for the active team member. To avoid this happening in the main experiment, participants were instructed to check their team space at least once a day. The importance of the active participation was also strongly emphasized in instructions. In addition, in every e-mail from researcher to participants in main experiment participation was emphasized.

Twelve graduate students took the survey after pilot experiment. Some of the survey items were refined after the pilot. After the pilot, Cronbach's alpha was highly efficient (0.883), providing support and confidence in the use of the survey instrument for the experiment. Some items were removed, and some scales changed after analyzing the survey data from the pilot due to variance and redundancy of answers. A listing of these modifications is included in the following table.

Table 30. Survey item Modifications

Pilot survey item	**Changes in question**	**Changes in scale**
I have had access to all of the technology that I needed to perform my work	our work	From 5-item satisfaction scale to Yes/No
Referring to previous changes, an item added. What was missing?	Added	Text answer
The team was equipped with adequate tools to perform our task.	Removed	
The electronic methods we used to	Removed	

communicate with one another were effective		
Please indicate in the space below what other communication method (if any) you used to communicate with your teammates other than features of the software provided in this experiment	Added	Text answer
Our team had an established communication process for making decisions	Removed	
Partners(members) used their own judgment in solving problems	Removed	
My partner was open to communication when we were developing task decisions	Removed	
The team environment allowed me to express my opinion on how the task should be done	Removed	
I felt comfortable leading the discussions to reach a decision	Removed	
Partners communicated with each other continuously in order to perform the assigned task	Removed	
Use of time was effective	Removed	
Approximately how many hours did you spend in this project to solve the task?	Added	
Team member morale was high in the team	Removed	
The team was effective in reaching consensus on final decision	Removed	
The team produced high quality work	Removed	
The team used an structured agenda for decision-making	Removed	

Based on the pilot data and analysis, it was determined that the deleted items added no value to the survey. Pilot testing also allowed the researcher to adjust the time allocated for taking the survey. Allocated time for the refined survey was tested again with two additional participants before proceeding with use in the main experiment.

The pilot study helped researcher to test assumptions and make adjustments to the experiment design and modified the survey items for the experiment. Based on results of the pilot experiment, the design of the main experiment was modified slightly. These modifications included: 1) Task agenda structure was taken out from the main experiment design. 2) Survey questions are modified. 3) Task is slightly modified.

From the pilot results, it was determined that dyadic teams reached the correct solution using less communication. Although this seemed promising evidence for hypotheses support, the data was very small to work on statistical analysis. However, this result at least gave the researcher the reason to pursue the hypotheses as legitimate for expanded examination. In this respect, the pilot was successful for identification of improvements and gaining confidence in the experimental design for research.

Appendix B: Survey Instrument: Self-Structured Teams

(Adapted from Gibson et al., 2003, Lurey, 1998)

Virtual Team-Satisfaction Survey

Thank you for taking the time to complete the following survey.

The purpose of this survey is to measure your satisfaction with working in virtual teams. This survey will take approximately 15-20 minutes to complete.

All information that you provide is strictly confidential and anonymous.

Please begin the survey.

Team Name
{Enter text answer}
[ ]

Your screen Name
{Enter text answer}
[ ]

School Year
{Choose one}
( ) Sophomore
( ) Freshmen
( ) Junior
( ) Senior
( ) Graduate
( ) Other [ ]

Have you worked in a team before?
{Choose one}
( ) Yes
( ) No

Have you worked in a virtual team* before?
{Choose one}
( ) Yes
( ) No

Please tell us about tools and technology your team used to perform the task

I have had access to all of technology that I needed to perform our task
{Choose one}
( ) Yes
( ) No

What was missing?
{Enter answer in paragraph form}[ ]

Please rank the frequency of use for the following tools to exchange routine task information with your partner--Rank them from most frequent [1] to least [6]
{Rank the following from 1 to 6}

[ ] Chat room
[ ] Forum
[ ] Inbox
[ ] Calendar
[ ] Drafting Room
[ ] Library

Please indicate in the space below what other communication method (if any) you used to communicate with your teammates other than features of the software provided in this experiment
{Enter answer in paragraph form}
[ ]

Please tell us about the overall communication and coordination process within your team

I was satisfied with our choice of communication mode* during this project
{Choose one}
( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree

The coordination within team was effective
{Choose one}
( ) Yes
( ) No

We had difficulty with coordination due to (select all that apply)
{Choose all that apply}
( ) Time zone differences
( ) Team member commitment
( ) Insufficient task planning
( ) Schedule conflicts due to team members workloads
( ) Other [ ]

I enjoyed our interaction during this project

{Choose one}
( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree

Please tell us about the level of satisfaction of the team members

I felt my input was valued by my teammates
{Choose one}
( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree

There was respect between teammates
{Choose one}
( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree

I would describe leadership process in this team
{Choose one}
( ) No leadership existed
( ) An informal leadership existed
( ) A formal leadership existed

Time was dedicated to developing social relations during this experiment
{Choose one}
( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree

Overall, I enjoyed being a member of this team
{Choose one}
( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree

In the future, I would be interested in participating in another virtual team
{Choose one}
( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree

I worried about my team's performance
{Choose one}
( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree

The team was effective in reaching its goals
{Choose one}
( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree

I was very satisfied with the quality of team's solution
{Choose one}
( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree

Approximately how many hours did you spend in this project to solve the task?
{Choose one}
( ) 0-2 hours
( ) 2-4 hours
( ) 4-6 hours
( ) 6-8 hours
( ) 8-10 hours
( ) More than 10 hrs

Please tell us about the overall performance of your team

Task information exchange within team was timely
{Choose one}
( ) Never
( ) Seldom

( ) Sometimes
( ) Usually
( ) Always

All team members contributed substantially in this task
{Choose one}
( ) Yes
( ) No

To what extent did the final decision reflect your inputs?
{Choose one}
( ) Not at all
( ) To a little extent
( ) To some extent
( ) To a great extent
( ) To a very great extent

Please rank your teammembers' contribution in this task in the space provided below(Indicate their name, and ranking) Please use this ranking scale: [1]none[2]A little[3]Some[4]Quite a lot[5]A Great deal)
{Enter answer in paragraph form}[ ]
The team was efficient*
{Choose one}
( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree
The team was productive*
{Choose one}
( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree
The team would be more efficient if
{Enter answer in paragraph form}
[ ]
The team would be more productive if
{Enter answer in paragraph form}
[ ]
Please provide your ideas in the space below
Any other comments
{Enter answer in paragraph form}
[ ]
Thank you for taking the time to complete this evaluation survey.
Please hit the "Finish" button at the bottom of this page to submit your answers

Appendix C: Survey Instrument: Dyadic Teams

(Adapted/Modified from Gibson et al., 2003, Lurey, 1998)

Virtual (Dyadic) Team-Satisfaction Survey

Virtual Team Survey

Thank you for taking the time to complete the following survey. You received this "dyadic survey" because you worked in a two-person virtual teams in this experiment.

In this research, a dyadic team is defined as a team structure that is composed of two members, and functions to perform a task for a limited period of time. The purpose of this survey is to measure your satisfaction with working in dyadic teams. This survey will take approximately 15-20 minutes to complete.

All information that you provide is strictly confidential and anonymous.
Please begin the survey.

Team Name
{Enter text answer}
[ ]

Your screen Name
{Enter text answer}
[ ]

School Year
{Choose one}
( ) Sophomore
( ) Freshmen
( ) Junior
( ) Senior
( ) Graduate
( ) Other [ ]

Have you worked in a team before?
{Choose one}
( ) Yes
( ) No

Have you worked in a dyadic team before?
{Choose one}
( ) Yes
( ) No

Have you worked in a virtual team* before?
{Choose one}
( ) Yes
( ) No

Please tell us about tools and technology your team used to perform the task

I have had access to all of technology that I needed to perform our task
{Choose one}
( ) Yes

( ) No

What was missing?

{Enter answer in paragraph form}

[ ]

Please rank the frequency of use for the following tools to exchange routine task information with your partner--Rank them from most frequent [1] to least [6]

{Rank the following from 1 to 6}

[ ] Chat room
[ ] Forum
[ ] Inbox
[ ] Calendar
[ ] Drafting Room
[ ] Library

Please indicate in the space below what other communication method (if any) you used to communicate with your partner other than features of the software provided in this experiment

{Enter answer in paragraph form}

[ ]

Please tell us about the overall communication and coordination process within your team

I was satisfied with our choice of communication mode* during this project

{Choose one}

( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree

The coordination within team was effective

{Choose one}

( ) Yes
( ) No

We had difficulty with coordination due to (select all that apply)

{Choose all that apply}

( ) Time zone differences
( ) Team member commitment
( ) Insufficient task planning
( ) Schedule conflicts due to team members workloads
( ) Other [ ]

I enjoyed our dyadic interaction during this project

{Choose one}

( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree

Please tell us about the level of satisfaction of the team members

I felt my input was valued by my partner

{Choose one}

( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree

There was respect between partners

{Choose one}

( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree

I would describe leadership process in this team

{Choose one}

( ) No leadership existed
( ) An informal leadership existed
( ) A formal leadership existed

Time was dedicated to developing social relations during this experiment

{Choose one}

( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree

Overall, I enjoyed being a member of this dyadic team.

{Choose one}

( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree

In the future, I would be interested in participating in another virtual team

{Choose one}

( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree

I worried about my team's performance

{Choose one}

( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree

( ) Strongly Agree

The team was effective in reaching its goals

{Choose one}

( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree

I was very satisfied with the quality of team's solution

{Choose one}

( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree

Approximately how many hours did you spend in this project to solve the task?

{Choose one}

( ) 0-2 hours
( ) 2-4 hours
( ) 4-6 hours
( ) 6-8 hours
( ) 8-10 hours
( ) More than 10 hrs

Please tell us about the overall performance of your team

Task information exchange within team was timely

{Choose one}

( ) Never
( ) Seldom
( ) Sometimes
( ) Usually
( ) Always

How would you rate your partner's contribution in this task

{Choose one}

( ) None
( ) A Little
( ) Some
( ) Quite a Lot
( ) A Great Deal

To what extent did the final decision reflect your inputs?

{Choose one}

( ) Not at all
( ) To a little extent
( ) To some extent
( ) To a great extent
( ) To a very great extent

The team was efficient*

{Choose one}

( ) Strongly Disagree

( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree

The team was productive*

{Choose one}

( ) Strongly Disagree
( ) Disagree
( ) Neutral
( ) Agree
( ) Strongly Agree

The team would be more efficient if

{Enter answer in paragraph form}

[ ]

The team would be more productive if

{Enter answer in paragraph form}

[ ]

Please provide your ideas in the space below

Any other comments

{Enter answer in paragraph form}

[ ]

Thank you for taking the time to complete this evaluation survey.

Please hit the "Finish" button at the bottom of this page to submit your answers

Appendix D: ODU Human Subjects Institutional Board Approval Form

No.: 05-069

OLD DOMINION UNIVERSITY
HUMAN SUBJECTS INSTITUTIONAL REVIEW BOARD
RESEARCH PROPOSAL REVIEW NOTIFICATION FORM

TO: Charles Keating — DATE: September 16, 2005
Responsible Project Investigator — *IRB Decision Date*

RE: A dyadic composition to foster virtual effectiveness: an experimental study
Name of Project

Please be informed that your research proposal has been reviewed by the Institutional Review Board. Your research proposal is:

___ Approved
___ Disapproved
_X_ Approved, contingent on making the changes below*

David P. L — 9-16-05
IRB Chairperson's Signature — *date*

Contact the IRB for clarification of the terms of your research, or if you wish to make ANY change to your research protocol.

If your project was approved, the approval EXPIRES IN ONE YEAR from the IRB Decision Date. You must submit a Progress Report and seek re-approval if you wish to continue data collection or analysis beyond that date, or a Close-out Report. You must report adverse events experienced by subjects to the IRB chair in a timely manner (see university policy).

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* Approval of your research is CONTINGENT upon the satisfactory completion of the following changes and attestation to those changes by the chairperson of the Institutional Review Board. Research may not begin until after this attestation.

In the application:
#20: Change the date to April 14, 2005 (i.e., the date on the document provided).

In the informed consent:
Researchers: Change "Responsible Principal Investigator" to "Responsible Project Investigator".
Description: Delete nearly all of the first paragraph, and briefly state the study's purpose in simple language. A detailed review of literature is not useful to potential subjects. In the second paragraph, add two or three sentences that describe the task that the subjects

will perform. Include a description of how team performance will be judged for the purposes of winning awards. Potential subjects must be able to understand what is being asked of them from reading this section. Also, correct grammatical errors: "fill two" should be "fill out two", "fill a" should be "fill out a", "satisfaction being" should be "satisfaction from being".
Exclusionary: Delete this information. The subjects do not need to know the sampling technique. Replace with specific requirements of being in, or not being in, the study, such as being at least 18 years old, having an appropriate computer for downloading the software, and having internet access.
Risks: Change "the participant" to "you", "occur in" to "occurs in", and "in normal" to "in a normal". Change the benefits to read "You may benefit from this study by learning to use new software, experiencing virtual teaming, and by possibly winning a gift certificate. Others may benefit if this study contributes to the knowledge of virtual team effectiveness."
Cost and Payments: Change "may pose" to "may require". Clarify what the individual members of the top three teams will win. Each person on winning teams must receive an award, as opposed to a single award to be shared by the team.
Confidentiality: Change "take following" to "take the following", and add a comma after "name" in the first sentence. Delete the last sentence and replace with wording from the current informed consent template on the Office of Research web page.
Compensation: Change "in any research" to "in this research". Replace Gamze Karayaz and her phone number with Charles Keating's name and phone number.
Voluntary consent: Change "investigator" to "investigators" and add contact information for Charles Keating.

In the flyer:
Description: Clarify the wording of the second sentence.
Sign-up: Delete "If".
Research Participation Credits: Replace this heading with "Awards", and clarify the gift certificates to be consistent with the informed consent as described above.
Researchers: Delete "as".

Attestation

As directed by the Institutional Review Board, the Responsible Project Investigator made the above changes. Research may begin.

IRB Chairperson's Signature — *date*

Appendix E: Task Instructions

Pre-experiment

So far, in the experiment, you have had the opportunity to meet, coordinate, or communicate with your teammates. If you have not done so, please contact with your team members. Acollab© has an e-mail feature that you can drop a line to your team members, or post your messages to Forum for others to retrieve later, or chat with your teammates if they are online. The goal is decide when and how to solve the task using Acollab©.

The last week, you have also had the opportunity to become familiar with the Acollab©. Remember, you are going to use ONLY the Virtual Team Collaborative Environment for this experiment, and Acollab© has many features that will help you to communicate and coordinate with your teammates in order to solve this task in the virtual space. I urge you to take advantage of all these features. Again, NO other types of communications other than Acollab© are allowed for the purpose of this experiment.

May we suggest a little help to solve the task?

The decisions that you will be making in this task are typical of those faced by admissions committees all the time. This fictional task requires the team to select from a list of three candidates, a suitable student, for admission to a University. You will be provided with a profile of each applicant consisting of scores on the Scholastic Aptitude Test (SAT), and other related background information that may affect the candidate's success. Based on the provided information, you will be asked to accept one candidate into the program, and rank the other two candidates. In this task, your goal is to make an accurate admission decision based on the information provided in each applicant's profile. These three candidates have varied qualifications, and you may find that some criteria for admission are more important to you than other members of the team. This is where you need to collaborate with your team members in order to discuss various alternatives. Since following an agenda technique in team meetings is an established practice for most organizations, therefore, we suggest a brief decision-making agenda to help you managing the task. However, this is not a restrictive list to follow, you may use your personal judgment whether to follow an agenda. Please find below the details of the suggested decision-making agenda (adopted from Gallup, et al., 1988, and Zigurs, et al., 1988):

-Read and analyze the task individually
-Define your selection criteria
-Initiate discussion about the selection criteria
-Generate alternatives
-Rank alternatives
-Resolve any conflict
-Vote on alternatives to reach consensus
-Decide and Post the final file to Acollab©

Post-experiment

After you reach the final consensus, you need to post your results in the **Library folder** in Acollab©, so I can retrieve it later. This file should include briefly your criteria and reasons explaining why you picked him/her.

After I receive the all answers, I will send you a post-experiment survey link in order to measure your satisfaction with this experiment. Following the survey answers, I will notify all teams about the correct answers.

Please participate to the best of your ability, and take your role in this study with the conscientiousness and earnestness that it deserves. Your voluntary participation is critical to the success of this experiment. Again, thank you very much for your participation.

Appendix F: Original Task

Task:

You are a member of a UGA admissions committee deciding who to accept for next year. Three high school students who were initially turned down have appealed. Information about the three students is presented below. You can only accept one student.
Which do you accept?

Jane Jones

Jane scored a 500 on the SAT-verbal and a 450 on the SAT-Math. Her GPA across all her high school courses was 2.70. She isn't sure of major, but intends to get a BA, probably majoring in English. She has taken a wide range of courses in high school, but has make sure that all are regular academic courses (e.g., english, chemistry, social studies); she has avoided non-academic courses such as home economics and health. One of her courses was an advanced placement college level course in English in which she got a B. She has not participated in any extra-curricular activities. She is from a small town in rural North Carolina. Her high school has a reputation for being a high quality school with a tough grading policy. Many students from her high school have attended UGA over the past three years and they have consistently done well. She is missing a History course which is required for admission to UGA because her high school has different graduation requirements than high schools in Georgia. She has written a letter stating that she will make up the deficiency by taking an extra history course at UGA in her first year. Her high school principal has written a letter of recommendation urging you to accept her. He says that his high school has a strong academic reputation, and Jane is a good, hard working student. Her English teacher has also written a letter recommending that UGA accept her and commenting on her talent for English. She lives with her parents on a farm. Neither of them have a college education, but Jane says they are encouraging her to get a degree.

William Walker

William scored a 425 on the SAT-verbal and a 500 on the SAT-Math. His GPA across all his high school courses was 2.80. He has always enjoyed math and has done well in it, so he plans to major in math. He has satisfied all UGA course requirements for admission, but has taken two non-academic courses, both physical education courses. If you calculate his GPA on just he academic courses, his GPA falls to 2.70. He lives in Atlanta with his parents. His father is a successful businessman. His father has written a letter urging you to accept him as it is a family tradition to attend UGA. William's father, grandfather, and great-

grandfather all attended UGA. His high school is a large school that sends many students to UGA. Many have done well at UGA, and many have not, which is typical of the students from many Georgia high schools. William is an athlete, having been on his high school track team every year, but has never won a race. His physical education teacher has written a letter, a recommendation urging you to accept him. He says that William is a good worker who trains hard, and while he may not be the fastest sprinter, he is always a team player. His health teacher has also written a letter of recommendation that says William works hard and always does his best.

Ted Thompson

Ted scored a 450 on the SAT-verbal and a 450 on the SAT-math. His GPA across all his high school courses was 2.95. However, he has taken several non-academic courses (e.g., physical education, typing). If you calculate his GPA in just the academic courses, it is 2.70. However, he has taken an advanced placement college level course in Chemistry in which he got a B. He lives with his mother in a small town just outside Athens. His parents are divorced. His mother is an elementary school teacher. She got her education degree from UGA many years ago, and is currently very active in the UGA alumni association and the PTA. He intends to become a high school teacher and will therefore major in education. He has worked at several odd jobs to help his mother support the family and to save enough money to go to college so he has not had time to participate in extra-curricular activities. His high school has not sent many students to UGA, so it is difficult to tell the quality of education he has received. It may be very good, very bad, or somewhere in-between. He is missing one science course that UGA requires before admission. He has written a letter stating that he intends to take the course during the summer so he will have completed it before entering UGA in the fall. The pastor of his church has written a letter of recommendation urging you to accept him and saying that he is an honest hard working young man committed to bettering himself. He is a member of the Army reserves and his commanding officer has written a letter of recommendation urging you to accept him because he works hard and always does his best without having to be asked.

Alan Dennis
Department of Management, Terry College of Business
University of Georgia, Athens, GA 30602
Phones: Office 404-542-3902 Fax 404-542-3743 Home 404-613-7807

Appendix G: Modified Task

Undergraduate Admissions Case:

You are a member of a Fictional University (FU) Undergraduate Admissions Committee deciding whom to accept for next year. Three high school students who were initially turned down have appealed. Information about the three students is presented below. You can only accept one student, and rank other two for the waiting list. **Which student would do you accept? In addition, what would your rankings be for the other two students?**

Applicant 1-- Jamie Jonas

Jamie scored a 500 on the Scholastic Aptitude Test (SAT)-verbal and a 450 on the SAT-Math. Her GPA across all her high school courses was 2.70. She is not sure of major, but intends to get a BA, probably majoring in English. She has taken a wide range of courses in high school, but has make sure that all are regular academic courses (e.g., english, chemistry, social studies); she has avoided non-academic courses such as home economics and health. One of her courses was an advanced placement college level course in English in which she got a B. She has not participated in any extra-curricular activities. She is from a small town in a rural part of the neighboring state of FU. Her high school has a reputation for being a high quality school with a tough grading policy. Many students from her high school have attended the FU over the past three years and they have consistently done well. She is missing a history course, which is required for admission to FU because her high school has different graduation requirements than high schools in the state where FU is located. She has written a letter stating that she will make up the deficiency by taking an extra history course at FU in her first year. Her high school principal has written a letter of recommendation urging you to accept her. He says that his high school has a strong academic reputation, and Jamie is a good, hard working student. Her English teacher has also written a letter recommending that FU accept her and commenting on her talent for English. She lives with her parents on a farm. Neither of them have a college education, but Jamie says they are encouraging her to get a degree.

Applicant 2-- Barry Walker

Barry scored a 425 on the SAT-verbal and a 500 on the SAT-Math. His GPA across all his high school courses was 2.80. He has always enjoyed math and has done well in it, so he plans to major in math. He has satisfied all FU course requirements for admission, but has taken two non-academic courses, both physical education courses. If you calculate his GPA on just the academic courses, his GPA falls to 2.70. He lives with his parents in a large city in another adjacent state to FU. His father is a successful businessman. His father has written a letter urging you to accept him, as it is a family tradition to attend FU. Barry's father, grandfather, and great-grandfather all attended FU. His high school is a

large school that sends many students to FU. Many have done well at FU, and many have not, which is typical of the students from many of this city's high schools. Barry is an athlete, having been on his high school track team every year, but has never won a race. His physical education teacher has written a letter, a recommendation urging you to accept him. He says that Barry is a good worker who trains hard, and while he may not be the fastest sprinter, he is always a team player. His health teacher has also written a letter of recommendation that says Barry works hard and always does his best.

Applicant 3-Henri York

Henri scored a 450 on the SAT-verbal and a 450 on the SAT-math. His GPA across all his high school courses was 2.95. However, he has taken several non-academic courses (e.g., physical education, typing). If you calculate his GPA in just the academic courses, it is 2.70. However, he has taken an advanced placement college level course in Chemistry in which he got a B. He lives with his mother in a small town just outside of the city where FU is located. His parents are divorced. His mother is an elementary school teacher. She got her education degree from FU many years ago, and is currently very active in the FU alumni association and the FU. He intends to become a high school teacher and will therefore major in education. He has worked at several odd jobs to help his mother support the family and to save enough money to go to college so he has not had time to participate in extra-curricular activities. His high school has not sent many students to FU, so it is difficult to tell the quality of education he has received. It may be very good, very bad, or somewhere in-between. He is missing one science course that FU requires before admission. He has written a letter stating that he intends to take the course during the summer so he will have completed it before entering FU in the fall. The pastor of his church has written a letter of recommendation urging you to accept him and saying that he is an honest hard working young man committed to bettering himself. He is a member of the Army reserves and his commanding officer has written a letter of recommendation urging you to accept him because he works hard and always does his best without having to be asked.