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AN EXAMINATION INTO HOW GROUP PERFORMANCE IS

INFLUENCED BY VARIOUS COMMUNICATION CHANNELS

Thesis

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AFIT/GIR/ENV/08-M16

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THESIS

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AN EXAMINATION INTO HOW GROUP DECISION MAKING IS

INFLUENCED BY VARIOUS COMMUNICATION CHANNELS

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Approved:

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Jason M. Turner, Maj, USAF (Member)	Date

AFIT/GIR/ENV/08-M16

Abstract

This purpose of this research was to look at the how group performance is influenced by various communication channels. Specifically, this research sought to determine what communication factors are affected when groups are forced to use different communications channels. The three communications channels tested were face-to-face communications, audio conferencing, and computer-mediated communications through an Internet chat program. Each channel was measured on accuracy, efficiency, and total number of ideas generated.

The research found that the groups using computer-mediated communications had a difficult time completing the exercises in the allotted time. Additionally, the computer-mediated produced significantly fewer total words and total inputs during the experiment. This research produced no statistical difference between any of the groups in total number of ideas generated and no statistical difference in any of the three categories between the face-to-face and audio conference groups.

Acknowledgments

Thanks to my wife and my three beautiful children for being supportive through this

entire process. I would also like to thank my thesis advisor, Dr. Heminger, and Major

Turner for all of their support.

<div style="margin-left:50%">

Jason Norgaard
Capt, USAF

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AN EXAMINATION INTO HOW GROUP PERFORMANCE IS INFLUENCED BY
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I. Introduction

Background

In the early part of the twenty-first century with the United States military deeply

involved in the war on terrorism the Rand Corporation's Nation Defense Research

Institute was commissioned to conduct a study on virtual collaborations. This study was

one part of a project that focused on high-level national-security decision making. The

goal was to gather together 40 years worth of research conducted on the different forms

of mediated communications with a focus on face-to-face (FTF), audio conference (AC)

videoconference (VC), and computer-mediated communications (CMC). This research

would then provide some strategy for selecting which form of communications to use for

a given task (Wainfan & Davis, 2004).

This type of research has become more and more necessary as military operations

and the communications capabilities to support them continue to grow. The Department

of Defense (DOD) has made it a priority "to respond to evolving and adaptive enemies"

(Requirements Directorate Office of the Under Secretary of Defense for Program

Integration, 2007). One single military attack can be executed from personnel at 8

different locations and commanded by a joint staff at a different location. A commander

must be able to get the information he needs to make a quick and accurate decision even

when the members of his team are geographically separated. I've been a part of military

teams that were forced to use an audio conference to link units on the ground, in the air, and at sea together to collect and disseminate information.

The need for new thinking when it comes to developing decision makers of the future is now. Currently the USAF company grade officer professional military education (PME) is focused on using face-to-face communications. Second Lieutenants at the Air and Space Basic Course (ASBC) are given class room instruction on team building and problem solving then they are put into six different situations which demand face-to-face problem solving and decision making (SOC/DE, 2006).The curriculum for Captains at Squadron Officer School (SOS) has a more advanced leadership and management program that adds a focus on the effect communication has on leadership and teambuilding (SOC/DE, 2006). No problem solving activities at either school involved the use of audio conference or computer-mediated communications during my three years as an ASBC instructor or my six weeks as an SOS student, although these forms of communications have proved essential in everyday decision making throughout my USAF career.

It was my three years of teaching group decision making and problem solving technique as ASBC that peaked interest in a 2006 research project completed at the University of Texas by a current AFIT professor on the "The Communication of Influence through Technology-Enabled Media." This research focused on how different influence messages are used when groups are forced to use different communications channels to solve a set of three scenarios (Turner, 2006). The fact that this research had an existing data set with 18 completed group problem solving exercises led itself to many

interesting research questions. The fact that over a three year period as an ASBC instructor I facilitated over 90 face-to-face group problem solving scenarios and no AC or computer based scenarios left me with a lot of what if's? These thoughts let to the choice of this research question.

Research Question

Research Question: What factors of group problem solving are influenced by changing communication channels?

This research study will attempt to give some insight into how changing the form of communications used to solve a problem can affect the way a decision is made. These factors could be key components for developing group problem solving training events in the future.

Implications

The Rand study mentioned earlier indicated that their "research shows that all media- videoconference, audio conference, and computer-mediated communication-change the context of the communication to some extent, reducing cues used to regulate and understand conversation, indicate participants' power and status, and move the group toward agreement" (Wainfan & Davis, 2004). Continued research into the impact that different communications channels have on problem solving could have an impact on the future of group interaction. Even President Bush and his cabinet hold meetings in which one or more of its members must attend through video conference because they can't attend in person. Additionally, "during military conflicts and civil crises, staffs are

commonly involved in virtual collaborations using e-mail, Web-based chat rooms, other forms of CMC, AC, and sometimes VC" (Wainfan & Davis, 2004).

The time when a person or business uses only one form of communications to complete important group problem solving tasks is over. We live in a society where over 75% of the American population has access to the Internet (Grace, 2004) and we are becoming more dependent on technology to complete our everyday tasks. As leaders we need to have the ability to adapt our problem solving skills to fit the scenario and communications capabilities that we are given. We can't depend on school house face-to-face scenarios and old experiences that were solely based on scenarios solved through face-to-face communications. It has become apparent to me after 16 years of working in both a leadership and subordinate role in the USAF that a good unit must be able to leverage the communications capabilities that they have access to in order complete their mission.

II. Literature Review

Chapter Overview

The purpose of this chapter is to provide an overview of literature dealing with the different communications channels used in this study and how different literature has sought to define elements of group performance as it relates to communications. A study on virtual collaboration by the Rand Corporation found over 1000 abstracts that dealt the different types of communications channels (Wainfan & Davis, 2004). This literature review will focus on the strengths and limitations of face-to-face communications, audio conference, and computer-mediated communications.

Face-to-face

A face-to-face meeting requires the members of a team to be located in the same physical place and allows verbal and non-verbal clues to be viewed (Alallah, 2007). It is the most common technique taught to USAF company grade officers in conjunction with problem solving tasks (SOC/DE, 2006). This type of communication has produced teams that are more satisfied with their performance than members of computer-mediated communications teams (Murthy & Kerr, 2003)and produced much higher amounts of social presence (Alge, Wiethoff, & Klein, 2003). Social presence of communication channel is defined by the "the degree to which it enables interpersonal interaction". (Barry & Fulmer, 2004) However, a 2003 study from Chico University found no

significant difference in total time spent and total team performance between face-to-face and computer-mediated teams (Corbitt, 2004).

Face-to-face communications can differ greatly depending on the subject or task given and different results can be expected when the task is changed from a social dilemma to a puzzle or other type of task. This result was evident in a study published in 1999 found that computer-mediated communications produced more ides when solving a Criminal Puzzle and higher levels of feedback when solving a Social Dilemma problem (Adrianson, 1999). Furthermore, one study found that 74% of its participants preferred face-to-face over computer-mediated communications and 40% said the reason for their preference was that they the team members paid more attention to their comments while they were face-to-face. Only 4% of the participants preferred to use computer-mediated communications (Murthy & Kerr, 2003).

Virtual teams often start out with face-to-face meetings. These meetings are designed to give teams a sense of shared understandings and help develop social ties that can help with online relationships. Additionally, virtual teams often require face-to-face meetings when the "task requires a high degree of interdependence, and when geographic, organizational, and/or cultural boundaries must be spanned" (Crowston, 2007).

Audio Conference Communications

Audio conferencing for the purpose of this study will be defined as "the use of the telephone to establish a voice-based network among a group of people" (Teles, 1991). This form of communication is generally used when members of an organization are

geographically separated and need to communicate to pass information or to make decisions. The standard set is a conference call that links multiple locations in to one conversation. These types of conference calls can involve multiple people at each location sitting at a conference table and using a speakerphone in the middle of table. In audio conferencing the "perception of participants toward each other has been found to be least positive" among the three communication channels. This form of communications eliminates visual cues and results in more choice shifting than face-to-face or Internet Chat communications (Wainfan & Davis, 2004).

Audio communications has many advantages compared to face-to-face and computer-mediated communications. The main advantages over face-to-face communications are distance and price. Companies spend an enormous amount of money and time every year to send their members to meetings around the globe instead of simply setting up an audio conference to discuss their ideas. The advantages differ somewhat when comparing audio conferencing to computer-mediated communications. Audio conferencing has very few compatibility differences, uses the most widely accessible technology, is easy to use, is relatively inexpensive to set up and use, communication occur in real time, and it allows interaction between all parties involved in the meeting (The University of Iowa College of Public Health, 2008). Audio conferencing is most useful when the number of sites that participate in a conference is limited to around eight or less. This will enable all members of the conference to have the opportunity to participate (Teles, 1991).

Audio conferencing comes with its share of disadvantages and it is considered a much less rich form of media (Felstad, 2003). When comparing it to face-to-face communications it loses all of the non-verbal communications aspects of the conversation along with the ability to see all parties involved. The disadvantages with computer-mediated communications come from possible distortions in phone qualities, the fax or mail presentations ahead of time to all participants, and the fact that some people may be reluctant to ask questions (The University of Iowa College of Public Health, 2008). Additionally, the immediate contact of audio conferencing can add additional pressure on its members to perform (Coombs, 1990). It is disadvantages like theses that have led many organizations to do away with audio conferencing and spend the extra money on high tech video conferencing units that will allow the members to view a presentation on part of the screen while seeing the participating members on the other screens.

Computer-mediated communications

Computer-mediated communications "refers to human communication via computers—including computer network communication on the Internet and the World Wide Web" (*Computer-mediated communication studies center, 2000*). It can also be defined as "person- to-person communication, often in text or graphic form, over computer networks" (Pickering & King, 1995). Computers play a role in everyday communications for most organizations and the more geographically separated the organization then the more dependent it is on computer-mediated communications. This form of communication allows members of an organization to view and discuss the same vital information through secure and non-secure means around the world.

Computer-mediated communications is better at idea-generation that requires a conveyance of information (Murthy & Kerr, 2003). Internet chat-based communication's advantage in brainstorming and idea generation comes from the ability to type ideas without having to wait in turn to communicate. This in turn helps broaden the inputs and ideas provided by the group by de-individualizing and de-inhibiting the member of the group. This sort of brainstorming can also lead to reduced efficiency, status effects, domination, and consensus (Wainfan & Davis, 2004). Furthermore, groups using web-based communications tools have scored significantly higher than face-to-face groups when it comes to creativity (Ocker, 1998). However, a 1994 study using all three communications channels showed that computer-mediated communications took significantly longer that face-to-face communications to come up with a decision on both tasks tested (Kinney, 1994).

The fact that computer-mediated communications is so powerful at generating ideas can also be a disadvantage. The average group doesn't have the time or resources to evaluate a large amount of ideas. The group facilitator may have to set some ground rule as to the types of messages allowed before the actual meeting occurs to help reduce wasted time for the participants to prevent judgmental criticisms and other types of comments that may be unproductive to what the group is trying to accomplish (Fobes, 2003). These groups have been found to produce riskier decisions that have answers that are further from away from its participant's initial choices than face-to-face groups (Valacich, 2002). This can limit team members' ability to accurately determine other members' priorities and has been shown to lower judgment, accuracy, and performance

(Hyeun-Suk Rhee, 1995). Many virtual teams found that they had lower levels of outcome and process satisfaction (Furumo, 2006).

Some of the research done in the field of computer-mediated communications has focused on Group Decision Support Systems (GDSS). "Group Decision Support Systems combine computer, communications, and decision technologies to support problem finding, formulation and solution in group meetings…the most fundamental goal of GDSS is to support and structure the exchange of ideas, opinions, and preferences within the group" (Gallupe & McKeen, 1990). These systems are used as a method to try and improve the quality and speed of group decision making. One study from Queen's University found that the groups using a GDSS had no significant improved decision quality over the groups no using a GDSS in both face-to-face and computer-mediated settings. Additionally, this study found that the groups using a GDSS took significantly longer to come to a consensus and had a much lower amount of decision satisfaction (Gallupe & McKeen, 1990). However, other studies have found that the use these systems can lead to an increase in decision quality, effectiveness, number of ideas generated, and group equality (Huang, 2001; Nunamaker, Dennis, Valacich, Vogel, & George, Jul 1991).

Group Performance Elements

It seems like many of the differences between communications mediums are obvious, but trying to figure out a way to measure these difference can be more difficult. Group performance has been used to measure many different types of communications and how they relate to group interaction. When trying to compare

different types of communications channels group performance can be broken down into the elements of accuracy, efficiency, and total number of ideas generated.

Group or "team decision accuracy was defined as the difference, on average, between the team's decision and the correct decision" (Hedland, Ilgen, & Hollenbeck, 1998).   A Yale and Michigan State University study from 1998 comparing face-to-face and computer-mediated group found that face-to-face groups scored significantly higher in decision accuracy and produced a higher number of input units. The results were significantly reduced when the number of messages inputs was restricted to equal out the number of inputs each group received (Hedlund, Ilgen, & Hollenbeck, 1998).

The second element of group performance that was studied was efficiency. In the case of this study, efficiency refers to how a group's performance was affected by an efficient or inefficient communications channel.   A 1993 study comparing face-to-face with GDSS found that task had a significant effect on efficiency. The GDSS group performed more efficiently when performing an intellective task and the face-to-face group were more efficient on the preference task (Tan, Wei, & Raman, 1993). A 2007 study from Carnegie Mellon University used the total number of words and total number speaking turns per task to measure the conversational efficiency of Chinese and American groups using different communications channels. The study found that communication medium had no statistical effect on either conversational efficiency variable (Setlock, 2007).

Total Number of Ideas generated is one of the key components studied when it comes to group problem solving research.   Idea generation is sometimes referred to as

"optional solutions because the goal is to complete a list of all conceivable alternatives to a problem (*Problem solving, 2007*)." A 1999 study tried to determine which produced more ideas a group support system or e-mail. The study found that the group support system was much better at producing more basic ideas, but e-mail performed better at large problem solving analysis (Shirani, Tafti, & Affisco, 1999).

Desert Survival Scenario

In 1970 a group problem solving scenario was designed to gives groups an opportunity to work together to demonstrate and achieve synergy (*The desert survival situation*1990; Lafferty, Eady, & Pond, 1973). Schools like Arizona State University and Keller Graduate School have been using the virtual version of this scenario for years to demonstrate situational analysis and group decision-making. This scenario is designed to show group members that the answer they get as a group is better than the answers achieved by each of the individual members of the group. This theory was tested in a 2004 using two different communications channels. The first set of 802 groups worked in a face-to-face setting and found that the groups scored higher than 74% of the individuals and lowered the average accuracy score by 8.9 from their individual scores. The second set of 227 groups worked on a virtual software version at different locations and found that the groups score better than 75.8% of the individuals and lowered the average accuracy score by 7.87 from their individual scores(Potter, 2004). A copy of the revised version of this scenario was used in Turner's 2006 study and can be viewed in Appendix A.

Summary

The topic of how the different communications channels affect decision making and group problem has been completed at many different universities and with many different scenarios. This literature review focuses on defining face-to-face communications, audio conference and computer-mediated communications. Each communications channel has advantages and disadvantages.

Decision makers must make the best use of the communications channel available to solve their problems. It is important to recognize what factors of media quality can be affected by changing the communications channels. Decision quality can be affected by not allowing the most accurate answer, using the most efficient communications channel, or by limiting the number of ideas generated. These factors must be taken into effect when a communications channel is selected.

The previous research provided in this literature review lead to the development of the following hypothesis 1. Hypothesis 1 was chosen because of the link between the time it takes to complete a task in computer-mediated groups and the time critical task selected for evaluation.

> *Hypothesis 1: Decisions made in a face-to-face communications and audio conferencing will be more accurate than that of computer-mediated communications.*

Hypothesis 2 was chosen because face-to-face communications uses all of the verbal and

non-verbal clues to efficiently complete the tasks.

Hypothesis 2: Face-to-face communications will score higher than audio conferencing and computer-mediated communications in terms of communications efficiency.

Hypothesis 3 was chosen because the literature is very supportive of the fact the

computer-mediated communications is very good at idea generation.

Hypothesis 3: Computer-mediated communications will produce more ideas than either face-to-face communications or audio conferencing.

III. Methodology

Chapter Overview

This chapter will identify the method used to collect data in phase 2 of Turner's (2006) study including group selection, experiment design, and data limitations. The chapter will then transition into the methodology used in this study to measure the different factors that are influenced by changing communications channels and group problem solving scenarios.

Participants

The subjects for this study were recruited through e-mail and word-of-mouth at large southern university. They were paid for completing research and volunteers were grouped based on the time they were available to participate in the study. The groups of volunteers were composed of six groups with four members each. Using a four-man group size is group because "groups of three to five people perform better than individuals when solving complex problems" (Van Wagner, 2006).

The subjects were made up of sixteen females and eight males that were a mix of undergraduate and graduate students along with two subjects that had completed their graduate degree within the last year. The subjects came from a wide variety of degrees from communications to engineering to history. One subject dropped out in the second voice conference group and one group was replaced completely on day two when two individuals failed to arrive. This left 23 that completed the tasks used to collect data in this research.

Data Collection Design

The research is a Split-plot repeated measure design in which X_1 is face-to-face, X_2 is audio conference, and X_3 is Internet Chat. The three observations occurred during the X and were captured on transcripts.

Time 1	Time 2	Time3
X_1O	X_1O	X_1O
X_1O	X_1O	X_1O
X_2O	X_2O	X_2O
X_2O	X_2O	X_2O
X_3O	X_3O	X_3O
X_3O	X_3O	X_3O

Figure 1. Split-plot Repeated Measure Design

The experiment consists of three days of group problem solving activities. On the first day each of the six groups completed the desert plane crash scenario (Appendix 1). Two of the groups used face-to-face communications in a single small conference room, two groups used hands-free capable telephones (Figure 2) in four separate conference rooms, and two groups used four computers set up with an Internet chat program loaded and running (Figure 3). This same format was duplicated for day two and three except the scenario was changed. The sequence of events used by Turner (2006) included:

Day 1
Introduction/Warm up (15 Min) – Establish Group/Communicative Context
Media Familiarization (10 Min)
Social Time (7 Min)
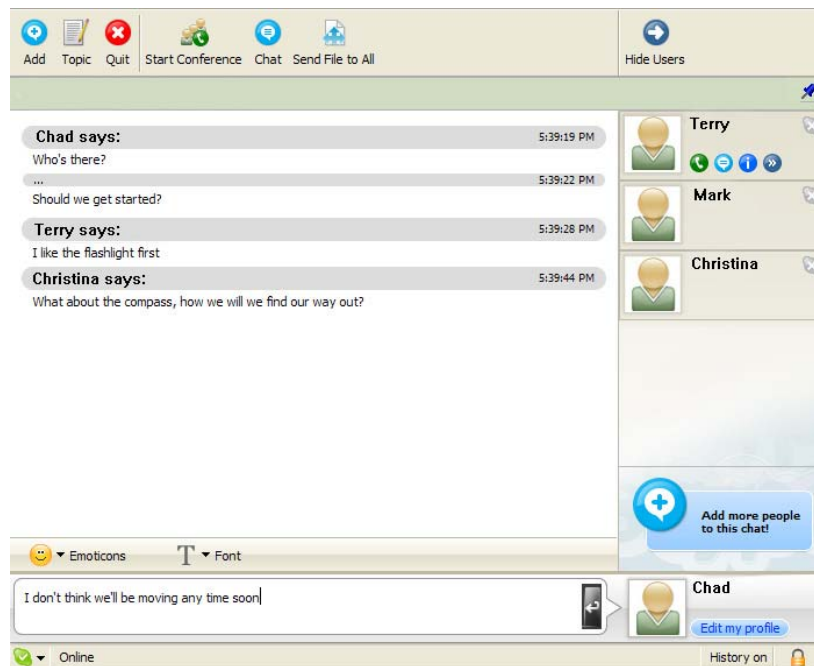Task (15 Min)

Day 2
Social Time (7 Min)
Task (15 Min)
Day 3
Social Time (7 Min)
Task (15 Min)

Figure 2. Base Station and Handsets for Voice Conference Capability

Figure 3. Skype Interface for Chat Capability

Data Evaluation Design

The transcripts from the each of the 18 different group solving events were used to identify the communications factors of accuracy, efficiency, and total number of ideas generated. The desert survival scenario will be evaluated for the accuracy by comparing the group's final answer to that of the survival expert. The survival expert's answers were taken from the Volunteer Power website (*Volunteer power: Answer to the team building exercise, 2008*). In order to obtain an accuracy score each answer given by the groups will be subtracted from that was the corresponding survivor's answers and then the absolute value of the differences will be added up to get a group accuracy score. The lower the group total the closer the group is to getting the right answer.   Example:

Ranking	Group 1	Survival Expert	Difference	Absolute Value
1	Map	Mirror	1 - 2 = -1	1
2	Salt Tablets	Map	2 - 10 = -8	8
3	Parachute	Pistol	3 - 11 = -8	8
4	Rain Coat	Rain Coat	4 - 4 = 0	0
5	Mirror	Book	5 - 1 = 4	4
6	Compass	Knife	6 - 8 = -2	2
7	Book	Flashlight	7 - 5 = 2	2
8	Flashlight	Compass	8 - 7 = 1	1
9	Whiskey	Whiskey	9 - 9 = 0	0
10	Knife	Salt Tablet	10- 6 = 4	4
11	Pistol	Parachute	11- 3 = 8	8
				38

Table 1: Accuracy Score Example

Efficiency and total number of ideas generated were evaluated using all three of the scenarios. Efficiency focused on three factors. The first factor is number of total words communicated during the 15 minutes of problem solving time. The second factor was the average number of words communicated during each transmission (from the start

18

of one person's conversation until the beginning of the second person's inputs). The

third factor was the total number of different conversation starts during the scenario.

This will be measured be counting each time one person stops his input and one person

begins. Example:

Scenari	Comm. Channel	Total	# of Inputs	Words Per Input
1	Face-to-face	1723	180	9.57
2	Audio Conference	2511	145	17.32
3	Computer-mediated	2097	134	15.65

Table 2: Efficiency Example

Total number of ideas generated was a simple calculation of the number of

different ideas generated in each scenario. A new idea is counted when the information

generated produces an answer that is different to the previous answer. Two other people

also performed idea generation counting to get a measure of reliability. The total used

was taken from a look at each rater's total and the average of the three totals (rounded to

the next number) to get the total number of ideas. Example:

Scenario	Comm. Channel	# Ideas Rater 1	# Ideas Rater 2	# Ideas Rater 3	Average
1	Face-to-face	40	37	38	38
2	Audio Conference	37	35	35	36
3	Computer-mediated	45	39	41	42

Table 3: Total Number of Ideas Generated Example

IV. Results and Analysis

Chapter Overview

       The purpose of this chapter is to provide the results and analysis from the methodology used in chapter 3. These results will identify how accuracy, efficiency, and total number of ideas generated are affected by a change in communications channel or task type. The ultimate goal of this chapter will be to provide useful answers to the research question asked in Chapter 1 and to help identify the possible directions to use in chapter 5 for follow-on research.

Accuracy Assessment

       Accuracy proved very difficult to measure in this research because only the desert survival task had a clear answer that could be used to compare the group results to and this answer was based on the groups' degree of agreement with the survival expert's decision to shelter in place. (*Volunteer power: Answer to the team building exercise, 2008*) The results for this section came from looking at the group's number of answers completed and accuracy score.

       Each was given specific instructions that they only had 15 minutes to complete the task. There were some differences among the groups.

	Communications Channel	Answers Completed
1.	Face-to-face	11/11
2.	Face-to-face	11/11
3.	Computer-mediated	5/11
4.	Computer-mediated	6/11
5.	Audio Conference	11/11
6.	Audio Conference	11/11

Table 4: Answered completed

The two groups that used the Internet chat program did not finish the exercise. The other four groups were able to complete all 11 answers.

The results below include extrapolating out the score of the two Internet chat groups that did not complete the exercise by using their average score difference and adding that total for each question left unanswered. The lower the score the better the group did in comparison to the expected right answer.

	Communications	Accuracy Score
1.	Face-to-face	48
2.	Face-to-face	36
3.	Computer-mediated	48
4.	Computer-mediated	38
5.	Audio Conference	44
6.	Audio Conference	30

Table 5: Total Accuracy Score

The overall scores are very similar between the three forms of communication with three groups having scores in the forties and three groups having scores in the thirties, but when the averages are compared it shows that audio conference scored slightly better. Audio conference had an average accuracy score of 37 for a 3.63 difference per question compared to 3.82 for face-to-face and 3.91 for computer-mediated communications. This comparison yielded a p-value of .7724 and therefore could not substantiate Hypothesis 1 that face-to-face communications would be more accurate than audio conferencing or computer-mediated communications.

Analysis of Variance

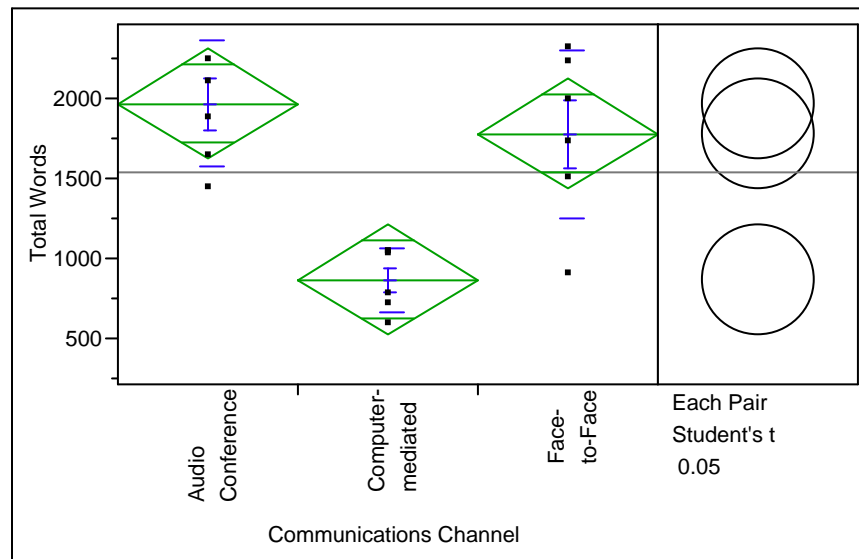| Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Communications Channel	2	41.33333	20.6667	0.2818	0.7724
Error	3	220.00000	73.3333		
C. Total	5	261.33333			

Table 6: ANOVA Average Accuracy Score

Efficiency Assessment

  The efficiency assessment results will be used to determine if there is a link between communications channel and level of richness and/or a link between scenario task and richness. Each of the six groups completed three scenarios that provide the 18 samples for this section.

  The first element of efficiency was the sheer volume or the total number of words used in an individual scenario.

Figure 4. Total Number of Words (Oneway Analysis)

Analysis of Variance
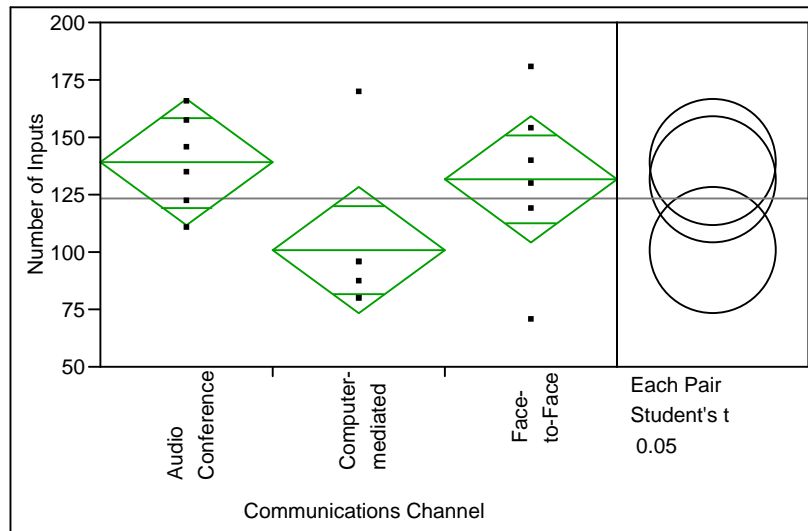
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Communications Channel	2	4167870.8	2083935	13.3264	0.0005
Error	15	2345649.0	156377		
C. Total	17	6513519.8			

Table 7: ANOVA Total Number of Words

The data given in the figure and table above are the results of the total number of words for each scenario in the entire sample. Each of the 3 communication channels has a total of six samples. The results clearly show that the groups using the computer-mediated communications did not communicate as efficiently as the other two groups. The face-to-face and audio conference

groups each communicated more than double the amount of words of the computer-mediated

communications group. There is no statistical difference between the face-to-face and audio

conference groups.

The second element of efficiency that was examined was total number of inputs. The

goal was to see if there was any relationship between the number of inputs and either

communications channel or scenario task. The results found that the average input total was

123.66 and that face-to-face communications produced 15% more inputs per scenario than

computer-mediated communications. Additionally, face-to-face was able to produced 10% more

inputs per scenario than audio conference. However, these differences were not statistically

significant because they had a P-value of .1174 which is greater than .05 needed to reject the null
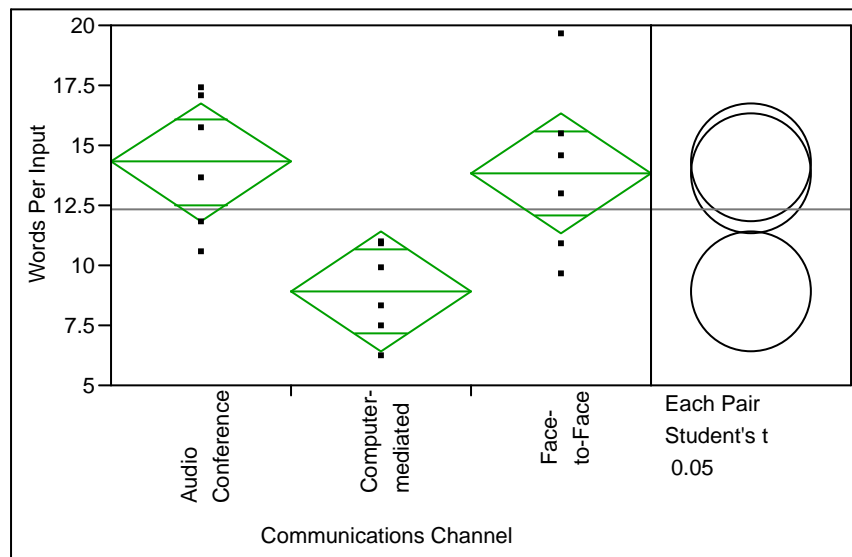
hypothesis.

Figure 5. Total Number of Inputs (Oneway Analysis)

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Communications Channel	2	4922.333	2461.17	2.4791	0.1174
Error	15	14891.667	992.78		
C. Total	17	19814.000			

Table 8: ANOVA Total Number of Inputs

23

The last factor used to calculate efficiency is average number of words per input. The goal was to look at how changing communications channels affected the number of total words that are used during each input. The results were broken down by communication channels. The average number of words per input for sample was 12.33. The audio conference groups produced 14.15 words per input which was almost a 65% increase from computer-mediated communications which produced only 8.57 words per input. The results show that only half of Hypothesis 2 is correct. There is no statistical difference between audio conference and face-to-face communications, but with a P-value of .0091 there is a statistical difference between computer-mediated communications and both face-to-face and audio conferencing.

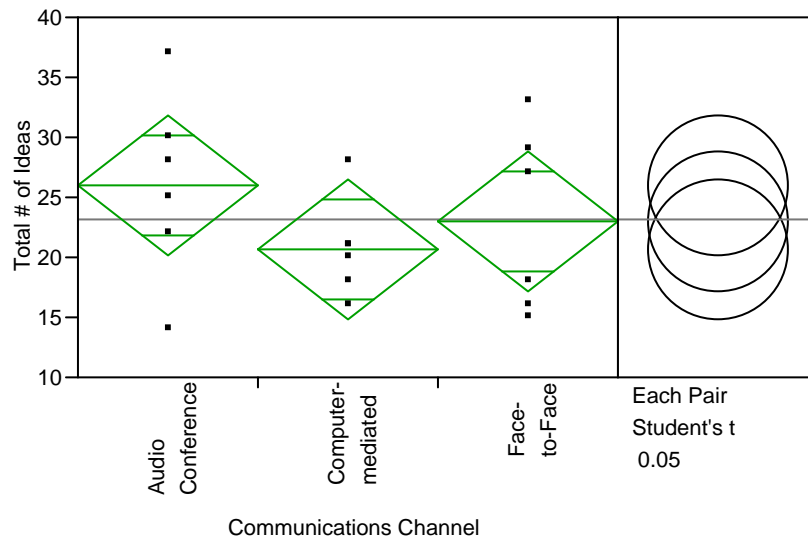**Figure 6. Total Number of Words per Input (Oneway Analysis)**

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Communications Channel	2	107.30163	53.6508	6.5397	0.0091
Error	15	123.05762	8.2038		
C. Total	17	230.35925			

Table 9: ANOVA Total Number of Words per Input

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Total Number of Ideas Generated Assessment

The total number of ideas generated had results taken from all 18 samples. The results produced no statistical findings with a P-value =.4079. The results showed Hypotheses 3 to be unsubstantiated because the groups using computer-mediated communications did not produce the most ideas.

Figure 7. Total Number of Ideas (Oneway Analysis)

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Communications Channel	2	85.77778	42.8889	0.9526	0.4079
Error	15	675.33333	45.0222		
C. Total	17	761.11111			

Table 4: ANOVA Total Number of Ideas

V. Discussion

Relevance of the Current Investigation

The different communication channels each come with unique advantages and disadvantages. The fact that the study was not able to find any significant difference between face-to-face communication and audio conferencing is very interesting. I expected face-to-face communications to perform better than audio conferencing on accuracy. The lack of difference may be explained by the limited size of the groups or the difference may not exist. A small group size may mask some of the limitations that can hamper groups using audio conferencing. This goes along with the notion that audio conferencing works best when limited to less than eight locations (Teles, 1991). Additionally, the similarities in the three efficiency assessments lead me to believe that the members of the group were very adept at using a telephone as a means to solve a problem. It suggests that a company can use a fact like this to set up small audio conferences whenever possible instead of spending the time and resources needed to get its members together for a face-to-face meeting.

The inability of the computer-mediated groups to complete the problem solving exercise was troubling. This study only used an Internet chat-based program for group interaction. However, the fact that the computer-mediated groups did not score significantly different on the answers to the problem solving scenarios leads me to believe that they may need assistance on time critical problem solving tasks. This assistance can come in the form of a speech-to-text program that eliminates the delays that occur while typing or a GDSS that will aide in the collaboration efforts and speed up the decision making process.

The efficiency assessments determined that all three communications channels produced roughly the same number of inputs even though the computer-mediated group used fewer total

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words and in turn fewer words per input. This would seem to suggest that the computer-mediated groups give shorter quicker answers than the other two communication channels. This could be a major advantage on tasks that do not require lots of justification.

This advantage did not show itself in the total number of ideas generated assessment. It may be because there were three different tasks that were not solely focused on idea generation. The computer-mediated groups were able to generate the same number of ideas with fewer words. This could be very beneficial to future groups if they recognize the need to organize these ideas to come to a consensus.

Assumptions/Limitations

This research assumes that the subjects had no prior knowledge of the tasks used to collect the data. Additionally, the subjects were not questioned on their prior relationship or if they had worked with another member of their group. This could affect the data because the number of hours working together can have the "biggest positive effect on communication quality and team performance (Adelman, Christian, Gualtieri, & Bresnick, 1998).

An additional limitation is that groups only involved four subjects which could add difficulties in trying to translate the results into scenarios where each location in an audio conference that has multiple people trying to communicate through one hands-free device. Also the total number of groups was low, reducing the ability clearly identify differences.

Future Possible Research

This research involved only three mediums of communication. Future research could look at using new and different mediums such as cell phone text messaging or speech-to-text computer software. Cell phone texting is becoming more popular and very little research has looked into how it compares to the other mediums. Speech-to-text computer software would be

a great addition to similar research, because it would increase the speech by which the computer-mediated groups could communicate.

Military Professional Education programs could benefit by doing future research into how to apply the differences in communications mediums into their leadership and group problem solving exercises.

Conclusion

Face-to-face and audio conferencing had no statistical differences in any of the group performance elements. Computer-mediated communications had significantly fewer statistical differences in the total number of words and total number of words per input. Companies that rely on computer-based systems to aide in their group problem solving activities should be aware of these differences.

Appendix: Tasks

A. **Day One Task**

You have been a passenger on a sight-seeing plane that has crashed in the Mojave Desert. The flight began early in the morning and it not yet mid-day. The pilot and copilot have been killed and the only survivors are the people in your group. You and a few of the fellow passengers were able to retrieve a number of items from the plane before it caught fire.
As a group:
1) Decide on an order (from 1 to 11) for these items in terms of importance for survival
2) For each item on the list, the group must reach consensus about its importance in the list
3) Provide your group's planned or expected use for each item on the list
4) Provide a rationale for why you ordered it between the items above and below it
Map of desert
Salt tablets
Parachute
Rain coats
Mirror
Compass
Book (edible plants of the desert)
Flashlight (working)
Pistol (loaded)
Fifth of whiskey
Hunting knife
You have 15 minutes to complete this task!

B. Day Two Task

Take some time to generate some ideas that will improve the quality of the physical environment at UT Austin or in the Austin metro area in general.
As a group:
1) Strive to produce ideas that would have
(a) maximal impact in improving the environment AND
(b) maximal feasibility of implementation
2) Generate as many ideas as possible but be sure to keep track of them
3) Decide as a group which idea you will implement and describe why
4) Develop a list of requirements, support, or resources that will be needed to implement the chosen idea.
You have 15 minutes to complete this task!

C. Day Three Task

Your group will be asked to settle a situation in which a college student bribed an instructor to change his grade in a course. The following pages describe the circumstances and the possible courses of action. Your task is to work as a group and determine which courses of disciplinary action to choose for the student and the teaching assistant (T.A.). Your group should consider the consequences of the different actions when making its decision. There are several departments on campus that have preferences for how this matter should be settled, strive to take into account the concerns of as many parties as possible.

 Please take a moment to read the details of the case:

This case involves determining the disciplinary actions for a situation in which a college student athlete has been found guilty of bribing an instructor to change his grade in a course. This event took place at a prestigious liberal arts college in the eastern U.S. The student, Jack, is a star athlete on the college basketball team. He leads the team in points, assists, blocked shots, and rebounds. He is very popular and has drawn larger crowds at the game than in previous seasons, substantially increasing the college's revenues due to athletics. In fact, Jack is such a good player and is so popular that the school has received a great deal of positive attention from the press, enhancing the college's reputation and attracting student enrollment.

Jack had been concerned about a grade in one of his courses. He needed a B or better on the midterm exam to get a B in the course and remain eligible to play basketball. He received a D on the midterm. To maintain his eligibility, he offered $200 to the course's graduate student teaching assistant to change his exam grade to a B. The teaching assistant, Tom, accepted the offer.

Another teaching assistant learned of the incident and reported both Jack and Tom to the administration. When confronted, Jack and Tom admitted to what they had done.

As the disciplinary action committee, your group's task is to choose the best courses of disciplinary action. There are five issues to settle in the case. Three issues pertain to disciplining Jack; including what to do about Jack's grade in the course, his status on the basketball team, and his status as a college student. The other two issues pertain to disciplining Tom; these issues include deciding what to do about Tom's status as an instructor and his status as a graduate student. When considering the alternatives for each issue, you should consider the consequences of the various options. In addition, be sure that you do not choose an illogical combination of alternatives (e.g. if you decide to suspend him from the academic program for one semester, then he cannot be suspended from playing basketball for only one game; if you decide to expel Tom from school, then he cannot work for the college as a teacher). The following information describes the different departments' preferences and the possible courses of disciplinary action for each of the five matters.

The athletic department does not condone cheating; however, it does not want to lose Jack from the team due to a suspension or expulsion. With Jack on the team, the school has a good chance at winning the conference championship. Without Jack, the college is unlikely 265 to win the championship. In addition, the money brought in from attendance at the games due to Jack's popularity has increased this department's resources, which it does not want to lose. On the grounds that extreme punishment for either Jack or Tom would only hurt the school and serve no useful purpose, the athletic department supports a lenient course of disciplinary action.

The college faculty wishes to uphold the highest academic and ethical principles.

After all, the main purpose of the college is as an academic institution. The faculty believes that cheating is reprehensible; is it the academic equivalent of theft and fraud, and the harshest punishment should be given to both Jack and Tom. In addition, a harsh and publicized disciplinary action will send a message to others that cheating is not tolerated at this college. This message will have a positive effect on the college's reputation for high academic standards. If the punishment is too light, then a precedent of lenience will be set for cases in the future, conveying the message that cheating is condoned, or it will convey a message that different standards apply to different students.

The college's administration wants a solution that takes into account the preferences of both the athletic department and faculty positions and protects the college's public image.

The administration wants to ensure the continued success of the athletic program. It also wants to uphold the college's academic standards and principles. Both the athletic and academic programs have contributed to the college's positive reputation. The administration is concerned that this matter be handled very carefully or the college may jeopardize its reputation, future enrollment, and financial support from other institutions and alumni.

As a committee, your task is to agree on how to settle this matter. You all must agree on one option to resolve each of the five issues. Remember, you must strive to make sure your solution takes into account the concerns of all parties.

Issues and possible courses of action:

Issue 1: Jack's grade in the course

1a. Give Jack his original grade on the exam (a D).

1b. Give Jack a failing grade on the exam.

1c. Give Jack a failing grade in the course.

Issue 2: Jack's status on the basketball team

2a. Make no change in Jack's basketball eligibility.

2b. Suspend Jack from the next basketball game.

2c. Suspend Jack from the basketball team for the rest of the season.

2d. Suspend Jack from the basketball team for an indefinite length of time and require that he appeal to be reinstated.

2e. Kick Jack off the team.

Issue 3: Jack's status as a college student

3a. Make no change in Jack's college status.

3b. Give Jack a warning, stating that if he is involved in another incident involving cheating in the future, he will be expelled.

3c. Suspend Jack from college (classes and athletics) for the rest of the semester.

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3d. Suspend Jack from the college for an indefinite length of time and require that he appeal for re-admittance.

3e. Expel Jack from the college.

Issue 4: Tom's status as an instructor (note: If Tom is restricted from teaching, he loses a source of income that helps pay his way through graduate school.)

4a. Make no change in Tom's teaching status.

4b. Give Tom a reprimand to be placed in his permanent record, which will be seen by potential employers after is finished with school.

4c. Suspend Tom from teaching for the rest of the semester

4d. Suspend Tom from teaching for an indefinite length of time and require that he appeal to be reinstated.

4e. Do not allow Tom to teach again during his time remaining in graduate school

Issue 5: Tom's status as a graduate student

5a. Make no change in Tom's college status

5b. Give Tom a warning, stating that if he is involved in another incident involving cheating in the future, he will be expelled.

5c. Suspend Tom from the college for the rest of the semester.

5d. Suspend Tom from the college for an indefinite length of time and require that he appeal for re-admittance.

5e. Expel Tom from the college.

You have 15 minutes to complete this task…please discuss this case as a group and try to resolve as many issues as possible.

1) Choose and agree on an option for each issue.
2) Indicate rationale for choosing each option.

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Vita

Capt Jason C. Norgaard graduated from Central High School in Saint Joseph, Missouri in June 1987. He enlisted in the United States Air Force in December of 1991 as a Telephone Systems Technician. His enlisted assignments included Kadena Air Base, Japan and McConnell Air Force Base in Wichita, KS. While enlisted he enlisted the University of Maryland and Butler County Community College before graduating from Newman University in May 1999 with a B.S. in Management Information Systems.

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13. SUPPLEMENTARY NOTES

14. ABSTRACT

This purpose of this research was to look at the how group performance is influenced by various communication channels. Specifically, this research sought to determine what communication factors are affected when groups are forced to use different communications channels. The three communications channels tested were face-to-face communications, audio conferencing, and computer-mediated communications through an Internet chat program. Each channel was measured on accuracy, efficiency, and total number of ideas generated.
The research found that the groups using computer-mediated communications had a difficult time completing the exercises in the allotted time. Additionally, the computer-mediated produced significantly fewer total words and total inputs during the experiment. This research produced no statistical difference between any of the groups in total number of ideas generated and no statistical difference in any of the three categories between the face-to-face and audio conference groups.

15. SUBJECT TERMS
Face-to-Face communications, audio conferencing, computer-mediated communications, group problem solving

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