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Distinguishing the communication and coordination differences between superior and good teams in tactical scenarios

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THESIS

DISTINGUISHING THE COMMUNICATION AND COORDINATION DIFFERENCES BETWEEN SUPERIOR AND GOOD TEAMS IN TACTICAL SCENARIOS

by

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March, 1995

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To establish effective Command and Control in Combat Information Centers (CIC) onboard Navy ships, it is very important that CIC teams develop proficient coordination, communication, and teamwork skills. The Navy has supported several research programs to investigate probable methods for enhancing these skills; one such program is the Tactical Decision Making Under Stress (TADMUS) program. Alphatech, INC., conducted the Tactical Adaptation and Coordination Training experiment (TACT) as part of this program to study how Navy CIC teams adapt to changing tactical environments. This thesis analyzes data from the TACT experiment in order to identify differences between superior and good teams.

Findings reveal that superior teams have better teamwork skills, experience higher subjective workloads, and have more confidence in their Tactical Action Officers. In addition, high stress caused teams to be less orientated towards teamwork and lowered their communication and coordination skills.

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DISTINGUISHING THE COMMUNICATION AND COORDINATION DIFFERENCES BETWEEN SUPERIOR AND GOOD TEAMS IN TACTICAL SCENARIOS

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ABSTRACT

To establish effective Command and Control in Combat Information Centers (CIC) onboard Navy ships, it is very important that CIC teams develop proficient coordination, communication, and teamwork skills. The Navy has supported several research programs to investigate probable methods for enhancing these skills; one such program is the Tactical Decision Making Under Stress (TADMUS) program. Alphatech, INC., conducted the Tactical Adaptation and Coordination Training experiment (TACT) as part of this program to study how Navy CIC teams adapt to changing tactical environments. This thesis analyzes data from the TACT experiment in order to identify differences between superior and good teams.

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I. INTRODUCTION

A. BACKGROUND

Team performance depends heavily upon effective communication among team members (Davis et al, 1985, p. 232). This is increasingly important in today's Navy, where teams are frequently required to deal with highly technical equipment and highly automated ships, capable of rapidly retrieving and processing vast amounts of data. This increased data throughput places a heavier burden on teams and demands effective team communications. One command and control center where effective team communications are paramount is the Combat Information Center (CIC) of a U.S. Navy ship, especially when the ship encounters highly stressful real world problems. The ability of a CIC team to deal with these problems depends heavily upon the ability of subordinates and superiors to develop effective communications. This, in turn, requires members of the team to know what communications are expected of them and to be able to accurately explain the communications that they receive (Rouse, Cannon-Bowers, and Salas, 1992, p.1302). Once they have developed this ability, CIC team members are capable of rapidly evaluating the large volume of data they receive and disseminating only the critical information necessary for the Tactical Action Officer (TAO) to accurately assess the current situation and make prompt decisions.

Effective communication performance plays a leading role in determining the success of a CIC team; however, there are other factors that also play a role. Such factors include: effective team coordination, a team's confidence in one another, team members' confidence in the leader (i.e., the TAO), a leader's confidence in the team (i.e., the subordinates), individual and team workload, a team's

experience level, and the ability of the team to adapt to changing environments. All of these factors are of interest to the U.S. Navy. There is particular interest in learning how these factors relate to effective team performance and the development of decision making skills.

A specific area of interest to the Navy and this thesis is a team's ability to adapt these factors and decision making skills when entering stressful conditions, thus allowing the team to sustain superior performance. The Navy realizes that stress tends to change a team's method of operation. Specifically, stress causes a team to alter communication strategies and decision making processes. Exactly how are these communication and coordination strategies changed? How does stress affect a team's ability to adapt to changing environments? How does stress change a team's decision making processes? Recent studies have attempted to answer some of these questions. These studies have shown that exposure to intense stress impairs individual decision making and induces a tendency to offer solutions before all alternatives have been considered. Furthermore, stress causes the decision maker to scan these alternatives in a nonsystematic fashion (Keinan and Friedland, 1986, p.219). This nonsystematic process prevents the decision maker from establishing a familiar routine or pattern that can be used to review other alternatives that may be better than the one originally chosen. Unfortunately, the Navy has experienced some tragic effects of stress on the decision making process. One particular example is the downing of an Iranian passenger plane in 1988 by the USS Vincennes. The AAW (Anti-Air-Warfare Officer) relayed preliminary reports from his subordinates to his Captain that an aircraft assumed to be an Iranian F-14 had changed its flight path into an attacking profile and was both descending and increasing

speed. It was later determined that the AAW had not confirmed these reports and "Quick reference to the CRO (character read-out) on the console directly in front of him would have immediately shown increasing not decreasing altitude...." (Gough, 1992, p.6). The ship's recent skirmishes with Iranian Gunboats had probably produced an extremely stressful environment that hampered the AAW's decision making process and eventually caused him to overlook several other alternatives. These alternatives, if chosen, might have lead to the prevention of the shootdown.

Having experienced the negative effects of stress, the Navy has devoted considerable time and research to programs that are investigating probable solutions by enhancing communication performance, coordination strategies, and the decision-making process for teams in stressful tactical scenarios. One such program is the Tactical Decision-Making Under Stress (TADMUS) program. The TADMUS program's primary objective is to develop techniques for training and supporting tactical commanders under operational conditions so that the likelihood of catastrophic failure, specifically in the area of target deconfliction in anti-air warfare (AAW) operations, is virtually eliminated (Entin, Serfaty, and Deckert, 1993, p. 1). The TADMUS program employs several companies and research institutions to conduct research in these areas. One company doing research under the TADMUS program is ALPHATECH. Their efforts seek to understand how CIC teams onboard Navy ships adapt to changing tactical environments. Furthermore, they are committed to understanding how team training and structural reconfiguration can contribute to the team's ability to successfully adapt its behavior to meet task demands (Serfaty, Entin, and Deckert, 1993, p. 1). ALPHATECH, in cooperation with faculty and students at the Naval Postgraduate School (NPS), Monterey, California, has

conducted prior studies to investigate these questions; such studies include the Situational Assessment In Navy Teams (SAINT) and Coordination In Hierarchical Processing Structures (CHIPS) experiments which were conducted at the Naval Postgraduate School. Test subjects involved students of the Joint Command, Control, and Communications (JC3) curriculum. The SAINT experiment was designed to study the effects of team leader feedback on situation assessment in distributed air defense teams. Findings include: feedback of the leader's current assessment lowers explicit coordination; feedback does not affect subjective workload; feedback increases error rates, and may affect error patterns (Gough, 1992, p. iii). The CHIPS experiment was designed to validate normative model predictions about hierarchical decision-making in a dynamic, distributed scenario (Armbruster, 1993, p. 15). Findings reveal that team performance declines when stress, increased risk, and increased feedback are introduced to subordinates in the team hierarchy.

The most recent study conducted by ALPHATECH at NPS is the Tactical Adaptation and Coordination Training (TACT) experiment. The main goal of this thesis is to analyze data collected during the TACT experiment and identify characteristics that distinguish the very best performing teams from the lowest performing teams Primary analysis focuses on how the superior teams differ from the others in their use of communication and coordination strategies across stressful conditions.

B. TACT EXPERIMENT

1. Objective

The TACT experiment is the third in a series of experiments designed by ALPHATECH to study team adaptation to stress. The TACT experiment has two objectives. The

primary objective is to investigate if CIC teams can be trained to improve their communication and coordination strategies and thereby enhance their overall performance. The secondary objective is to design and test a training procedure that focuses on developing the following skills in a CIC team: recognition of external and internal signs of stress for the team, acquisition of team-communication skills, learning different team-coordination strategies, and appropriate adaptation of the different strategies to various stress inducing operational conditions. (Entin, Serfaty, and Deckert, 1994, p. 1) The core premise driving the experiment is that highly effective teams develop a shared situational mental model of the task environment and a mutual mental model of team members' tasks and abilities. It is hypothesized that these mental models enable a team to develop decision-making and coordination strategies that allow it to adapt to changing environments and stresses. Furthermore, development of these models causes a team to shift from explicit to implicit communications. Before an overview of the TACT experiment is conducted, a discussion of mental models and explicit and implicit communications is necessary.

2. Background and Theory of Mental Models

Mental models are the mechanisms whereby humans generate descriptions of system purpose and form, explanations of system functioning and observed system states, and predictions (or expectations) of future system states (Rouse, Cannon-Bowers, and Salas, 1992, p. 1300). Referring to the TACT experiment, the term "System" refers to the CIC team, its intermember interactions, communications and coordination strategies, and its overall purpose or objective for carrying out assigned missions. The mental model definition is applied to the TACT experiment as follows: Generating descriptions of system

purpose and form refers to team members' ability to describe why the team has been formed (i.e., desired objectives) and how the team has been structured to produce optimal results. Explanation of system functioning refers to team members' ability to explain how the team members are supposed to interact with one another and how their collective efforts affect the outcomes of the scenario. Explanation of observed system states refers to team members' ability to access the team's current condition and determine the input that is required to help the team sustain a level of performance. In other words, what type of information transfer is necessary for team members to perform their jobs effectively. Lastly, generating predictions of future system states refers to team members' ability to predict the future conditions of the team. It also involves understanding the information required to propel a team to a desired state. Simply stated, developing mental models basically boils down to developing team familiarity.

Past studies have examined the development of mental models in teams. They have found that teams that develop mental models tend to adapt to changing environments and stresses better than teams that do not develop mental models. In addition, effective teams develop a mental model of their common task that enables them to use team structure to maintain team coordination and performance under a wide range of conditions (Entin, Serfaty, and Deckert, 1994, p. 4). With this in mind, mental models can be broken down into shared mental models of the situation and task environment and mutual mental models of team members' tasks and abilities. Shared mental models of the situation and task environment allow team members to anticipate how the situation will evolve. It implies that team members have common knowledge about the situation, environment, and priorities (Entin, 1995). Mutual mental models allow a team

member to generate expectations of how other team members will respond, given current conditions. It involves team members being "in sync" with each other. One of the hypotheses generated from the TACT experiment is that teams that have developed a high level of congruence between their mental models, both shared and mutual, are able to make use of these models to anticipate the way the situation will evolve as well as the needs of the other team members. These teams will perform consistently better under a wide range of conditions (Entin, Serfaty, and Deckert, 1994, p. 5).

Having grasped the concept of mental models, one can now see why ALPHATECH has incorporated them in the TACT experiment. Mental Models determine how a team communicates, how they use coordination strategies, and how they effectively adapt to stress. This is why ALPHATECH has placed emphasis on training techniques that help develop mental models within a team. In addition to the analysis mentioned earlier, this thesis plans to analyze whether superior teams in the TACT experiment use or develop mental models more than good teams.

3. Explicit Versus Implicit Communication

There are two types of communication within a team; explicit and implicit communication. Explicit communication involves specific communications that are usually transferred between team members upon request. In other words, for a team member to receive information, he must specifically prompt another team member for the information transfer. Implicit communication involves the transfer of information to another team member without that information being requested. The key to implicit communication is that it is communication pertinent to an individuals needs, not just communication transfer. The beauty of implicit communication is that it reveals the presence of shared

mental models within a team. A team's increase in the use of implicit communication indicates that team members are predicting the needs of others more frequently. Analysis of the data generated from the TACT experiment in this thesis shows superior teams shift towards implicit communications more than other teams. This would imply the development of mental models.

4. Overview of the TACT Experiment

The TACT experiment was designed to simulate operations in combat information centers (CIC) onboard Aegis capable ships. The experiment utilizes the Decision Making Evaluation Facility for Tactical Teams (DEFTT) lab that is located at Surface Warfare Officers School (SWOS) in Newport Rhode Island and the Naval Postgraduate School (NPS) in Monterey, California. The DEFTT simulation originated from the Tactical Anti-Submarine Warfare Instructional Trainer (TASWIT) and provides a relatively realistic abstraction of five CIC watch stations in "air-alley" found aboard Aegis capable platforms (Entin, Serfaty, and Deckert, 1994, p. 9).

The TACT experiment employed 59 military officers and one civilian, 30 from SWOS and 30 from NPS. These officers were split into 12 five person teams and were tasked to perform situation assessment and contact deconfliction by correctly inferring the identity, and thus the intentions (i.e., potentially hostile or neutral), of detected air and surface contacts (Entin, Serfaty, and Deckert, 1994, p. 8). Each team was set up in a hierarchical arrangement. Four subordinate team members supported the Tactical Action Officer (TAO) by providing information that enabled the TAO to make decisions on a contact's identity, capability, and intention. The TAO was also responsible for deciding the actions to be taken regarding the contact. The four subordinate positions are: an Identification Supervisor (IDS), a Tactical Information Coordinator (TIC), an Anti Air

Warfare Coordinator (AAWC), and an Electronic Warfare Supervisor (EWS).

Prior to the start of the experiment, the 12 teams were assigned to three training groups; each group had four teams. One group was the control group and received no extra training. Another group received TACT+ training that involved the use of periodic situation assessment updates by the TAO. The final group received TACT training that involved no situation assessment updates by the TAO. For a more detailed description of the training techniques used in the TACT experiment, refer to ALPHATECH's 1994 final report on Team Adaptation and Coordination Training or Lieutenant Commander Lonnie R. Green's 1994 thesis on the Effectiveness of Tactical Adaptation and Coordination Training On Team Performance In Tactical Scenarios.

Prior to the start of the four data collection scenarios, teams were given an overview of the TADMUS project. They also received refresher training on the DEFTT simulator and watch station functions. To further familiarize them with TACT equipment and team dynamics, each team was given three practice scenarios. At the conclusion of the third practice session, the data collection scenarios commenced. Each team was run through two tactical scenarios, one high stress and one low stress. Data was collected using audio, video, trained observers, and team questionnaire forms. At the end of the second scenario, the teams received their perspective training intervention. At the conclusion of its training intervention, each team was run through two more tactical scenarios, one high stress and one low stress. Data was again collected, team members filled out background questionnaires, and the experiment concluded. A more detailed description of the TACT experiment is covered in the Experimental Design section.

ALPHATECH's goal was to compare the data obtained prior to training with the data obtained after training to determine the effectiveness of the training interventions. More specifically, the data was analyzed to see if training intervention had an effect on a team's development of mental models. This was accomplished by identifying a team's shift from explicit to implicit communications. In contrast, the main focus for this thesis is the communication and coordination characteristics that distinguish superior teams, regardless of the training methods used to heighten team proficiency.

C. THESIS STATEMENT OF WORK

1. Scope

This thesis focuses on distinguishing the differences in communication and coordination skills between superior and good teams.[1] More specifically, how do these communication and coordination skills differ between team subordinates and TAOs on superior and good teams. The communication and coordination data was collected over the entire course of the TACT experiment, under two main conditions of stress (low & high), and over three time periods.[2] In terms of stress, this thesis seeks to distinguish how communication and coordination skills differ between superior and good teams in low versus high stress conditions, and how teams (regardless of being superior or good) differ in low versus high stress conditions.

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[1]The 12 teams used in the TACT experiment are ranked from highest to lowest based on performance. The top 4 teams are called [superior], the bottom 3 teams are called [good].

[2]Scenarios are divided into three time periods. Period 1: first 11 minutes, period 2: middle 6 minutes, and period 3: 17 minute mark until the end. Communication and coordination data is collected for each specific time period.

Regarding time periods, each period has its own operations tempo (OPTEMPO).[3] So, by analyzing how superior and good teams adapt their communication and coordination skills differently across the time periods, the thesis examines these adaptations across changing OPTEMPOs. The overall objective of the communication and coordination analysis is to determine whether subordinates, TAOs, and the team as a whole, for superior teams, develop implicit communication strategies across stresses and OPTEMPOS more than good teams. This again would imply that superior teams develop a mental model that allows them to adapt to changing environments and sustain a desired level of proficiency.

After analyzing the communication data, the thesis turns its attention toward identifying other factors that distinguish superior teams from good teams. These factors are identified by analyzing data collected from several questionnaires: background questionnaires are analyzed to determine the differences in time at sea and time in CIC between members of superior and good teams, teamwork questionnaires are evaluated to determine the differences in teamwork skills between superior and good teams, team workload questionnaires are analyzed to establish whether superior teams differ from good teams in overall workload experienced across a scenario, and finally, post-mission questionnaires are analyzed to determine team members' confidence in one another and their ability to anticipate the actions and decisions of other team members. The communication variables and team questionnaires are explained in more detail in the experimental design section.

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[3]OPTEMPO refers to the amount of workload that each period generates. Period 1 is low input workload, period 2 is increasing input workload, and period 3 is high and sustained input workload.

2. Anticipated Results

The following results were anticipated for teams that participated in the TACT experiment:

- Superior teams use implicit communication more than good teams.
- Superior teams increase their implicit communication rate more than good teams when entering high stress conditions.
- Teams will be able to anticipate each other better in high stress versus low stress conditions.
- Superior teams will adapt better than good teams to the change in operations tempo between the three time periods
- TAOs on superior teams will have more past experience in CIC than TAOs on good teams.
- Superior teams will have higher teamwork ratings than good teams.
- Superior teams and their TAOs will report a higher workload rating delta in high versus low stress conditions than good teams and their TAOs
- Superior teams will place more confidence in team members' ability to complete the mission.
- Superior teams will be able to anticipate the actions and decisions of other team members better than good teams.

These are only the main anticipated results. More specific anticipated results are discussed in the results section.

II. EXPERIMENTAL DESIGN

A. OVERVIEW

The TACT procedure is designed to train team members to adapt their coordination strategies to take account of changes in workload or stress (Entin, Serfaty, and Deckert, 1994, p.4). Teams develop these strategies by participating in several tactical scenarios. Each scenario is developed with a high-workload/ambiguity version (scenario labels 1+ & 2+) and a low-workload/ambiguity version (scenario labels 1- & 2-) (Entin, Serfaty, and Deckert, 1994, p.10). Thus, there are a total of four scenarios. It is assumed that the two high-workload scenarios (1+ & 2+) are functionally equivalent. In other words, they produce the same level of high stress for the teams. The two low-workload scenarios (1- & 2-) are also assumed to be functionally equivalent. They produce the same level of low stress for the teams. High stress scenarios differ from low stress scenarios in the total number of contacts that are introduced on the screen. High stress scenarios have a greater contact density than low stress scenarios. These pre-designed tactical scenarios are run in the DEFTT lab, which utilizes six personal computers to simulate CIC tactical displays of the scenario information.

The individuals who participate in the tactical scenarios are divided into 12 teams, each consisting of five members. The teams structure is hierarchical, four subordinate team members work together to support a TAO's decision-making process. The teams' main function is to identify, track, evaluate and disseminate information on various surface and air contacts throughout the scenario. Experimental conditions are the same for all teams for the first two runs, after that, the teams receive different training interventions. Four teams are placed in a control

group, four in TACT intervention, and four in TACT+ intervention. After receiving the intervention training, the teams are exercised through two more scenarios. Data is collected and analyzed to determine if the training interventions have any effect on a team's ability to deal with stress. More specific details are provided in the following sections.

B. SETUP

This section describes the physical setup, the subjects involved, the graders' objectives, the experimental design, and the procedures followed from start to finish for the TACT experiment.

1. Physical

The physical setup of the TACT experiment is broken down into the following categories: DEFTT lab make-up, scenario composition, and task structure.

a. DEFTT Lab

The DEFTT lab provides users the capability of simulating CIC watch stations onboard Aegis capable ships. Referring to Figure 1, there are five watch stations that make up a CIC team. Each watch station is equiped with an IBM-AT 386 personal computer that simulates one operator workstation, providing either an Aegis display system, a command and display system, or an electronic warfare supervisor display system. The six personal computers are networked to a Hewlett-Packard 9000/345 experimental control station (ECS) that generates and controls experimental scenarios, supports a multi-channel communications system, and runs a Barco graphics Large Screen Display (Green, 1994, p. 12). Each station has a headset and microphone that is used by team members to monitor internal and external communication channels (one channel per ear). Team members are capable of communicating with each other as well as the

outside world. The outside world is handled by role players who simulate positions such as:

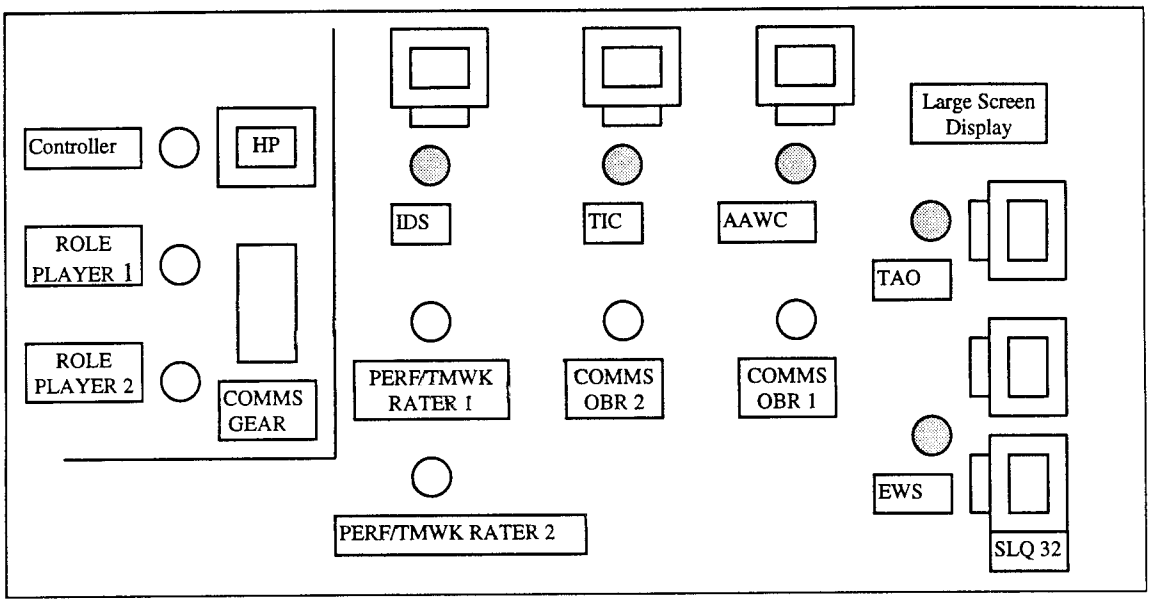

Figure 1. DEFTT Layout

Bravo Golf (battle group commander), Sea Snake (friendly SH-60 helicopter), commercial airliners, and other outside friendly, neutral or hostile forces. The DEFTT system is capable of time-stamped recording of all verbal communications among team members (Green, 1994, p. 12). A primary function of DEFTT is to execute pre-planned scenarios that provide the problem environment and tasks for the subjects (Entin, Serfaty and Deckert, 1994, p. 10).

b. Scenarios

The theater of operations for all DEFTT scenarios is the Arabian Gulf region. This region was chosen due to its realistic portrayal of high density air operations and potential for hostile developments. During an experimental run, team members are faced with various types of ambiguous situations and problems. These ambiguous situations and problems are developed over a scenario that lasts approximately 25-30 minutes. Furthermore, each scenario is divided into three periods. The first period is 11 minutes

long and involves low input workload. Teams are basically monitoring their screens and keeping track of potentially hostile situations. Period 2 is 6 minutes long and involves increasing input workload. The ambiguous situations and problems are starting to develop, and teams generally hit a peak workload level. Period 3 starts at the 17 minute mark and runs to the end of the scenario. Teams are still working to solve problems, but no new problems are introduced. The three time periods are continuous (subjects are unaware that the scenario is split into the three periods).

Most stress within a scenario is generated by attempting target deconfliction on surface and air contacts, with a strong emphasis placed on the air picture. Some of the contacts are known and some are unknown. A scenario is filled with the following types of contacts: friendly surface/air, neutral surface/air, and hostile surface/air. Specifically, the surface picture includes contacts such as: friendly US Navy ships (FFGs, CGs, and CVs), neutral ships (tankers, fishing boats), and hostile ships (Boghammers). The air picture includes such contacts as: friendly US air (F-14s, F-18s, P3s), neutral air (commercial airliners), and hostile air (Foxbats, Mirages, Forgers). Facing this type of traffic, teams are presented with several tasks.

c. *Tasks*

The teams' primary task is to distinguish the identity of each contact and assess any potential dangers that it offers. Each individual team member is responsible for identifying, evaluating, and disseminating information which allows the TAO to make decisions on courses of action. Each member is tasked with keeping track of a part of the surface or air picture. The following list identifies specific roles of each team member:

- Identification Supervisor (IDS): usually tasked with identifying and tracking surface contacts.
- Tactical Information Coordinator (TIC): usually tasked with assisting the AAWC in tracking all air contacts. He is occasionally assisted by the IDS.
- Anti-Air Warfare Coordinator (AAWC): mainly responsible for tracking and taking action on potentially hostile air contacts that propose a threat to the ship or battle group. He is often considered the TAO's right-hand man.
- Electronic Warfare Supervisor (EWS): tasked with identifying all electromagnetic signals and emitters. Is responsible for coordinating and correlating this information with other team members in order to correctly identify contacts.
- Tactical Action Officer (TAO): tasked with making decisions based on the information received from his subordinates. The TAO manages and directs the team. The TAO usually has weapons release authority from the commanding officer.

The roles and tasks just mentioned are not steadfast. It is only an example of how teams usually task their positions. At the beginning of the experiment, each team is given literature and training on the responsibilities of each position. However, freedom is left to the TAO to decide team organization. For example, some TAOs task the TIC with identifying all air and surface contacts between 0-180 degrees while tasking the IDS with identifying all air and surface contacts between 180-0 degrees, thus splitting responsibilities for both the air and surface picture between the IDS and TIC. Other TAOs task the TIC with the Surface picture and the IDS with the air picture. Some TAOs have the TIC send warnings to potential threats and some have the AAWC send the warnings. Regardless of the set-up, the main task for the team is to correctly identify all contacts, evaluate their intentions, send warnings to those that offer potential harm, and take appropriate actions on those that fall under the rules of engagement (ROE).

2. Subjects

Subjects included 59 military officers and 1 civilian. Thirty naval officers from Department Head School at the Surface Warfare Officers School (SWOS) located in Newport RI were placed into six teams, each team consisting of five members. Twenty-nine officers and one civilian from the Naval Postgraduate School located in Monterey, CA were also placed into six teams of five members. The breakdown of officers at NPS was: 14 Navy, 8 Air Force, 4 Army, and 3 Marine. All subjects, with the exception of three navy, one Marine, eight Air Force, four Army, and one civilian, have time at sea. All members selected for TAO have past experience in that position. The ranks of the sixty subjects are distributed as follows: fifty-four 0-3s, four 0-4s, one CW02, and one GS-12.

For this thesis, 7 of the 12 teams used in the TACT experiment are analyzed. The 12 teams are separated into 3 classes based on performance. Four teams are grouped at the top, five in the middle, and three at the bottom. The top four are considered the "superior" class, the middle five are considered the "very good" class, and the bottom three are considered the "good" class. The top four superior teams are compared to the bottom three good teams. The five teams in the middle class are not analyzed. Further details on class characterization of the seven teams are provided in the data description section.

3. Graders

Two active duty naval officers at NPS and two retired naval officers at SWOS were trained to use the observer's rating form (Appendix A). These officers were utilized to provide expert assessment of teamwork and performance. (Entin, Serfaty, and Deckert, 1994, p. 14) The observers were positioned to be able to view all watch stations during a scenario. Their main objective was to evaluate teams'

teamwork and performance skills as well as their overall anti-air warfare (AAW) performance. The later assessment is used by this author to distinguish between superior and good teams. Each observer was given headphones in order to monitor team communications. Also, an outline of the scenario was provided for them to follow along.

ALPHATECH analyzed the agreement between the two NPS observers and between the two SWOS observers. They found the agreements to be quite high. Coefficient alpha equaled a very respectable 0.79, which was computed to assess overall inter-judge agreement (Entin, Serfaty, and Deckert, 1994, p. 14). Coefficient alpha is the expected correlation (measure of reliability) between two tests when these tests claim to measure the same thing (Nunnally, 1967, p.197). A value of 0.0 implies that there is no agreement, a value of 1.0 implies there is perfect agreement. It was therefore decided to average the two assessment ratings at each site into one overall rating. ALPHATECH performed other analysis on the four observers. They found that NPS observers were a little more lenient in their grading of performance outcome and teamwork. Because the design counter-balances all the experimental conditions across the two sites, the difference between the judges at the two sites was assumed to have no impact on experimental assessment (Entin, Serfaty, and Deckert, 1994, p. 15).

Two psychologists were used to record CIC team communications. One observer recorded the TAO's communications and the other observer recorded the subordinate's communications. The CIC team communication recording form is found in Appendix A. These two observers were trained prior to the TACT experiment by observing video tapes of helicopter pilot communications. After approximately 16 hours of practice and discussion, the two coders (observers) attained an 85 percent agreement (Entin,

Serfaty, and Deckert, 1994, p. 15). The observers were responsible for marking all communications within a scenario. Furthermore, effort was made to code communications for each specific time period. Therefore, the observers use a fresh rating form at the beginning of each new period.

4. Statistical Design

The statistical design used for the TACT experiment is a pre-test/post-test control group design that is modeled from Campbell and Stanley's Design 4 (Entin, Serfaty, and Deckert, 1994, p.18). There are three levels of experimental condition (control, TACT, and TACT+), two levels of training intervention (pre and post), and two levels of stress (low and high). These factors are completely crossed. Figure 2 depicts the experimental design for the TACT experiment.

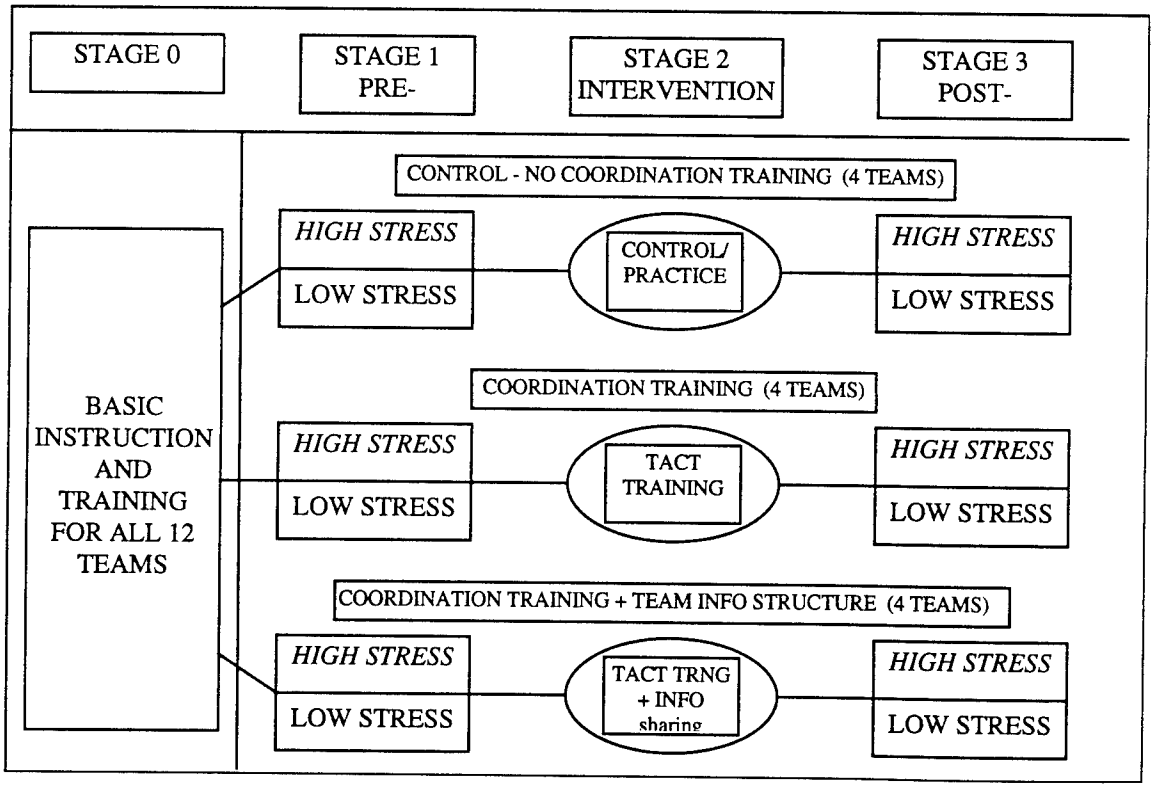

Figure 2. Experiment Design After Entin et al

The primary tool of analysis for this thesis is the analysis of variance (General linear model - unbalanced design). The reader can see that all 12 teams received initial basic instruction and training. From there, each team was run through two scenarios, one high stress and one low stress. After these two scenarios, four teams received no coordination training (control), four teams received coordination training (TACT), and four teams received coordination training plus team information structure (TACT +). The teams were then run through two more scenarios. Data was collected and the experiment concluded.

C. PROCEDURES

Prior to the start of the experiment, teams were divided into three experimental groups. Four teams were placed in the control group, four in TACT, and four in TACT+. Each of the three groups had two teams from NPS and two teams from SWOS. The experimental design was replicated at each site to control for site differences (Entin, Serfaty, and Deckert, 1994, p. 19). Before the scenarios were conducted, all 12 teams were given basic instruction. The teams received refresher instruction on the DEFTT simulator and were given briefings on each watch station's functions and roles. The instruction was performed by NAWC-TSD agents and mostly involved instructions via written briefs or large screen display presentations.

The 12 teams were then run through three practice scenarios. The first scenario involved DEFTT familiarization and basic buttonology learning. It also afforded team members the opportunity to familiarize themselves with their particular watch station roles. The second practice scenario afforded members further instruction on watch station roles. It also allowed team members the opportunity to familiarize themselves with

communication procedures and setup. The third practice scenario was used by team members to practice team building and tactics. During the three practice scenarios, NAWC-TSD agents were available to assist team members in DEFTT familiarization.

Prior to the start of the first data collection scenario, teams received mission briefs regarding goals, threats, and rules of engagement. Furthermore, TAOs were afforded the opportunity to brief their teams. The teams filled out a pre-mission questionnaire and then started the scenario. At the end of the scenario, teams filled out a post-mission questionnaire. A short break was usually given between scenarios. Prior to the start of scenario two, the teams followed the same briefing procedures given in scenario one. The scenario was conducted, and at the conclusion, post-mission questionnaires were filled out and collected. Prior to the start of scenarios three and four, the teams were given their assigned intervention training. Upon completion of the training, the last two scenarios were conducted following the same procedures presented in scenarios one and two. At the end of the last scenario, team members also filled out a background questionnaire. Pre-mission questionnaires were only filled out prior to scenario one and three. During the TACT experiment, teams were exposed to low and high stress scenarios. The presentation of low and high stress level was counter-balanced over the four trials using an "abba" or "baab" ordering (Entin, Serfaty, and Deckert, 1994, p.21). The TACT experiment for the subjects was then concluded.

D. ASSUMPTIONS

There are four basic assumptions associated with the TACT experiment. They are:

- DEFTT is a legitimate simulation of an Aegis CIC environment.
- After initial familiarization training, all teams are near the same level of competence and understanding of the functionality/buttonology of their respective watchstations.
- Observers' ratings of team performance are quantitatively consistent throughout the course of the experiment.
- Subjects are willing and enthusiastic participants.

The assumptions listed above are found in (Green, 1994, pp. 17-18).

E. MEASURES

There are several measures in the TACT experiment that are used to assess team performance. Some measures involve a team's evaluation of itself and other measures involve observer's evaluation of the team. There are seven basic data collection sheets. They are as follows:

- Teamwork and Performance Observer's Rating Form
- Overall AAW Team Performance Assessment Form
- Pre-mission Questionnaires
- Post-mission Questionnaires
- Background Questionnaires
- CIC Team Communication Recording Form for the TAO
- CIC Team Communication Recording Form for the team.

These data collection forms are found in Appendix A. All of these forms except the pre-mission questionnaire are used for analysis in this thesis.

1. Teamwork and Performance Rating Form

These forms are rated by the four observers mentioned earlier. The teamwork and performance rating form is broken down into 15 items that are used to assess team performance. The 15 items are arranged to assess six dimensions of teamwork. The dimensions are as follows:

- team orientation
- communication behavior
- monitoring behavior
- feedback behavior
- back-up behavior
- coordination behavior

Team orientation refers to the commitment team members have and exhibit to working together. Communication behavior involves the exchange of information between two or more team members in the prescribed manner, using proper terminology. Monitoring behavior refers to observing the activities and performance of other team members. Feedback behavior involves giving, seeking, and receiving information among members. Back-up behavior involves assisting the performance of other team members. Coordination behavior refers to team members executing their activities in a timely and integrated manner. (Entin, Serfaty, and Deckert, 1994, p. B-2) The first question under each of the six dimensions of teamwork is considered the "key component" question and the alternate questions under the six dimensions are considered the "supporting" questions. (Serfaty, 1994) This thesis focuses on the key components. Each team is evaluated four times, twice during pre-training and twice during post-training. Again, the author is concerned with a team's performance at a point in time and is not concerned with the training methods used to get teams

to that point. Therefore, only post-training data is evaluated.

2. Overall AAW Team Performance Assessment

The questions on these forms are also assessed by the four naval officer observers located at NPS and SWOS. This form involves 12 items that are used to assess a team's overall AAW performance. Observers rate the teams in the following categories:

- making radar detection reports
- making ESM detection reports
- identification/correlation reports
- assessment of contacts' hostile intent
- monitoring the threat
- taking appropriate action in accordance with rules of engagement (ROE)
- planning for upcoming mission
- overall performance rating for this scenario
- performance of critical events (four critical events).

Again, post-training data is analyzed for this thesis and the author uses the data collected from these forms to identify superior and good teams. The method for distinguishing superior and good teams is described in the data description section.

3. Pre-Mission Questionnaires

The pre-mission questionnaires are administered prior to and after training. The questions are designed to assess the perceived congruence among team members of the mental model of the tactical situation. (Entin, 1994) The data generated from the pre-mission questionnaires is not analyzed in this thesis.

4. Post-Mission Questionnaires

The post-mission questionnaire is filled out by team members at the end of each scenario. The questions are divided into two measuring devices. The first eight questions are used to assess a team's anticipation, confidence, and monitoring. The last six questions are comprised of Task Load Index (TLX) data that is used to measure a team's overall workload throughout each of the four scenarios. The TLX is a self-report subjective measure of workload that elicits a subject's ratings of six dimensions (mental demand, physical demand, temporal demand, performance, effort, and frustration) (Entin, Serfaty, and Deckert, 1994, p. 18).

For this thesis, question number two of the TAO's questionnaire (TAO's confidence that other team members will complete the mission) is compared to question number one of the team members questionnaire (team confidence that the TAO will complete the mission). These two questions are analyzed to assess upward and downward confidence in superior and good teams. Questions three and four are not analyzed because they are reflected in the teamwork data mentioned earlier. Question number six of the TAO's questionnaire (TAO's ability to anticipate the actions and decisions of other team members) is compared to question number five of the team's questionnaire (team's ability to anticipate the actions and decisions of the TAO). These two questions are analyzed to assess upward and downward anticipation of superior and good teams.

Finally, the TLX data is analyzed for superior and good teams. This thesis concentrates on average workload and TAO workload. Average workload involves the team as a whole (i.e., IDS, TIC, EWS, AAWC, and TAO). TAO workload is self explanatory. The six dimensions of workload are not analyzed individually. They are combined into one overall

rating for the TAO and one rating for the team. Only the two post-training questionnaires are analyzed for this thesis. Furthermore, superior teams' post-mission questionnaires are compared to those of good teams. Team questionnaires are also compared between the low and high stress conditions to establish whether stress has an effect on a subjects perception of how the scenario unfolds.

5. Background Questionnaires

Background questionnaires are filled out at the end of the last scenario by team members. This questionnaire is designed to attain important background information on the experimental subjects. Two main areas of interest are analyzed. One area involves subject's time at sea and the other involves more specific information, mainly, subject's experience in CIC. This data is analyzed to identify and examine any differences in sea time experience between superior and good teams. There are two other areas of interest that are not analyzed in this thesis, yet they deserve to be mentioned. These two areas are training schools attended and last command position. The author hoped to be able to determine whether a team's prior training had any effect on team performance. However, the data collected from these two areas is widely dispersed and a method has not been determined for correctly rating a team's score.

6. CIC Communication Recording Form

The data collected from these forms comprises the main focus of this thesis. Referring to Appendix A, the data is collected separately on the TAO and Team. The form is designed to record data on two main types of communication, communication requests and communication transfers. Requests and transfers are further broken down into:

- requests for information
- requests for action and task
- request for problem solving and planning
- transfers for information
- transfers for action and task
- transfers for problem solving and planning

The two trained psychologists mentioned earlier evaluate communication patterns on each of the four scenarios. Furthermore, they evaluate each scenario across the three time periods. Whenever a new period within a scenario commences, they start recording on a new form. The two post training forms are analyzed for this thesis.

F. UTILIZATION OF MEASURES

The main composition of this thesis involves analysis of the communication data. The author identifies how superior teams differ from good teams in their development of communication patterns, and how superior teams adapt during the three time periods as compared to good teams. An analysis of how teams change their communications structure in high versus low stress conditions is also conducted. Communication use is not the only factor that distinguishes superior teams from good teams. This thesis also concentrates on the other factors mentioned in section E. After all analysis has been concluded, the author fuses the information from all the measures together to develop a clear characterization of the differences between superior and good teams.

III. DATA DESCRIPTION

The TACT experiment data analyzed in this thesis was collected using several questionnaires and assessment forms. This section begins by describing how teams were placed into superior and good classes. Next, it identifies the communication variables used to monitor team communication performance and explains how these variables relate to one another.[4] This is followed by a description of other non-communication variables used to assess team performance.

A. POST TRAINING DATA

As explained in the experimental design section, subjects were exposed to four data collection scenarios, two pre-training and two post-training. Previous studies (Entin et al, and Green) compared the pre-training data to post-training data to analyze the effectiveness of training. This thesis focuses on distinguishing the characteristics of superior and good teams, regardless of the training techniques used to develop these characteristics; therefore, this thesis only analyzes post-training data.

B. TEAM CHARACTERIZATION

Data collected from the Overall AAW Team Performance Assessment Form (Appendix C) was used to select teams for assignment to the superior and good classes. This form, comprised of 12 questions, was used to assess team performance for several tasks and activities. These 12 questions were answered by the observers for both low and high stress scenarios, resulting in twenty-four data points for each team. These 24 data points were averaged together

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[4] The 56 communication variables are distinguished by alphanumeric identifiers (AC1 to AC56). Appendix B contains the list of communication variable identifiers.

to get an overall performance rating. The overall performance ratings for the 12 teams were ranked from highest to lowest and were examined to identify high and low clusters. The highest cluster consisted of four teams which were grouped into a class called (Superior), the lowest scoring cluster consisted of three teams which were grouped into a class called (Good).[5] Performance of the teams in these two classes is compared across several variables throughout the thesis to identify characteristics that can be used to distinguish between them.

C. COMMUNICATION DATA

The majority of the analysis in this thesis focused on the communication and coordination data, a collection of more than 56 dependent variables (Appendix B). These variables were used to measure various aspects of communication and coordination within a team. The variables were grouped into the following communication categories: total communication (any utterance spoken); direction of communication (up, down, lateral, or outward); type of communication (requests, transfers, or acknowledgments); content of communication (information, actions & tasks, or problem solving & planning); combination of direction, type, and content of communication; and anticipation ratios. The variables and categories of communication are explained in the sections that follow.

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[5] The Superior class has 4 teams and the Good class has 3 teams due to natural grouping. Four teams were distinctly separated at the top, three teams distinctly at the bottom. Adding a fourth team to the good class or removing one from the superior class would skew the data.

1. Total Communication

Communication was defined as any utterance that was spoken by a team member. Total communication (AC1) referred to the total number of utterances made by a team over the course of a scenario. Total communication rate (AC2) for a team is determined by dividing the total number of utterances in a scenario by the scenario length. For example, if 120 utterances were made in a 30 minute scenario, the total communication rate for a team would be 120/30 = 4.0 per minute. To calculate the rate for a specific period within the scenario, total utterances for the period were divided by the period length in minutes. Total communication rate for a team was broken down into TAO and subordinate communication rate (AC3 & AC4). Subordinate rates were further broken down into TIC, IDS, AAWC, and EWS rates (AC5 to AC8 respectively); this was done so individual member's communication rate could be observed.

2. Direction of Communication

To help evaluate where communications within a team were being sent, four communication directions were created: upward, lateral, downward, and outward communication (AC9 to AC12 respectively). Upward communication involved communication that was sent from the subordinates to the TAO. Lateral communication was communication between subordinates. Downward communication involved communication that was sent from the TAO to subordinates. Outward communication was communication that was sent from the TAO to the outside world (non-team members). The communication rates were determined by dividing the total number of utterances in a specific direction by the scenario length. If a team had an upward communication rate of 4.00, this meant that the team sent an average of four messages a minute to the TAO. Figure 3 depicts the communication direction layout (After Entin et al, p.30).

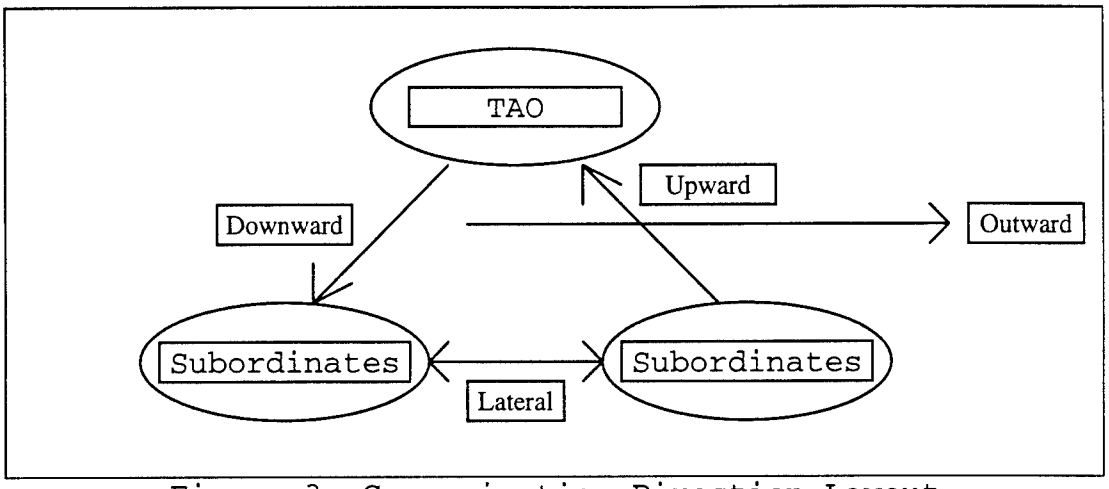


Figure 3. Communication Direction Layout
After Entin et al, p. 30

3. Type of Communication

Communications were further grouped into three main types; requests, transfers, and acknowledgments. Request communications involved team members asking others to send some type of verbal message. Transfer communications were messages sent from one team member to another, without that message being requested. Acknowledgments were verbal communications that indicated a team member had received a message (e.g., "roger", "aye-aye", "I copy", "affirmative"). Total requests, transfers, and acknowledgments were collected for each team (AC14, AC15, and AC16 respectively). Total requests, transfers, and acknowledgments were further separated into TAO and subordinate's requests, transfers, and acknowledgments (AC16 to AC21). This afforded the opportunity to observe who, within a team, was sending these types of communication.

4. Content of Communication

Communications were divided into three categories based on contents: information, actions & tasks (A&T), and problem solving and planning (PS&P). Information communications were communications that requested or relayed the specifics of an entity. For example, they might

involve: asking for a contacts speed, supplying information on a contacts arrival, or asking a member what they hold on a certain bearing. Actions and tasks were communications that invoked a member to take some type of action. They also included a member telling another that an action had been taken (e.g., "AAWC, this is TAO, take track 2531 with birds", or "TAO, this is AAWC, at 20 miles I illuminated track 2531 with fire control radar"). Problem solving and planning were communications concerned with preparation for future events. For example, the TAO may say to the AAWC, "if track 2345 gets within 20 miles of the ship, illuminate it with our fire control radar." The TAO is sending a message that plans for a future event and includes a solution to the unspoken question of what to do when the contact closes to a certain proximity. Total information, A&T, and PS&P (AC22, AC23, and AC24 respectively) frequencies were collected for each team. This information was also tallied separately for TAOs and subordinates (AC25 to AC30).

5. Combination of Direction, Type, and Content

This section describes variables that were made up of a combination of direction, type, and content. The reader should refer to the CIC Team Communication Recording Form (TAO or Team) located in Appendix A to see how the information for these variables was recorded. This section will describe the combination variables mainly by providing examples.

There were two CIC Team Communication Recording forms that were filled out during a scenario, one for the TAO and one for the team (Appendix A). These forms were completed by the two trained psychologists mentioned earlier. Whenever they heard a member communicate, they put a tally mark in the appropriate box that highlighted the specific content of the members communication. For example, suppose

the TAO sent the following message, "AAWC, this is TAO, take track 2345 with birds." The DIRECTION of the message is DOWNWARD to a subordinate, the TYPE of message is a REQUEST, and the CONTENT of the message is ACTION & TASK. Hearing this message, the recorders would put a tally mark in the (requests/action & task/AAWC) block. Some messages are counted in more than one communication variables; thus, these variables are not totally independent. For example, the message above would be counted in three different variables: total requests (AC13), total TAO requests (AC16), and total TAO request for actions & tasks (AC33). To calculate total request rate (AC13), all tally marks placed in the 18 boxes under REQUESTS, for both TAO and Team recording forms, are tabulated and divided by the scenario length. To calculate TAO request for A&Ts rate (AC33), all tally marks on the TAO recording form in the blocks (requests/action & task/TIC-IDS-AAWC-EWS-ALL-OUT) are tabulated and divided by scenario length. All other communication variables were calculated using this method. The following are examples of communications that are recorded in more than one combination variable. Looking closely, the reader will see that these messages involve direction (upward, downward, lateral, or outward), type (request, transfer, or acknowledgment), and content (information, A&T, or PS&P).

- request for information: "AAWC, this is TAO, what is the speed of track 1234?" "EWS, this is IDS, what do you have on a bearing of 270?"
- request for action & task: "AAWC, this is TAO, send a warning to track 1234." "IDS, this is TIC, help me find track 1234." acknowledgment: "roger"
- request for problem solving and planning: "IDS, this is TAO, when track 4321 gets within 20 miles of the ship, send a warning." IDS acknowledgment: "aye aye"

- transfer of information: "TAO, this is IDS, track 2341 is an Iranian F-4." TAO acknowledgment: "thanks"
- transfer of action and task: "TAO, this is AAWC, at 15 miles I sent a second warning to track 3456." TAO acknowledgment: "I copy"
- transfer of problem solving and planning: "TAO, this is AAWC, at 12 miles I will send a third warning to track 3456." TAO acknowledgment: "OK"

Figure 4 is a flow chart that depicts the relationships between the communication variables. This flow chart is based on the author's view of the communication relationships.

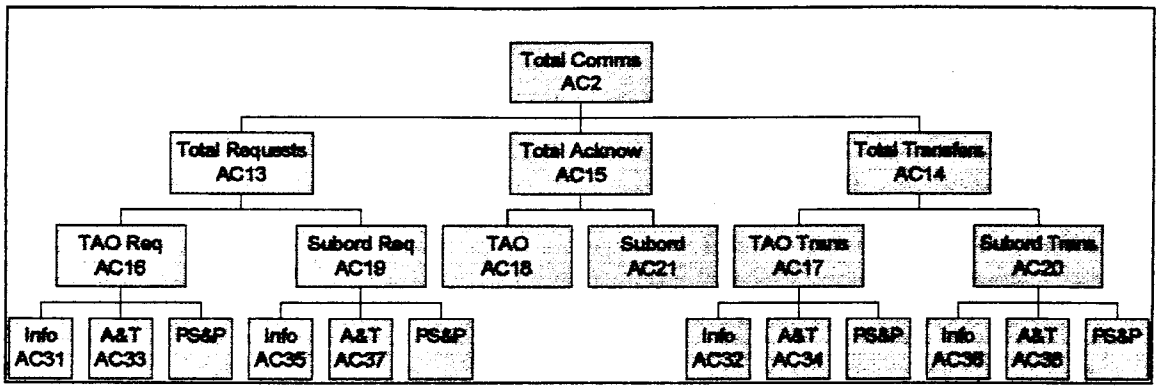


Figure 4. Communication Variable Relationship

The chart is organized in a way that is conducive to the presentation of the communications variables in the results section. Viewing the chart, a team's total communications is comprised of total requests, transfers, and acknowledgments. A team's total requests is made up of TAO requests and subordinate requests. Furthermore, a TAO's total requests is broken down into requests for information, requests for A&Ts, and requests for PS&P. The same applies for subordinate requests. Turning to total acknowledgments, these are comprised of TAO and subordinate acknowledgments. There was no need to separate acknowledgments any further. Looking at total transfers, they were made up of TAO and subordinate transfers. TAO and subordinate transfers are

made up of TAO and subordinate transfers of information, transfers of A&Ts, and transfers of PS&P. Looking closer, the chart shows TAO and subordinate requests and transfers for problem solving and planning. Actually, the TAO's requests and transfers are combined into one measure (i.e., Problem solving and planning rate of TAO, or AC27). The same applies to subordinates.

There are other ways of looking at the communication relationships. For instance, another person could split total communications into TAO and subordinate communications. TAO communications could then be broken down into TAO information communication, TAO A&T communication, and TAO PS&P communication. Each of these could be further broken down into requests and transfers. Again, this thesis looked at the relationships as presented in Figure 4 because they facilitated the presentation of results.

6. Anticipation Ratios

Anticipation ratio is the ratio of the number of transfers to X to the number of requests made by X. Hopefully, teams will have a large ratio of transfers to requests; this means that the member receiving the transfers is being anticipated by his team (i.e., the member requests little because the team anticipates his needs, and therefore transfer messages before the member has a need to request them). An anticipation ratio greater than one is interpreted to mean that a member's needs were being anticipated; this implies that the team was using implicit communications, which came about due to the development of mutual mental models. A large anticipation ratio indicated partial confirmation for mental models (Entin, Serfaty, and Deckert, 1994, p. 40).

In the results section, this thesis uses the equation mentioned above (transfers to X/requests made by X) to

establish whether teams are anticipating one another better than other teams. The mean number of transfers is simply divided by the mean number of requests to come up with an anticipation ratio. For example, if the mean number of transfers is 3.3 per minute and the mean number of requests is 2.1 per minute, the anticipation ratio would be (3.3/2.1 = 1.57). This is saying that there are 1.57 transfers for every request. ALPHATECH also had a number of variables that directly determined a teams anticipation ratio, these are identified as the anticipation variables (AC43 to AC56). The raw data generated from these variables were calculated using an equation that calculated a proportion of transfers to requests, i.e., (transfers to X)/(transfers to X + number of requests made by X). These numbers were then transformed into an anticipation ratio similar to the one mentioned above by using the equation (proportion of transfers)/(1 - proportion of transfers). This thesis uses the same equation for transforming the raw data (supplied to the author in the form of proportions) into an anticipation ratio for the anticipation variables (AC43 to AC56). For example, take the variable that measures subordinate anticipation of information to the TAO (AC53). The raw data is averaged to be 0.621, which is a proportion. This thesis transforms this number into an anticipation ratio using the equation (0.621/(1 - 0.621) = 1.63). This number is the anticipation ratio that is reported for the anticipation variables in this thesis; it is the same as the anticipation ratio first mentioned in this paragraph, for every request, there are 1.63 transfers.

D. TEAMWORK DATA

Teamwork questionnaires consisted of 15 questions that helped asses six dimensions of teamwork (Appendix A). The spreadsheet for the teamwork data is located in Appendix C. Univariate analysis of variance was used to look for significant differences in the means of each of the dependent variables due to differences between the two classes, superior and good, and between the two stress levels, low and high, and to examine the interaction between class and stress. The data coding scheme for this data is similar to that of Table 6 (Appendix C). The main difference is that teamwork data is collected per scenario, there is no way to assess this data for individual periods within a scenario.

E. POST-MISSION/TLX DATA

Post mission questionnaires (Appendix A) were filled out by team members after each scenario. These questionnaires were designed to assess a member's perception- how they felt about the team's performance. The data spreadsheet is located in Appendix C. Analysis focused on superior and good teams in two main areas; the confidence that TAOs and subordinates had in each other (questions one and two), and the ability of TAOs and subordinates to anticipate each other (questions five and six). Analysis was also conducted on the differences between TAOs on superior and good teams and between subordinates on superior and good teams.

The Task Load Index (TLX) questions were a self-report subjective measure of the workload that a member felt during a scenario. The data collected for these questions are located at the end of the post-mission questionnaire spreadsheet in Appendix C. The TLX data was analyzed for average workload and TAO workload. Average workload refers

to the team's (TAO included) average workload. TAO workload is self explanatory. Effort was placed on distinguishing the differences in workloads between teams and TAOs on superior and good teams.

F. BACKGROUND DATA

The background data questionnaires are located in Appendix A. A summary of the data collected for superior and good teams is found in Appendix D. This thesis concentrated on the amount of time TAOs and subordinates spent at sea and in CIC. These times were compared between superior and good teams. Originally, interest was placed in linking prior training to TACT performance; however, the array of training schools attended by subjects was too diversified to establish relationships.

IV. RESULTS

The dependent variables in this thesis were analyzed using Univariate analysis of variance, performed by the statistical package, MINITAB. All analysis was conducted using a significance level of α = 0.05. This quantity is the probability of rejecting the null hypothesis ($\mu_1 = \mu_2$) when the null hypothesis is actually true; and is often referred to as the Type I error rate. MINITAB computes p-values that represent the smallest value of α for which the null hypothesis can be rejected based on the observed data. When α is greater than or equal to the p-value, the null hypothesis is rejected, implying that the means of the dependent variables differ due to the relationships with the independent variables (i.e., class, stress or period). If a p-value is greater than 0.05, there is not sufficient evidence to suggest that the null hypothesis should be rejected. I.e., there is not sufficient evidence to conclude that the means of the dependent variable differ as a result of the settings of the independent variable. In this thesis, results with p-values (0.1 > p >0.05), are considered marginally significant. All significant and marginally significant results in this section are displayed with the means and p-values.

A. ANALYSIS OF TEAMWORK

This section describes the analysis of the effects of the independent variables class and stress, and the interaction of class and stress, on teamwork performance. Readers are encouraged to view the Teamwork and Performance Observer's Rating Form (Appendix A) as they follow this section. The variables, ATM1, ATM2...ATM15 refer to questions 1, 2,...15 respectively. Output for teamwork data is located in Appendix C.

1. Teamwork by Class

Results indicate that superior teams have significantly better teamwork ratings than good teams. A summary of these results for all 15 teamwork measures is shown in Table 1. Concentrating on the key component questions under each of the six dimension of teamwork (highlighted in Table 1), the following results were found:

- superior teams were oriented towards teamwork significantly better than good teams (ATM1, p = 0.000)
- superior teams communicated significantly better than good teams (ATM4, P = 0.000)
- superior teams monitored each other's behavior significantly better than good teams (ATM7, p = 0.000)
- superior teams provided significantly better feedback to one another than good teams (ATM9, p = 0.011)
- superior teams provided significantly better backup to one another than good teams (ATM10, p = 0.001)
- superior teams have significantly better coordinated behavior than good teams (ATM14, p = 0.000).

Shifting to other non-key teamwork measures, the following results were also found:

- superior teams had significantly less errors caused by inadequate team communication than good teams (ATM2, p = 0.000)
- superior teams had significantly less errors caused by improper individual actions or decisions than good teams (ATM3, p = 0.007)
- TAOs on superior teams provided significantly more tactical direction to subordinates than TAOs on good teams (ATM5, p = 0.000)

- subordinates on superior teams provided significantly more relevant tactical information to the TAO than subordinates on good teams (ATM6, p = 0.000)
- TAOs on superior teams significantly anticipated the need to provide assistance to one or more team members more than TAOs on good teams (ATM11, p = 0.002)
- subordinates on superior teams anticipated the need to provide assistance to the TAO significantly more than subordinates on good teams (ATM12, p = 0.001)

In general, there is overwhelming evidence that teams with superior performance also have better teamwork skills.

Variable key bolded	**Class**		**Stress**		**P value**	
	Superior	Good	Low	High	Class	Stress
ATM 1	5.750	2.733	4.786	4.129	0.000	0.055
ATM 2	5.325	2.233	4.414	3.586	0.000	0.004
ATM 3	5.213	2.983	4.386	4.129	0.007	0.818
ATM 4	5.887	2.567	4.671	4.257	0.000	0.088
ATM 5	5.762	2.667	4.671	4.200	0.000	0.072
ATM 6	5.588	3.267	4.843	4.343	0.000	0.044
ATM 7	5.175	2.850	4.529	3.829	0.000	0.078
ATM 8	5.500	2.933	4.629	4.171	0.000	0.264
ATM 9	4.900	2.817	4.171	3.843	0.011	0.622
ATM 10	5.150	2.967	4.443	3.986	0.001	0.341
ATM 11	5.050	2.717	4.443	3.657	0.002	0.179
ATM 12	5.300	3.267	4.843	4.014	0.001	0.074
ATM 13	5.137	2.633	4.300	3.829	0.000	0.274
ATM 14	5.925	2.783	5.029	4.129	0.000	0.000
ATM 15	5.675	2.667	4.671	4.100	0.000	0.073

Table 1. Means and P-Values for Teamwork Measures

2. Teamwork by Stress

Across stress, results show that teams generally had higher teamwork ratings in low versus high stress

conditions. For the key measures, the following results were observed for low versus high stress conditions:

- teams were oriented towards teamwork marginally more in low stress conditions (ATM1, p = 0.055)
- teams communicated marginally better in low stress conditions (ATM4, p = 0.088)
- team members monitored each other's behavior marginally more in low stress conditions (ATM7, p = 0.078)
- teams behavior was coordinated significantly better in low stress conditions (ATM14, p = 0.000)

There was no significant difference between teams' feedback and backup behavior between stress levels, although, low stress conditions still produced better ratings for teams.

For the non-key measures, there were two significant results: high stress conditions yielded more errors caused by inadequate communication (p = 0.004), and high stress conditions caused subordinates to send significantly less relevant tactical information to the TAO (p = 0.044). Overall, teamwork within a team seems to be effected by high stress conditions.

3. Teamwork by Interaction of Class and Stress

The interaction of class and stress produced only one significant finding; this occurred with the variable that measured the extent to which a team's behavior was coordinated (ATM14). Table 2 displays the means across this interaction (p = 0.007).

	LOW	HIGH
SUPERIOR	6.150	5.700
GOOD	3.533	2.033

Table 2. Means for Coordination Behavior

Viewing Figure 5, it is apparent that superior teams in both low and high stress conditions have better coordinated

behavior than good teams. Looking within teams, both superior and good teams had better coordinated behavior in low versus high stress conditions, again indicating that high stress had an effect on the team. In fact, stress effects goods teams coordination more than that of superior teams.

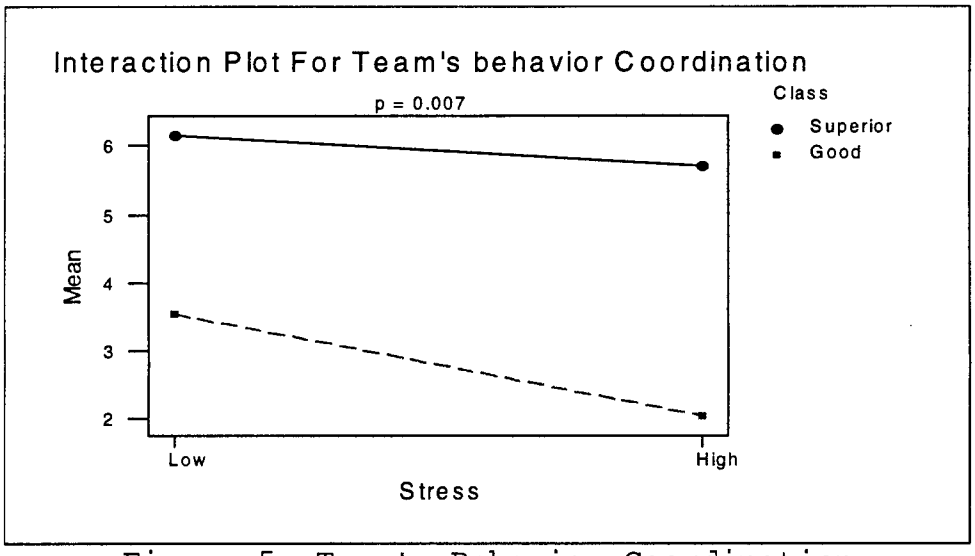


Figure 5. Team's Behavior Coordination as a Function of Class and Stress

Results similar to those above were also found for the remaining teamwork measures; however, they were not significant. The only measure that did not follow this pattern was ATM3; good teams actually had more errors in low stress conditions caused by improper individual actions or decisions. They had fewer errors in high stress conditions.

Summarizing, superior teams had significantly better teamwork ratings than good teams. The independent variable, stress, did have an overall significant effect on teamwork ratings. Individually, there were some marginal effects and some significant effects.

B. ANALYSIS OF COMMUNICATIONS

This section presents the results of the analysis of the effects on the communication variables of the

independent variables; class, stress, and period. These results were generated using Univariate analysis of variance. Further analysis using the two sample t-test and the Mann-Whitney test is presented at the end of this section. This analysis was conducted to suplement the Univariate analysis results.

1. Total Communication

Initial analysis revealed that superior teams had more communications per scenario than good teams. Superior teams average 81.46 utterances per scenario, good teams average 62.67, $p = 0.027$. Further analysis tended to contradict this finding and is provided at the end of this section. Dealing with stress, teams communicated marginally more in high versus low stress conditions (81.52 and 65.29 respectively, $p = 0.059$). Teams probably communicated more in high stress conditions because the pace of the scenario created a sense of urgency within the team and forced team members to increase their communication rates just to keep pace with the scenario. Total communication also differed significantly across periods; this was probably at least partially due to the unequal lengths of each period. Longer periods naturally had more communications because there was more time to accumulate them. For this reason, all remaining communication variables were converted into communication rates by dividing the measures by the period length in minutes.

2. Total Communication Rates

To gain a better understanding of the communication results, it is important for the reader to see how team members proportioned total communications among themselves. Figure 6 displays the total communication percentages for members of superior and good teams. Notice that in both classes, a large portion of communications within a team was performed by the TAO. The TAO was the leader of the team

and was responsible for coordinating all activities within a team. Overall, TAOs on superior teams accounted for approximately 43% of the team's total communications, TAOs on good teams accounted for approximately 35%.

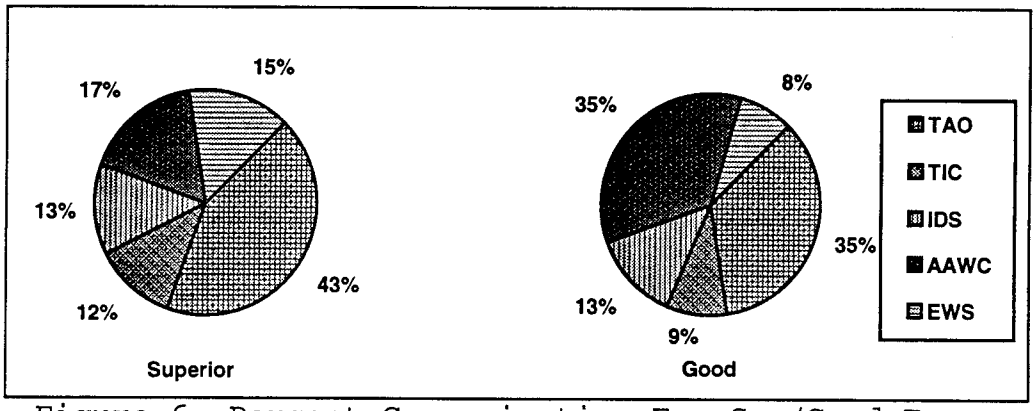


Figure 6. Percent Communication For Sup/Good Teams

Looking at total communication rates between classes, results indicated that superior teams communicated at a significantly higher rate than good teams (7.667 comms/min and 6.250 comms/min respectively, $p = 0.045$). There is also a significant finding across stress; teams in high stress conditions communicate significantly more than teams in low stress conditions (8.044 comms/min & 6.076 comms/min, $p = 0.008$). This was probably due to the fact that high stress conditions required higher rates of communication among team members (Entin, et al, p. 31). Team members probably felt obliged to communicate more in order to keep pace with the scenario and sustain their input contributions to the team. There were no findings with regards to the interactions of class, stress, and period. The following patterns did emerge though; superior teams had higher communication rates than good teams in all three time periods, and superior teams had higher communication rates than good teams in both low and high stress conditions.

As mentioned earlier, total communication rate within a team was divided into TAO communication rate (AC3) and

subordinate communication rate (AC4). There were some significant findings for these variables. TAOs on superior teams communicated at a significantly higher rate than TAOs on good teams (3.175 comms/min & 2.027 comms/min, p = 0.010). This was not the case for subordinates, there was no significant difference between communication rates for subordinates on superior and good teams. Combining these results - a significant difference in communication rate between teams (superior higher than good), a significant difference in communication rates between TAOs (superior higher than good), and no significant difference between communication rates for subordinates (almost the same) - suggests that the significant difference in TAO communication rate was mainly responsible for the significant difference in team communication rate (team = TAO + subordinates). The TAO played a major role in the make-up of team communications. Turning to stress, TAOs in high stress conditions had significantly higher communication rates than TAOs in low stress conditions (3.133 & 2.232 comms/min, p = 0.045). The same is applied to subordinates (4.909 & 3.844 comms/min, p = 0.011). There are no significant differences for TAO and subordinate communication rates across the interactions of class, stress, and period.

3. Direction of Communications

Mentioned earlier, measures were created to track where communications within a team were being sent and the rates at which they were being sent. Figure 7 displays the breakdown of communications for superior and good teams with regards to direction.

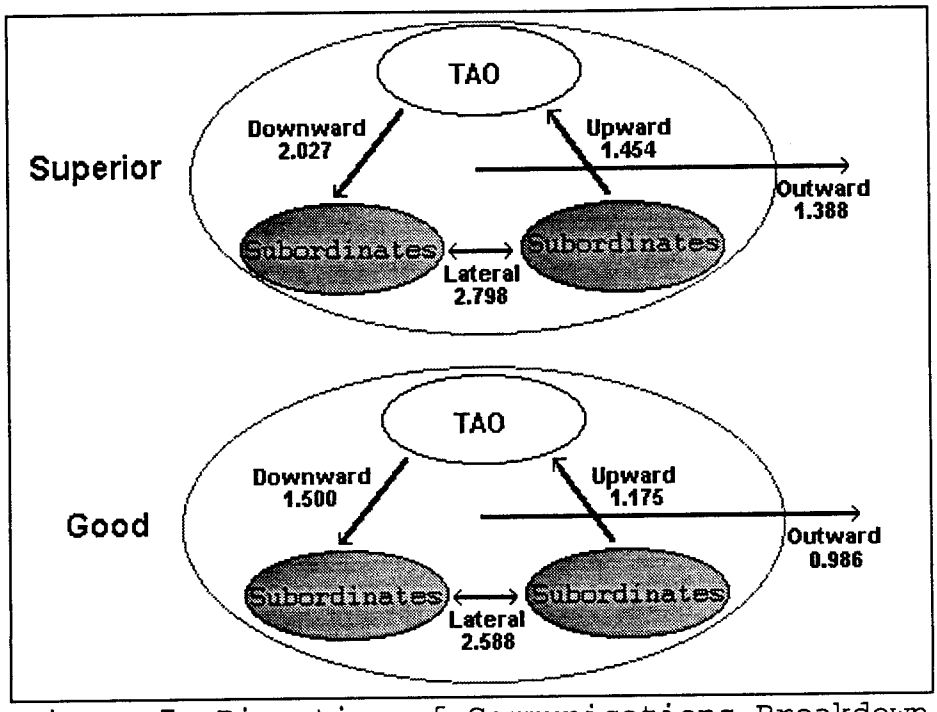


Figure 7. Direction of Communications Breakdown

Significant differences were found only in outward communications. TAOs on superior teams communicated significantly more to the outside world than TAOs on good teams (1.388 & 0.086 comms/min, $p = 0.017$), possibly suggesting that TAOs on superior teams were more aware of the responsibilities and importance of informing outside entities such as the battle group commander of the ship's current status. Another possibility is that TAOs on superior teams made time or had more time to keep the outside world informed. Outward communications were also effected by stress conditions, TAOs communicated to the outside world significantly more in high versus low stress conditions (1.520 & 0.912 comms/min, $p = 0.001$). This finding suggests that the TAOs adapted their outward communication rates to cope with the increased demands of stress. Another possible suggestion is; since high stress was created by increasing the number of contacts in the scenario, TAOs might have had more to report on,

anticipating the needs of their commanders. TAOs also significantly increased their rate of communications to the outside world across the three time periods ($p = 0.018$). Looking at the main effects plot in Figure 8, the significant difference across periods appears to be the result of the large jump in communication rate between period one and two.

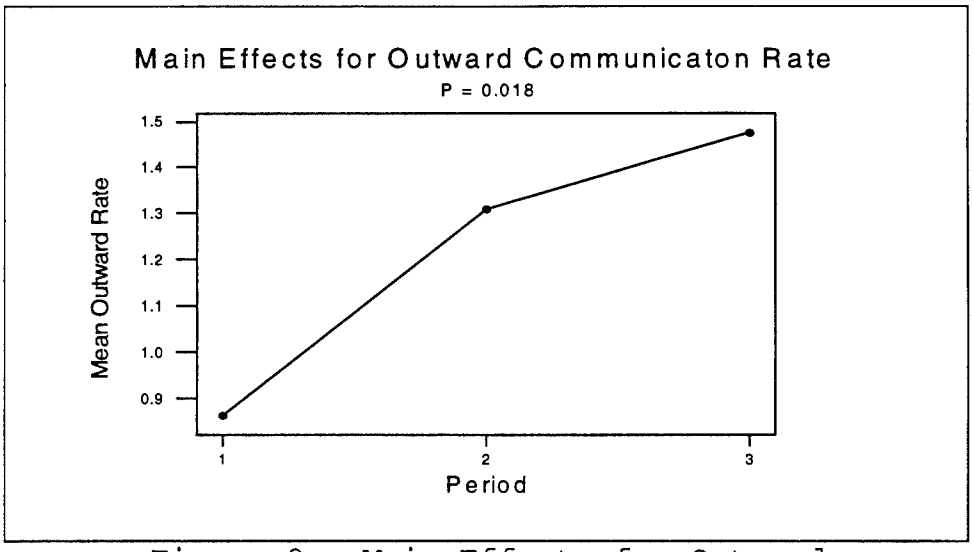


Figure 8. Main Effects for Outward Communication as a Function of Period

TAOs seemed to be adjusting their outward communication rates in order to accommodate the increased demands generated by the high OPTEMPO that developed in period 2. TAOs also increased their rates in period 3, however, the difference in the change of rate between periods 2 and 3 was smaller than the change of rate between periods 1 and 2. The only other significant finding for outward communication came in the interaction of stress by period ($p = 0.040$), Table 3 and Figure 9 display the means across this interaction. Looking at Table 3, it is apparent that TAOs communicated more in high versus low stress conditions for periods 2 and 3, but the rates were nearly the same in period 1.

	Period 1	Period 2	Period 3
Low Stress	0.857	0.877	1.000
High Stress	0.869	1.739	1.951

Table 3. Outward Means for Stress by Period

Viewing Figure 9, an interesting occurrence appeared in period 2 under the high stress condition; TAOs sharply increased their outward communication rates. This was probably due to the combination of the high stress condition and the increased OPTEMPO that period 2 generated. TAOs were probably trying to adjust their outward communication rates to meet these demands. There was also an increase in outward communication rate for period 3, however, TAOs in both high and low stress conditions had nearly the same change of rate.

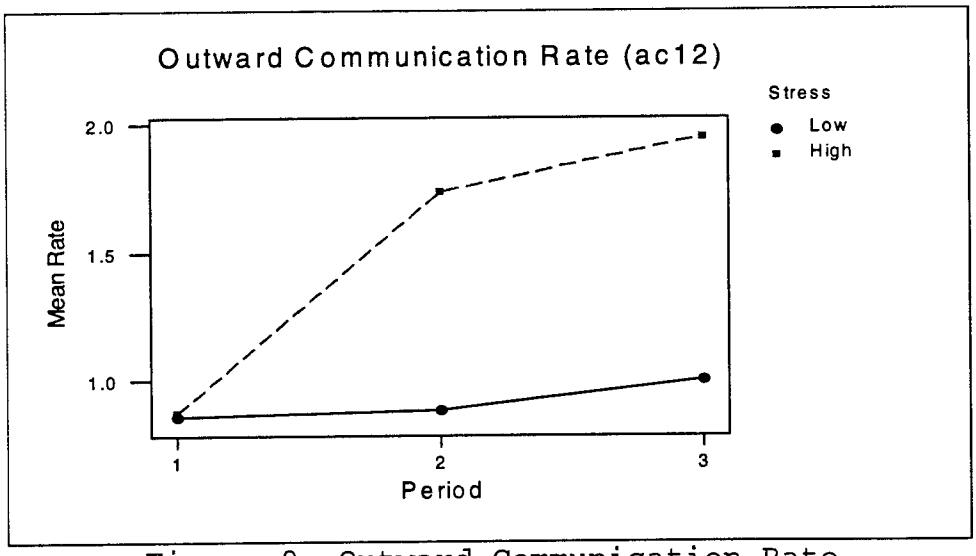


Figure 9. Outward Communication Rate as a Function of Stress and Period

Although not significant, there were some interesting patterns that develop in upward, lateral, and downward communications that warrant discussion. First, subordinates on superior teams communicated more with their TAOs than subordinates on good teams, subordinates on superior teams communicated more with each other than subordinates on good

teams, and TAOs on superior teams communicated more with subordinates than TAOs on good teams. These patterns were found to exist for each of the three time periods, TAOs and Subordinates on superior teams always had higher rates. Second, across stress, subordinates on both superior and good teams had higher upward and lateral communication rates in high versus low stress conditions, and, TAOs on both superior and good teams had higher downward communication rates in high versus low stress conditions. Figure 10 shows the last remaining significant finding. Subordinates on good

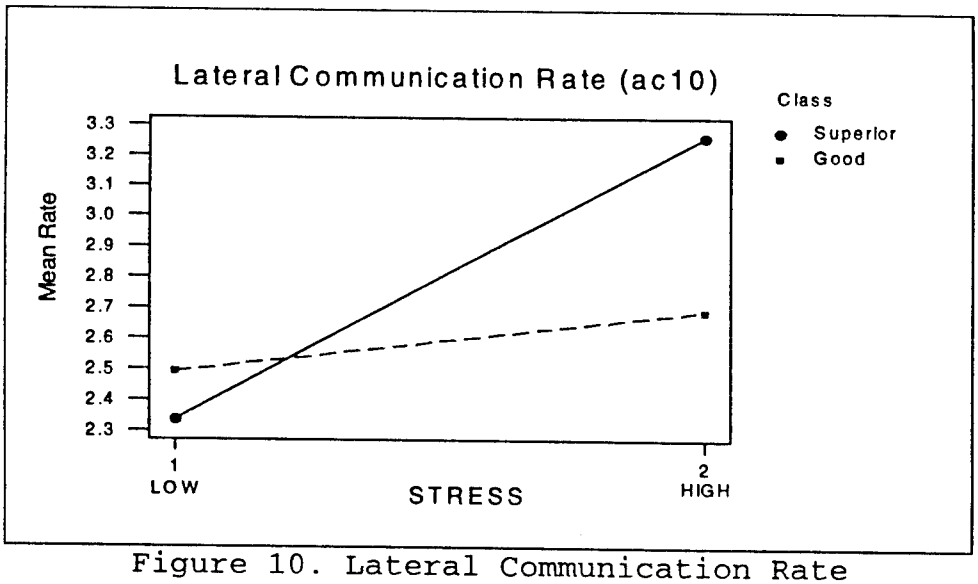


Figure 10. Lateral Communication Rate as a Function of Class and Stress

teams had higher lateral communication rates than subordinates on superior teams in low stress conditions. This role was reversed in high stress conditions, possibly suggesting that subordinates on superior teams shifted to a more adaptive strategy under high stress.

4. Type of Communication

Mentioned in the data description section, communication was categorized into total team transfers of communication and total team requests for communication.

These requests and transfers were further broken down into TAO and subordinates requests & transfers.

a. *Total Team Requests*

Two significant differences were found for total request rate; these findings came across stress, and the interaction of stress and period. Teams had significantly higher request rates in high versus low stress conditions (2.294 & 1.553 requests/min, $p = 0.002$). As stated earlier, there are more contacts on a member's display screen in high stress conditions; thus, teams might have requested more because there were more contacts to inquire about. The interaction of stress by period was also significant ($p = 0.046$). Looking at the interaction plot in Figure 11, teams in high stress conditions had higher request rates than teams in low stress conditions for periods 2 and 3. This was not the case for period 1, both stress conditions yielded almost identical rates, with high stress conditions actually having lower request rates. The significant difference in the interaction of stress and period appeared to be the result of the large jump in request rate from period 1 to period 2 for high stress conditions. This jump most likely was attributed to the high stress condition. Since teams in low stress conditions actually decreased their request rate in period two, where the OPTEMPO increased, and teams in high stress conditions increased theirs, it would appear that this difference was mainly due to the independent variable, stress, and not due to the OPTEMPO of period 2.

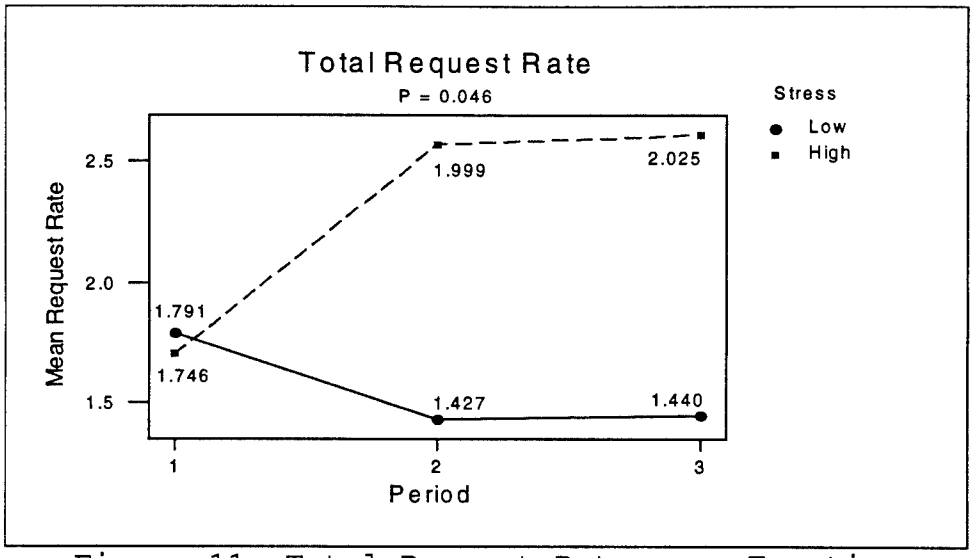


Figure 11. Total Request Rate as a Function of Stress and Period

b. *TAO and Subordinate Requests*

Findings reveal that TAOs on superior teams had marginally higher request rates than TAOs on good teams (0.992 & 0.672 requests/min, p = 0.071). Across stress, TAOs and subordinates had significantly higher request rates in high versus low stress conditions (1.080 & 0.629 requests/min, p = 0.013 for TAOs, and 1.215 & 0.924 requests/min, p = 0.011 for subordinates). An interesting occurrence appeared in subordinate request rate between superior and good teams. Subordinates on good teams actually had a significantly higher request rate than subordinates on superior teams (1.239 & 0.9421 requests/min, p = 0.013). This is important to know because TAOs on good teams had significantly lower transfer rates than TAOs on superior teams (0.779 vs. 1.236 transfers/min, p = 0.012). The implication is that subordinates on good teams are requesting more because their TAOs are transferring less. Looking at this from another view, subordinates on superior teams are requesting less because their TAOs are transferring more. Another possible reason why subordinates on good teams have significantly higher request rates is

because their TAOs have significantly lower acknowledgment rates. The implication here is that subordinates might be sending repetitive requests because their TAOs are not acknowledging these requests (Entin, 1994).

c. *Total Team Transfers*

Analysis revealed that superior teams had significantly higher transfer rates than good teams (3.633 & 3.062 transfers/min, $p = 0.042$). Superior teams were sending more messages without them being requested. This finding was expected because it implied that superior teams were probably using implicit vice explicit communications. An interesting occurrence that was noted was; superior teams had higher transfer rates than good teams, yet their request rates were almost identical. One might have expected their request rates to be significantly lower because their transfer rates were significantly higher. Within superior teams, only subordinates had significantly lower request rates as expected. Digging deeper, this was not due to subordinate transfers to subordinates, it was due to TAOs transfers to subordinates. The finding above - that superior teams had significantly higher transfer rates than good teams - is therefore actually due to TAO transfers and not subordinate transfers. Another interesting occurrence was that TAOs on superior teams had higher request rates than TAOs on good teams, despite the fact that subordinates in both classes had almost identical transfer rates to their TAOs. In other words, TAOs on superior teams requested more, even though the same amount was transferred to them. This might suggest that these TAOs were aware of other important information that TAOs on good teams did not recognize. For example, TAOs on good teams might have asked for the bearing and range of a contact that was threatening the ship. TAOs on superior teams would have taken this a couple of steps further, requesting more information about

the same contact. TAOs on superior teams might at first have asked for the bearing and range of the contact, but this would be followed by further requests for track history, possible emitters, altitude, IFF codes, and status of CAP. The TAO on the superior team was much more aware of the information needed to develop a picture of the current situation. Turning to the effects of stress on transfers, stress also had a significant effect on a team's transfer rate; teams in high stress conditions had significantly higher transfer rates than teams in low stress conditions (3.831 & 2.945 transfer/min, $p = 0.003$). This again possibly suggests that the nature of the high stress condition is forcing teams to communicate more. There were no other significant findings for total transfers, however, the following patterns did emerge: superior teams had higher transfer rates than good teams in both low and high stress conditions; and, superior teams had higher transfers rates than good teams in all three time periods.

d. *TAO and Subordinate Transfers*

Findings show that TAOs on superior teams have significantly higher transfer rates than TAOs on good teams (1.236 & 0.779 transfers/min, $p = 0.012$). There is also a significant difference across the time periods ($p = 0.034$). Figure 12 displays the main effects plot for TAO transfer rate across the three time periods. Notice the large jump in TAO transfer rate from period 1 to period 2. This again is probably due to the increased OPTEMPO in period 2. TAOs, recognizing this change in OPTEMPO, probably feel obliged to transfer as much information to their team as possible in order to keep them informed. They also might be changing their transfer rate to a more adaptive strategy in order to cope with the pace of period 2. Although not significant, an interesting pattern is, TAOs on superior teams have

higher transfer rates than TAOs on good teams across all three time periods.

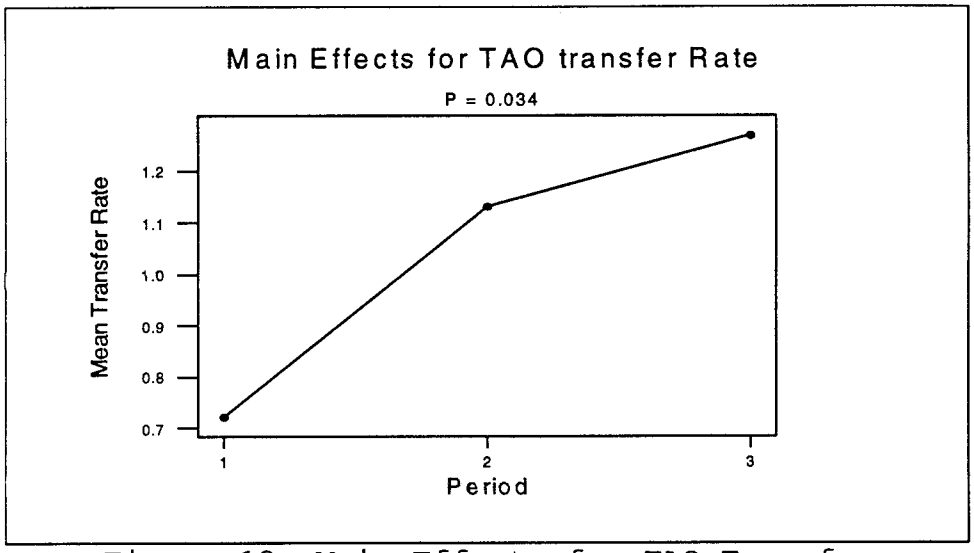


Figure 12. Main Effects for TAO Transfer Rate as a Function of Period

Turning to subordinate transfers rates, the only significant finding came with stress. Subordinates in high stress conditions had higher transfer rates than subordinates in low stress conditions (2.631 & 2.063 transfer/min, p = 0.005).

e. *Total Acknowledgments*

There was only one significant finding for total acknowledgments; superior teams had significantly higher acknowledgment rates than good teams (2.102 & 1.278 acknowledgments/min, p = 0.013). Breaking this down, TAOs on superior teams had significantly higher acknowledgment rates than TAOs on good teams (0.947 vs. 0.575 acknow/min, p = 0.031) and subordinates on superior teams had marginally higher rates than subordinates on good teams 1.154 vs. 0.704 acknow/min, p = 0.089, t-test p = 0.054) Reviewing other findings, it was stated that subordinates on superior teams had almost the same rate of transfers as subordinates on good teams. Since TAOs on superior teams had significantly

higher acknowledgments, despite no difference in subordinate transfers, this would imply that they were acknowledging more than TAOs on good teams because they simply understand the importance of responding to a message (i.e., letting the other members know the message had been received so it doesn't have to be sent again). Subordinates on superior teams have marginally more acknowledgments than subordinates on good teams probably because their TAOs are transferring significantly more.

5. Combination of Direction, Type, and Content

Recapping earlier discussion, TAO and Subordinate requests and transfers were broken down into requests and transfers of information, actions and tasks, and problem solving and planning. There was a significant difference between classes for TAO requests of information; TAOs on superior teams had significantly higher information request rates than TAOs on good teams (0.505 & 0.2283 requests/min, $p = 0.015$). One would thus expect subordinate transfers of information to the TAO to be lower for subordinates on superior teams (the lack of transfers is causing the TAO to request more). This expectation did not occur, subordinates on superior teams actually had slightly higher transfer rates to the TAO than subordinates on good teams, yet the TAO was still requesting more information. This seems to imply that TAOs on superior teams requested more specific types of information than TAOs on good teams (i.e., they knew exactly what information was necessary to deal with the current situation, possibly, TAOs on good teams did not). There were no significant differences in information request rates for the subordinates; subordinates on superior teams requested information from their TAOs and subordinates at only slightly higher rates. With regards to actions and tasks, there were no real differences between TAO request rates for superior and good teams. An interesting finding

came with subordinate action and task request rates from subordinates. Subordinates on good teams had significantly higher request rates for A&Ts than subordinates on superior teams (0.452 & 0.172 requests/min, $p = 0.001$). This implies that subordinates on good teams were continually sending A&T messages to other team members. For example, subordinates on good teams had to repeatedly send messages such as "IDS, this is AAWC, send a warning to track 1234." If these subordinates had followed the TAOs orders at the beginning of the scenario, they would have automatically sent warnings when contacts approached a range of 25 miles from the ship, a second warning at 15 miles, and a third warning at 10 miles. Good teams would have had to request (remind others) to send warnings on three separate occasions, superior teams would have no requests to send out warnings because they acted on the TAOs initial orders.

There were only three other significant findings for the combination variables, other than the ones mentioned above. There was a significant interaction between class and stress for subordinate A&T requests from the TAO ($p = 0.022$), a significant interaction between class and period for subordinate information request rate from subordinates ($p = 0.012$), and a significant difference across periods for subordinate A&T transfers to subordinates ($p = 0.014$). Figure 13 displays the mean A&T rates for subordinates across the interaction of class and stress. In this interaction, it is interesting to note that in low stress conditions, subordinates on good teams had lower request rates for A&Ts to their TAOs than subordinates on superior teams. What is even more interesting is that subordinates on superior teams decrease their request rate to the TAO in high stress conditions, while subordinates on good teams increase theirs to the point where they have higher request rates than superior team subordinates in high stress

conditions. There are two possible reasons for this. First, in high stress conditions, TAOs on superior teams might be adapting their strategy to the increased level of stress, thus increasing their actions and tasks to meet stress demands.

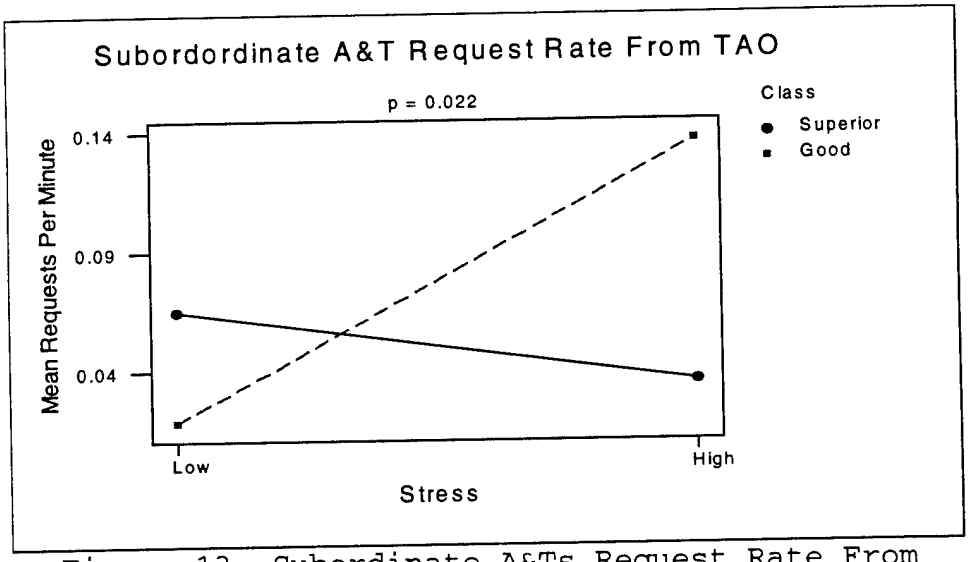


Figure 13. Subordinate A&Ts Request Rate From Subordinates as a Function of Class & Period

Second, it is possible that TAOs on superior teams are simply sending more A&T transfers to subordinates in high stress conditions (i.e., telling them that he has taken an action or has performed a task). Subordinates on superior teams therefore do not need to send as many A&T requests. In fact, TAOs on superior teams do have marginally higher A&T transfer rates than TAOs on good teams (0.019 & 0.000 transfer/min, $p = 0.087$). Conducting further analysis, the two sample t-test confirms that this finding is very close to being significant, $p = 0.051$. Looking to see if TAOs on superior teams actually increase these A&Ts transfers during high stress conditions, they in fact do, however, this finding is not significant.

Turning to subordinate information request rates from subordinates, Figure 14 displays the mean request rates for

teams across the three time periods. The significant difference between the means across the interaction of class and period seems to be the result of the large difference between the two classes in period 2. This result is opposite of the one expected; we would have expected subordinates of superior teams to have lowered their request rates in the high paced conditions of period two, hoping that their subordinate transfers to subordinates increased.

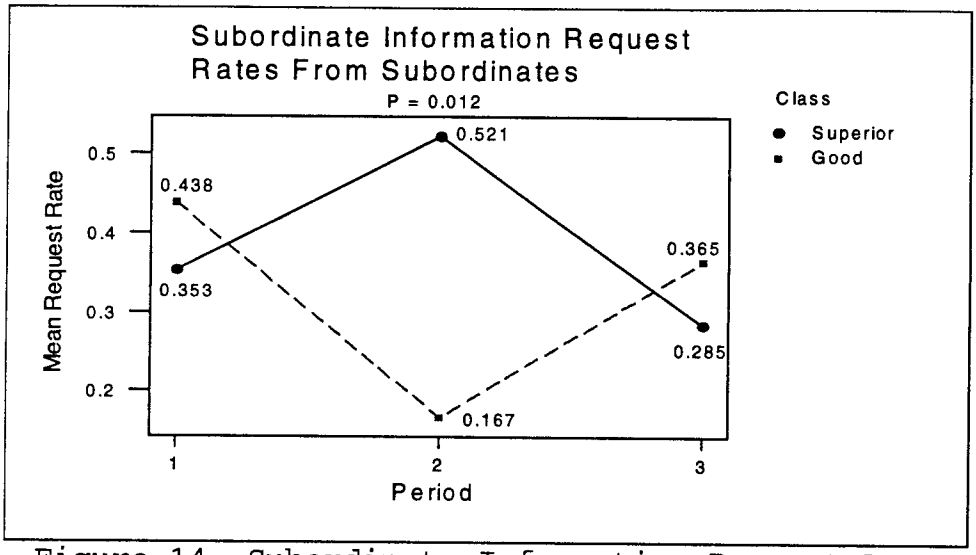


Figure 14. Subordinate Information Request Rate From Subordinates as a Function of Class and Period

This would have indicated that subordinates were adapting to the high OPTEMPO of period two and were possibly shifting their communication strategies from explicit to implicit communications. Contrary to expectations, subordinates on superior teams actually decreased their transfers in period 2 (yet still remained higher than their good team counterparts). The question of why the requests rates are so high still remains. As explained with the TAO, one possible suggestion is that subordinates on superior teams are just more knowledgeable about the information that is necessary to develop a picture of the situation, thus, they might have asked for more specific information spread over several requests.

Shifting attention to Subordinate A&T transfers to subordinates, the significant difference between the periods seemed to come at period 2 again. Both teams' subordinates reduced their transfers in this period, actually to the point where no transfers where recorded. We would have hoped to see subordinates on superior teams increase their A&T transfer rates in this busy period, indicating that they were telling other members that they had completed an action or task.

6. Anticipation Ratios

The anticipation ratios are another way to determine whether teams are using explicit versus implicit communications. There were several significant results in the anticipation ratios. These results are described in this section.

a. *Transfers vs. Requests*

One particularly important result was based on all transfers versus all requests made in a team. Superior teams had a marginally higher anticipation ratio than good teams (1.97 & 1.65, $p = 0.099$). This means that over all communications, superior teams sent a higher ratio of transfers to requests than good teams, indicating more use of implicit communications. With regards to the interaction of class by period, superior teams had a much higher anticipation ratio than good teams in periods 1 and 3 as expected (2.39 Vs 0.531 & 1.88 Vs 1.72 respectively, $p = 0.050$). This expectation did not hold for period two, good teams had a higher ratio of transfers to requests than superior teams (1.91 Vs 1.73). In period 2, where the OPTEMPO was high, we expected superior teams to transfer more messages (which they did), yet they also requested more. The unexpected ratio of transfers to requests for period 2 is thus deceiving at first. Another significant finding was found in the interaction of stress and class, p

= 0.036. It was assumed that both stresses would have increased anticipation ratios as teams traversed across the three time periods. This only occurred for low stress conditions; teams had anticipation ratios of 1.674, 2.003, and 2.289 respectively across the three time periods. Teams in high stress conditions had ratios of 2.086, 1.632, and 1.445. These anticipation ratios actually dropped across the time periods and were lower than the low stress ratios in periods two and three. We would have hoped that teams had high ratios in high versus low stress conditions, meaning that they were adapting to the change in stress. To see why these results occurred, a deeper look into TAO and subordinate anticipation ratios is needed.

b. *Transfer vs Request for TAOs and Subordinates*

Regarding transfers versus requests for the TAO, there was a significant difference in the anticipation ratios across the interaction of class and period. TAOs on superior teams had higher ratios than TAOs on good teams in periods 1 and 3 (1.310 vs. 0.531 & 1.525 vs. 1.48 respectively, p = 0.025). In period 2 again, TAOs on good teams had a higher ratio than TAOs on superior teams (1.532 Vs 1.041). It was expected that TAOs on superior teams would have higher ratios in period 2. Inspection of the information and A&T anticipation ratios will explain these results in the next section.

Referring to subordinates, subordinates on superior teams did have a significantly higher anticipation ratio than subordinates on good teams (2.546 Vs 1.915, p = 0.028). This finding was contrasted by the t- test and is discussed later in this chapter. With regards to the interaction of stress by period, similar results to that of a team's total transfer to request ratio was found. Refer to Appendix I to compare these results. Again, subordinates increased their ratios across the periods for low stress

conditions, yet decreased them in high stress conditions. To understand these findings, inspection of TAOs and Subordinates transfer Vs request ratios for information and A&T is necessary.

c. *Information and Action & Task Ratios*

There is an unexpected finding for TAO information transfers Vs requests anticipation ratio; TAOs on good teams had a higher ratio than TAOs on superior teams (2.356 Vs 0.842, $p = 0.002$). Also, across the interaction of class by period, TAOs on good teams had higher ratios in periods 2 and 3, $p = 0.001$. This implied that TAOs on good teams had a larger ratio of transfers to requests than TAOs on superior teams, thus indicating that they were using implicit communications while TAOs on superior teams are using explicit communications. This result so far is unexpected. Digging deeper, there is a reason for this unexpected result. In previous sections, it was stated that TAOs in both classes had almost identical transfer of information rates (0.495 & 0.494 transfers/min). Looking at request rates, TAOs on superior teams had significantly more information requests than TAOs on good teams (0.505 & 0.228 requests/min, $p = 0.015$). Combining these two results, it can be easily seen why TAOs on good teams have a higher Transfer to Request ratio than TAOs on superior teams; TAOs on superior teams had more requests in the denominator of the equation and had the same amount of transfers in the numerator, which makes their transfer to request ratio smaller. It was also stated earlier that they had more information requests because they probably knew more specific questions to ask about the situation. They didn't request more because their subordinates transferred less, in fact, their subordinates transferred more (not significant though). Looking at actions and tasks, there was only a marginal difference in TAO A&T transfer Vs request ratios

between classes, p = 0.093. TAOs on good teams had slightly higher ratios, however, it was hard to compare the two classes because TAOs on good teams had 0.00 requests for A&Ts.

There was no significant difference between superior and good teams for subordinate information transfers Vs request to the TAO. We would have liked to see subordinates on superior teams have a higher ratio, indicating that they were transferring much more than they were requesting. Actually, subordinates on superior teams had more transfers and requests to the TAO, yet the ratio of transfer to requests came out the same. An anticipation ratio for A&T transfer Vs request for subordinates to the TAO could be computed, however, the ANOVA could not be performed due to a rank deficiency in the ANOVA test; the column containing the data had many zero values or missing data. There is a significant finding across the interaction of class and period for subordinate to subordinate information transfers Vs request ratio, p = 0.008. The interaction graph in Appendix I shows subordinates on good teams having a higher anticipation ratio than subordinates on superior teams in period 2, thus implying that they might be adapting to the high OPTEMPO of period two better than superior teams. This finding is deceiving though. Looking at the graph for subordinate to subordinate information transfers, superior teams, as expected, had high transfer rates than good teams. This implied that they were sending more information without it having to be prompted by others. Having a higher transfer rate, theory suggests that the request rates would therefore be lower (i.e., no need to ask for information when it is already being transferred without request). Despite this theory, superior teams still have higher request rates than good teams, possibly suggesting again that they know more specific information to request

than good teams. Therefore, the reason the anticipation ratio is higher in period 2 for good teams is because they merely have a higher proportion of transfers to requests, even though superior teams have more transfers and more requests.

The only other significant finding came in the ratio of team information transfers to the TAO Vs information requests of the team from the TAO. Results indicate that good teams anticipated their TAOs better than superior teams (3.425 Vs 1.695). This finding was the opposite of what was expected, however, this was again due to the unusual amount of requests by the TAOs on superior teams. Again, subordinates on superior teams still transferred more than subordinates on good teams, but the TAOs also requested more despite more transfers.

C. TWO SAMPLE T-TEST

This section focuses on the communication measures that were analyzed using Univariate analysis of variance. Univariate analysis of variance assumes that the variances within the communication measures are equal. The two sample t-test need not assume that the variances are equal. It was performed on all two level measures to further confirm or contradict the initial ANOVA results. The following results were found.

It was stated that superior teams had significantly more total communications (utterances) than good team, $p = 0.027$. The t-test concluded that there was only a marginal difference in total communications between superior and good teams, $p = 0.068$. With regards to lateral communications across stress, the t-test concluded that teams had a slightly higher significant difference in high versus low stress conditions, $p = 0.054$ as compared to the initial finding of $p = 0.091$. Total TAO requests were also found to

have a slightly higher difference between superior and good teams, p = 0.055 as compared to initial findings of p = 0.071. Initial analysis revealed that subordinates on superior teams only had a marginally significantly higher rate of acknowledgments than subordinates on good teams. It was expected that they would have significantly higher acknowledgment rates because their TAOs had a significantly higher transfer rates. The t-test actually supported this expectation, p = 0.054 as compared to p = 0.089, which is fairly closer to the expected significant difference. The two sample t-test also strengthens the expectations that TAOs on superior teams will send significantly higher rates of action and task transfers to their subordinates. Initial findings revealed a marginally higher transfer rate (p = 0.087), t-test findings revealed a fairly significant difference in the rate of A&T transfers (p = 0.051). Subordinate action and task transfers to the TAO across the stress conditions revealed that subordinates had significantly higher transfer rates in high stress conditions, which confirms the expectation that high stress conditions cause a team to communicate more than low stress conditions. The same applied for subordinate information transfer rates to subordinates; they were found to have a marginally higher transfer rate in high versus low stress conditions, as opposed to no significant difference in initial ANOVA analysis.

D. ANALYSIS OF POST-MISSION DATA

Analysis revealed that there was no significant difference between TAOs and subordinates confidence in each other for superior teams. Comparing the confidence levels for good teams, the same result applied. Comparing TAOs, there was no significant difference between TAOs on superior teams and TAOs on good teams when it came to their

confidence in the team. When comparing subordinates, subordinates on superior teams had significantly more confidence in their TAOs than subordinates on good teams (6.281 & 5.795, p = 0.042).

There were several significant differences across the independent variable, stress. Subordinates on superior teams felt they were able to anticipate the actions and decisions of TAOs significantly more in low versus high stress conditions (5.875 & 5.593, p = 0.023). The same applies to subordinates on good teams (5.800 & 4.875, p = 0.046).

E. ANALYSIS OF WORKLOAD DATA

Analysis revealed that workload for TAOs on superior teams did not significantly differ from workload for TAOs on good teams. Looking at the team as a whole (i.e., TAO included), superior teams did not significantly differ from good teams when it came to workload experienced. There is a significant finding for workload experienced by subordinates. Subordinates on superior teams experienced a higher workload than subordinates on good teams (9.625 & 8.576, p= 0.054). This finding is interesting because it suggests that subordinates on superior teams are experiencing a higher workload demand, yet they are still communicating and performing their jobs better than subordinates on good teams. They are able to adapt to the higher workload placed upon them and still sustain better performance.

There was a significant difference between workload rating across the stress levels for TAOs, Teams, and subordinates. TAOs experienced a significantly higher workload in high versus low stress scenarios (13.634 & 9.361, p = 0.000), teams had a significantly higher workload in high versus low stress conditions (10.902 & 8.263, p =

0.000), and subordinates teams had significantly higher workloads in high versus low stress conditions (10.265 & 8.048, p = 0.000). This seems to confirm that the levels of stress did have an effect on teams perception of the amount of work they were doing.

F. ANALYSIS OF BACKGROUND DATA

The two items that were analyzed from the background questionnaires were team members' time at sea and time in CIC. These were analyzed to establish whether there was a link between time spent on a ship and a team's performance ratings in this experiment. The following results were expected: TAOs on superior teams would have more time at sea, TAOs on superior team would have more time in CIC, and Subordinates on superior teams would have more time at sea. Looking at Table 4, only the TAOs time in CIC seemed to favor superior teams. (further analysis denies this confirmation).

	SEA		CIC	
	Superior	**Good**	**Superior**	**Good**
TAOs	36.25	40.00	18.25	8.66
SUBORDINATES	31.20	52.8	Missing Data	

Table 4. TAO & Subordinate Time at Sea and Time in CIC (Months)

Inspecting these results even further, there were no significant differences between superior and good teams for any of the measures; both analysis of variance and the two sample t-test suggested that there was not sufficient evidence to conclude that the times at sea and times in CIC differed significantly between TAOs or subordinates on superior and good teams. By general inspection, it would appear that TAOs on superior teams had significantly more time in CIC than TAOs on good teams (18.25 months compared to 8.66 months). Also, it would appear that subordinates on

good teams had significantly more time at sea than subordinates on superior teams (52.80 months compared to 31.20 months). Scatter plots were run to inspect why these significant differences did not appear. Figure 15 shows scatter plots for TAOs time in CIC and subordinates time at sea. The middle five teams (classified as very good) were added to this plot for the sake of comparison.

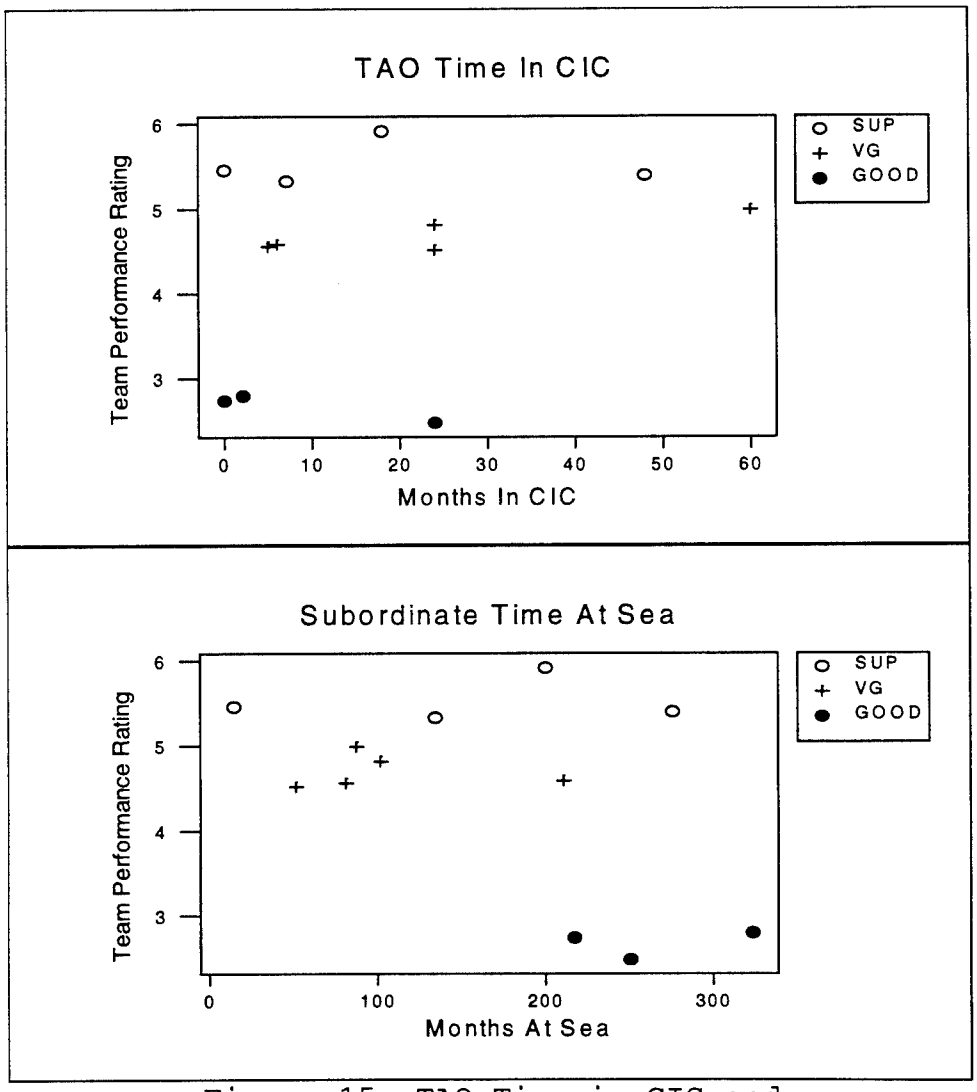


Figure 15. TAO Time in CIC and Subordinate Time at Sea

The reader will notice that for TAO time at sea, superior, very good, and good teams' TAOs had a fairly tight grouping

between 0-30 months. There was one TAO on the superior team that had much more time in CIC than any other TAOs; this TAO was responsible for skewing the average of the superior teams' TAOs, thus making it appear that TAOs on superior teams had more average time in CIC. Looking at subordinate time at sea, subordinates on good teams seem to have much more average time at sea than subordinates on superior teams. There is one subordinate team in the superior class that had almost no time at sea, and this skewed superior classes' average to the left. Furthermore, superior teams were quite diversified in their average time spent at sea.

V. DISCUSSION

This chapter reviews the findings presented in Chapter IV, RESULTS and attempts to group or summarize the characteristics that distinguish superior teams from good teams with regards to the TACT experiment. It also discusses some of the results in more detail, with a deeper look into the differences between teams across the independent variable, period. The results are presented in the following format; expected results, actual results, explanation of results. As a refresher, teams were selected for the superior and good classes based on their AAW team performance assessments. Once these teams were identified, this thesis sought to determine whether superior and good teams performed differently across several potential team characterizing variables. In addition, it attempted to establish whether superior teams use better explicit and implicit communication strategies.

A. DISTINGUISHED CHARACTERISTICS BETWEEN CLASSES

1. Teamwork Ratings

Analysis of the teamwork results came out as expected.

- Expected result: superior teams will have better teamwork ratings than good teams.
- Actual result: superior teams had significantly better teamwork ratings than good teams.

Specifically, superior teams had significantly better team orientation ($p = 0.000$), significantly better communication behavior ($p = 0.000$), significantly better monitoring behavior ($p = 0.000$), significantly better feedback behavior ($p = 0.011$), significantly better backup behavior ($p = 0.011$), and significantly better coordination behavior ($p = 0.000$). Past studies, such as the one conducted by Stout, Cannon-Bowers, Salas, and Morgan (1990), found that teams

that had higher performance ratings tended to receive higher coordination ratings (Rouse, Cannon-Bowers, and Salas, 1992, p.1298). This seems to concur with the findings above.

2. Communication Variables

As a refresher, communications were measured in rates, specifically, communication per minute. This was calculated by tallying the total number of communications in a period and dividing this total by the length of the period in minutes. Communication rates were identified for both classes of teams, superior and good. These rates were also identified for members within the classes, specifically, the TAO and his subordinates. Team, TAO, and subordinate communication rates were further broken down into communication requests and communication transfers. Requests and transfers were further broken down into requests and transfers for information, actions & tasks, and problem solving and planning.

The primary expectation was that superior teams would develop better mental models than good teams. For this to occur, superior teams should use more implicit communication than good teams, implying that they transfer more information (without a request for it) and request less information than good teams. This leads to the following:

- Expected results: superior teams should have higher communication transfer rates and lower communication request rates than good teams.
- Actual results: superior teams had significantly higher transfer rates ($p = 0.042$), yet almost identical request rates.

Half of the expectation above was confirmed; superior teams do indeed have higher transfer rates. This finding would indicate that superior teams were anticipating the needs of others more than good teams. It was expected that if the transfer rates were higher, the request rates would be lower (i.e., one does not need to request information if it is

already being transferred). To see why superior teams did not have lower request rates (despite higher transfer rates), analysis of TAO and subordinate communication was necessary to see who was doing the transferring and requesting. This leads to the following:

- Expected results: TAOs on superior teams should have higher transfer rates to subordinates than TAOs on good teams, thus causing lower requests rates for subordinates on superior teams.
- Actual results: TAOs on superior teams have significantly higher transfer rates to subordinates than TAOs on good teams ($p = 0.012$). Subordinates on superior teams have significantly lower request rates than subordinates on good teams ($p = 0.013$).

Up until this point, it is established that superior teams have higher transfer rates than good teams as expected, and their TAOs also have higher transfer rates as expected. The results directly above show that subordinates on superior teams have significantly lower request rates than subordinates on good teams (as expected), yet, the team as a whole (TAO + subordinates) does not have lower request rates. This leads to the implication that TAOs on superior teams must have higher request rates than TAOs on good teams, thus keeping the overall team request rate for superior teams from being lower than good teams as one would expect. Examining this implication, the following is found:

- Expected results: TAOs on superior teams should have lower request rates to subordinates than TAOs on good teams.
- Actual results: TAOs on superior teams have marginally significantly higher request rates to subordinates than TAOs on good teams ($p = 0.055$).

So in fact, it does appear that TAOs on superior teams are responsible for keeping the team's average request rate from being lower than good teams'. As suggested earlier, TAOs on superior teams may be requesting more because they are more

aware of the specific information that is necessary to create a better picture of the developing scenario. They might be searching for answers to the specific information by sending out more requests.

Up to this point, it is suggested that higher TAO transfer rates to subordinates on superior teams is partially responsible for keeping their subordinates' request rates lower than those on good teams. To examine whether subordinates also played a role in keeping subordinate request rates low, it was necessary to look at types of transfers and requests (information, A&Ts, and PS&P). This was also done for the TAO transfers. The following was found:

- Expected results: subordinates and TAOs on superior teams should have higher transfer rates of information and A&Ts to other subordinates than those on good teams.
- Actual results: There was no significant differences between the two classes for subordinate transfer rates to subordinates. No significant difference between classes for TAO information transfer rate to subordinates. A marginally significantly higher A&T transfer rate to subordinates for TAOs on superior teams.
- Expected results: subordinates on superior teams should have lower information and A&T request rates to other subordinates and the TAO than subordinates on good teams.
- Actual results: No significant difference between classes for subordinate information request rates to other subordinates or the TAO. No significant difference between classes for subordinate A&T request rate to the TAO. A significantly higher A&T request rate to other subordinates on good teams ($p = 0.001$).

Since subordinates on superior teams had significantly lower overall request rates and the only significant finding between superior and good teams' subordinates came with subordinate A&T request rate from other subordinates, the

latter was probably responsible for the significant difference in overall request rates for superior teams' subordinates. As stated in Chapter IV, RESULTS, this finding also suggests that subordinates on good teams were constantly reminding other subordinates to take actions and perform tasks, even in light of the TAO specifically ordering these A&Ts at the beginning of the scenario.

There were other ways to determine communication characteristics of superior and good teams. This was done using the anticipation ratios discussed in Chapter IV. With regards to the differences between classes, three significant findings were revealed. Subordinates on superior teams had a significantly higher ratio of transfers vs. requests to the TAO than subordinates on good teams (71.83% of all messages to the TAO for subordinates on superior teams were transfers, compared to 65.67% for subordinates on good teams). TAOs on good teams had significantly higher ratios of information transfers vs. requests than TAOs on superior teams (70.17% of all information messages from the TAO to subordinates on good teams were transfers, compared to 45.70% for TAOs on superior teams). Finally, Subordinates on good teams appeared to anticipate their TAOs better when it came to subordinate information transfers vs. TAO information requests (3.42 vs. 1.69, $p = 0.027$). The latter two results tend to favor good teams, which was not expected; however, possible explanations for these results were provided in the anticipation ratio section of Chapter IV.

3. Post-Mission Data

Regarding post-mission questionnaire data for superior and good teams, the following was found:

- Expected results: TAOs on superior teams would have more confidence that their subordinates would successfully complete the mission. Subordinates on superior teams would have more confidence in their TAOs.
- Actual results: No significant difference for TAO's confidence between superior and good teams. Subordinates on superior teams had more confidence in their TAOs than subordinates on good teams.

Speculating, it is quite possible that this characteristic also played a role in helping to reduce overall subordinate request rates for superior teams. Generally, if subjects do not have a good feeling about their leader's capability to lead in crisis situations, they will ask more questions to prompt the leader into focusing on the area that the subjects feel is being neglected, or, they could be second guessing the leader. Looking at this from another view, since subordinates on superior teams had significantly more confidence in their TAO, they probably felt more comfortable during the scenario and trusted the leaders decisions, thus requesting less. Turning to the question that asked members to assess their ability to anticipate the actions and decisions of another, the following was found:

- Expected results: TAOs on superior teams would be able to anticipate the actions and decisions of their subordinates better than TAOs on good teams. Subordinates on superior teams would be able to anticipate their TAOs better than good teams.
- Actual results: There was no significant difference between classes for TAO and subordinate abilities to anticipate actions and decisions.

4. Workload

With regards to team workload experienced, the following was found:

- Expected results: TAOs and subordinates on superior teams will have a higher subjective workload than their counterparts on good teams.

- Actual results: Only subordinates on superior teams felt a significantly higher workload than subordinates on good teams.

For subordinates, this means that overall, they felt; a higher mental demand, a higher physical demand, a higher temporal demand, possibly lower performance, higher effort, and greater frustration. With all these self evaluating increases, they still maintained better performance, better teamwork ratings, and more confidence in the TAO.

5. Experience

Turning to experience, it was expected that TAOs and Subordinates on superior teams would have more shipboard experience. For this experiment, there was no conclusive evidence of these expectations.

B. DISTINGUISHED CHARACTERISTICS BETWEEN STRESSES

1. Teamwork Ratings

Overall, the independent variable of stress tended to have a negative effect on a team's teamwork ratings. The following was found for high versus low stress conditions:

- Expected results: Teams will have less orientation towards teamwork, lower communication behavior, lower monitoring behavior, lower feedback behavior, lower backup behavior, and lower coordination behavior.
- Actual results: Teams had marginally significantly less orientation towards teamwork ($p = 0.055$), marginally significantly lower communication behavior ($p = 0.088$), marginally significantly lower monitoring behavior ($p = 0.078$), no difference in feedback behavior ($p = 0.622$), no difference in backup behavior ($p = 0.341$), and significantly lower coordination behavior ($p = 0.000$).
- Expected results: Superior teams will have less of a tendency to stray away from teamwork than good teams.

- Actual results: Superior teams have less tendency to stray away from teamwork in high stress conditions. Superior teams drop their teamwork ratings from 5.850 to 5.650 in low versus high stress conditions, vice 3.367 to 2.100 for good teams (rating scale was calibrated from 1 to 7)

In other studies, under higher stress conditions, it was found that subordinates tend to shift their attention towards the leader (shift away from lateral communication and towards upward communication), become less coordination oriented, and become more action oriented (Wang, Luh, Serfaty, and Kleinman, 1991, p.2044). It is quite possible that the lower backup and lower monitoring behavior for teams in high stress conditions in this experiment was a result of subordinates shifting their attention towards their own tasks. Looking at the communication variable for subordinate A&T transfers (i.e., telling another that one has completed an action or task), subordinates did indeed increase these transfer rates in high stress conditions (0.0986 vs. 0.0300 transfers/minute). This finding was not significant though, and it cannot positively suggest that subordinates were actually becoming more action oriented (they might have just increased acknowledgments to others that they had completed an action or task). Concerning lateral communication, teams actually increased their lateral communication rate in high vs. low stress conditions ($p = 0.054$). Looking at the differences between subordinates on superior and good teams, subordinates on superior teams increased their lateral communication rate by 39.8% in high stress conditions, subordinates on good teams increased theirs by 8%. Shifting to upward communication to the TAO, subordinates on superior teams increased their upward communication rate in high stress conditions by 3.5%, subordinates on good teams increased theirs by 58%. These findings were not significant; however, the pattern seems to

suggest that subordinates on superior teams turn towards each other during high stress conditions (avoiding the tendency to turn to the TAO) while subordinates on good teams turn towards the TAO (leader).

2. Communication Variables

Regarding the effects of stress on other communication variables for teams, the following was found:

- Expected results: Teams will increase their request and transfer rates in high versus low stress conditions. This expectation applies to TAOs and subordinates also.
- Actual results: Teams significantly increase their request and transfer rates in high versus low stress conditions ($p = 0.002$ & 0.003 respectively). TAOs significantly increase their request rates ($p = 0.013$) and marginally significantly increase their transfer rates ($p = 0.088$). Subordinates significantly increase their request rates ($p = 0.011$) and significantly increase their transfer rates ($p = 0.005$).

The findings above were probably due to the greater number of contacts on the screen in high versus low stress conditions. There were some other expectations when it came to request and transfer rates for superior and good teams between classes:

- Expected results: Superior teams would have a larger increase in transfer rates and a lower increase in requests rates than good teams in high versus low stress conditions (implying that superior teams were adapting to stress and anticipating one another better)
- Actual results: There were no significant differences between teams' requests and transfer rates in high versus low stress conditions.

Although the results were not found to be significant, superior teams did increase their transfer rates from low to high stress conditions by 34.8%, as opposed to 23% for good teams. Also, superior teams increased their request rates from low to high stress conditions by 41%, as opposed to 57%

for good teams. Evaluating these results for TAOs and subordinates on superior and good teams, the following was found:

- Expected results: TAOs and subordinates on superior teams would have a larger increase in transfer rates and a lower increase in request rates than their good team counterparts in high versus low stress conditions.
- Actual results: There were no significant differences for TAO and subordinate's request and transfers rates in high versus low stress.

Although these results were not found to be significant, the following patterns did emerge: TAOs on superior teams increased their transfer rates from low to high stress by 39%, as opposed to 29% for TAOs on good teams; TAOs on superior teams increased their request rates by 60%, as opposed to 98% for TAOs on good teams; subordinates on superior teams increased their transfers by 33%, as opposed to 21% for subordinates on good teams; and subordinates on superior teams increased their requests rates by 24%, as opposed to 40% for subordinates on good teams. Summing the results above, as expected, TAOs and subordinates on superior teams did have higher transfer rates than their counterparts on good teams in high versus low stress conditions. They did not have lower request rates as was expected; however, their percentage increase in requests going from low to high stress was lower than that of good teams. This suggests that TAOs and subordinates on superior teams might have been adapting their communication strategy to meet the high stress demands. Despite the patterns above, there was no significant evidence to suggest that superior teams shifted from explicit to implicit communication more than good teams across the two stress conditions.

3. Post-Mission Data

It was found that stress had the following effects on teams' post mission questionnaires:

- Expected results: TAOs and subordinates will have lower anticipation skills in high versus low stress conditions.
- Actual results: Subordinates on both superior and good teams felt they were able to anticipate the actions and decisions of the TAO better in low versus high stress conditions.

It is apparent that the increase in stress changed a subordinate's perception of how well they were able to anticipate the TAO. There were no significant interactions between class and stress.

4. Workload

With regards to workload; teams, TAOs, and subordinates all felt a stronger workload in high stress conditions. High stress conditions tended to increase mental and physical demands, along with the amount frustration and effort put forth. There were no significant differences between superior and good teams' workloads between stresses.

C. DISTINGUISHED CHARACTERISTICS BETWEEN PERIODS

The purpose of analyzing differences between periods was to investigate how teams react to stresses that are building within a scenario; ALPHATECH calls these interior stresses, "micro-bursts" of stress. As a refresher, period 1 was considered to be low input workload, period 2 had increasing input workload, and period 3 had high and sustained input workload. There were some significant differences between periods and a significant interaction between class and period.

The first finding came with lateral communication between subordinates. The following results were found:

- Expected results: Teams will increase their lateral communication rate across the three time periods.
- Actual results: Teams decreased their lateral communication rate across the three time periods.

The expected results above are considered from an operational standpoint. One would expect that teams would try to communicate more laterally in order to adjust to the increasing OPTEMPO. The actual results are found in other studies, specifically, Wang, Luh, Serfaty, and Klienman. Referring to Appendix H, main effects plot for lateral communications, the reader can see this decrease in communication rates across the three time periods. With this decrease in lateral communication, one would expect that teams would shift to more upward communication, in fact, they do. Figure 16 shows this increase in upward communication.

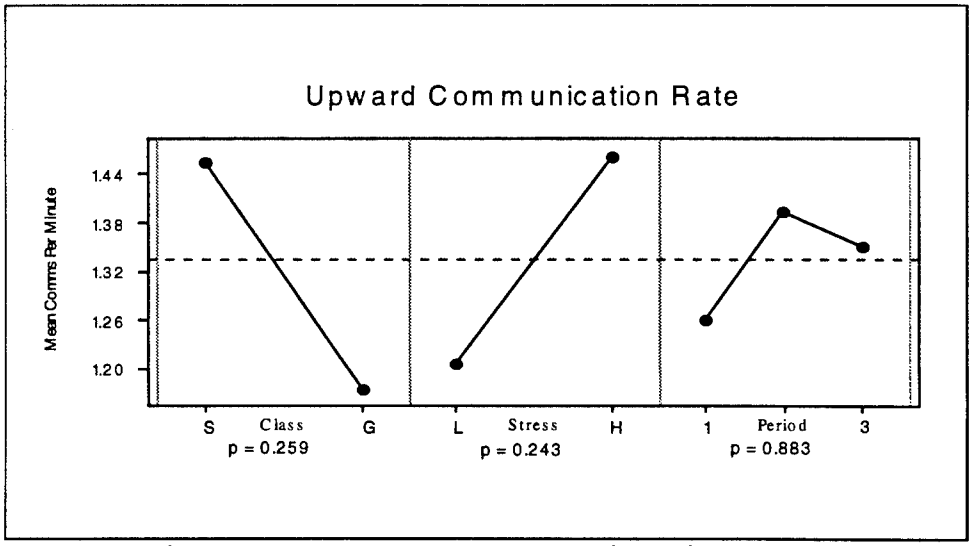


Figure 16. Upward Communication Rate

Looking closely, teams actually increase their communication with the TAO from period 1 to period 2, where the change in OPTEMPO is large. Inspecting this further, the decrease from period 2 to period 3 is actually due to good teams. Figure 17 shows this change. Superior teams actually kept a

steady increase across the three periods (1.410, 1.459, & 1.494 comms/minute respectively). Good teams had (1.060, 1.305, & 1.160 comms/minute respectively).

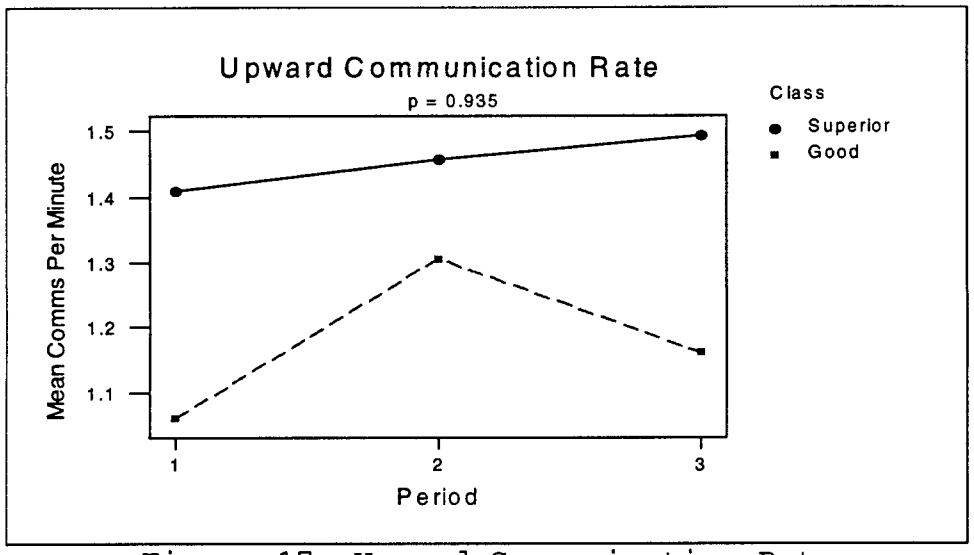


Figure 17. Upward Communication Rate as a Function of Class and Period

The initial expectation was that teams in general would increase their upward communication rate across the three time periods; it was found that only superior teams do this. Another finding came with outward communication; The following results were found:

- Expected results: TAOs will increase their outward communication rate across the three time periods.
- Actual results: TAOs increased their outward communication rate across the three time periods ($p = 0.018$).

Just as with lateral communication, TAOs on superior teams steadily increased their communication rate across the three time periods, TAOs on good teams actually decreased their communication rate in period 3. Figure 18 shows this pattern. A possible reason for the rate of change between classes in period 3 is that TAOs on superior teams probably recognized the importance of keeping their commander informed, and when time permitted at the end of the

scenario, they probably felt obliged to keep their commander abreast of the events that unfolded.

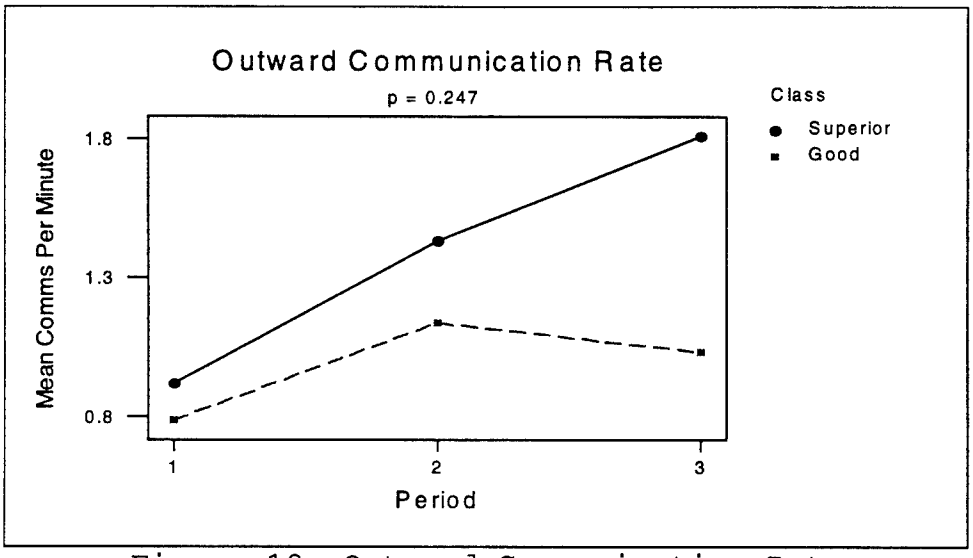


Figure 18. Outward Communication Rate as a Function of Class and Period

Regarding TAO transfers, the following results were found:

- Expected results: TAOs will increase their transfer rates across the three time periods.
- Actual results: TAOs increased their transfer rates across the three time periods.

It was expected that as the stress built within the scenario (i.e., across the three time periods) TAOs would adapt to this increasing stress by sending more transfers to other members. Digging deeper, TAOs on superior teams steadily increased the rate of transfer across the three time periods (0.066, 1.229, & 1.513 transfers/minute respectively). TAOs on good teams increased their transfer rate in period 2, yet again, decreased this rate in period 3 (0.393, 1.000, & 0.943 transfers/minute). Figure 19 shows this pattern. Regarding the results that were just mentioned above, the pattern seems to be that TAOs on good teams tend to slow their communication rate in period 3 while TAOs on superior teams continue to keep up the pace until the scenario actually ends.

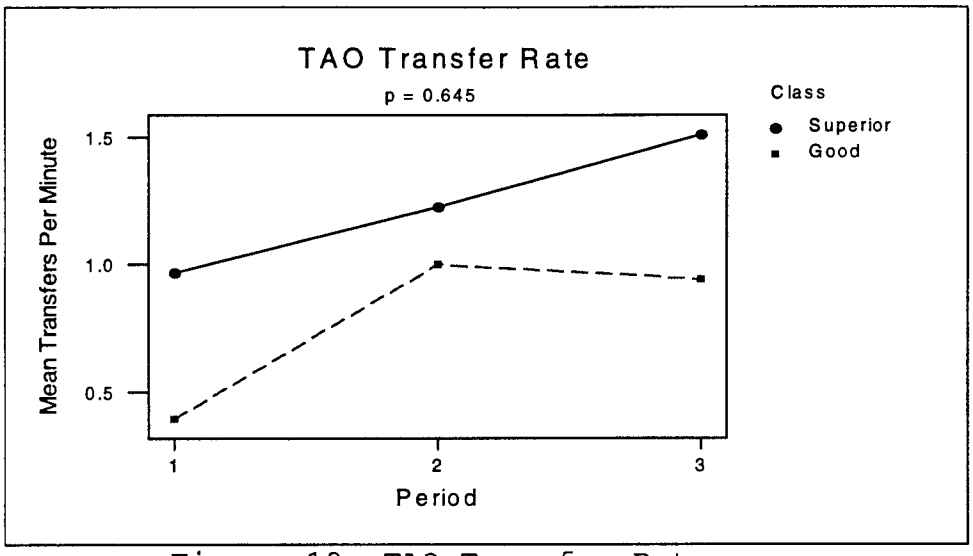


Figure 19. TAO Transfer Rate as a Function of Class and Period

There was an interesting occurrence that appeared in the interaction of class and period for subordinate information request rate from subordinates. The following results were found:

- Expected results: Subordinates on superior teams would have lower information request rates across the three time periods than subordinates on good teams.
- Actual results: Subordinates on superior teams had lower information request rates in periods 1 & 3, but higher request rates in period 2.

Figure 14, RESULTS, section 5, shows the interaction of class by period for subordinate information request rate form subordinates. In period 2, subordinates on superior teams increased their request rates while subordinates on good teams decreased theirs. This occurrence might suggest that subordinates on superior teams in period 2 had lower transfers to other subordinates, and subordinates on good teams in period 2 would have higher transfers to other subordinates. Part of this statement is true; subordinates on superior team do actually decrease their transfers in period 2, yet, so do subordinates on good teams.

Subordinates on superior teams actually have higher transfer rates than subordinates on good teams in each of the three time periods. The implication here is, subordinates on superior teams have higher request rates in period 2 because they are probably requesting more specific types of information that will help them better assess the unfolding events in this high OPTEMPO period. They might be anticipating required information better than subordinates on good teams, despite more transfers to them.

Delving into the anticipation ratios, there is a significant difference between teams' transfers vs. requests ($p = 0.050$). This appears to be due to the difference in period 1 between classes. Superior teams tend to have a higher proportion of transfers to requests in this period. Another finding is, TAOs tend to increase the proportion of transfers to requests across the three time periods ($p = 0.043$). Looking at the differences between TAOs in the classes across the three time periods ($p = 0.025$), TAOs on superior teams have higher proportions of transfers to requests in periods 1 & 3, yet have lower proportions in period 2. The results for period 2 are unexpected, it was expected that TAOs on good teams would have a higher proportion of transfers to requests in period 2 since this is the period where most of the action takes place. Explanations for this occurrence is provide in Chapter IV. Shifting to a more specific anticipation ratio, there is a significant difference in the interaction of class and period for TAO information transfers vs. requests ($p = 0.001$). For the most part, TAOs on good teams have higher proportions of information transfers vs. requests in periods 2 & 3. TAOs on superior teams actually decrease this proportion going from period 1 to period 2. These results were also unexpected. Shifting to subordinates, subordinates do tend to produce expected results.

Subordinates on superior teams do have higher proportions of transfers to requests than subordinates on good teams ($p = 0.026$). These higher proportions are found in periods 2 & 3, where the OPTEMPO is high. This finding suggests that subordinates on superior teams might be using more implicit communication than subordinates on good teams in period 2 & 3 (where it counts the most). The final finding came in the anticipation ratio for subordinate information transfers to the TAO vs. information requests from the TAO. Subordinates on superior teams tended to anticipate their TAOs less in periods 2 & 3 and slightly more in period 1 than subordinates on good teams. These results were unexpected and were explained in the results section. The main reason for the unexpected results was that TAOs on superior teams tended to request more, regardless of how much was transferred to them. This heightened request rate caused the anticipation ratios to be lower for superior teams and weakens the argument that good teams anticipated their TAOs more.

D. CONCLUSION

One of the primary goals of this thesis was to investigate whether superior teams used more implicit communication - leading towards the development of mental models - more than good teams. It was shown that superior teams do indeed send messages in the form of transfers more than good teams, yet they also send more requests. This heightened amount of requests by superior teams (which was unexpected at first) rendered the anticipation ratio measurement of a teams ability to anticipate one another to be less effective. Furthermore, it was expected that this increase in the amount of requests was due to superior teams asking for more specific information that was spread out over several requests. It was suggested that superior teams

tried to take in more specific information that they felt would help them assess the situation better. Good teams might have had more broad or general requests that gave them only part of the picture.

It was found that superior teams had significantly better teamwork ratings, felt significantly more workload (yet performed better), and had significantly more confidence in their TAOs. It was found that stress also had an effect on teams. In most cases, teamwork ratings dropped and the amount of workload increased. Across stress, superior teams still had better teamwork ratings than good teams in both low and high stress conditions. Both classes felt that they were able to anticipate their TAOs better in low versus high stress conditions.

Regarding stress within each scenario, for the most part, superior teams had better communication use. Superior teams tended to adapt to the increasing OPTEMPO as stress built within the scenario. Even in times where good teams had more transfers or requests, superior teams seemed to overtake good teams when the OPTEMPO shifted to a higher pace.

VI. RECOMMENDATIONS

This chapter provides recommendations for the enhancement of the TACT experiment and gives suggestions for improving team training within Navy CIC teams.

A. ENHANCEMENTS TO THE TACT EXPERIMENT

For the most part, the TACT experiment proved a useful tool for measuring team performance and communication skills within a team. It was stated earlier that the anticipation ratio measurement of a team's ability to anticipate one another seemed to be skewed by the unexpected amount of requests that superior teams generated. This high request rate tended to lower the anticipation measurement of superior teams. It was also shown that superior teams did not request more due to less transfers; it was speculated that they requested more specific types of information that allowed them to generate a better or more complete picture of the unfolding events. This was only a speculation, there was no way to tell if they actually were requesting more specific information. It is recommended that some type of measure be devised to determine when teams are requesting more enhancing information. Placing a "value" or "importance factor" on the communication message itself (i.e., information, A&Ts, and PS&P) may lend insight to this problem. Teams may have the same request and transfer rates, but did one team request or transfer messages that were more vital to the accomplishment of the teams goal? As an example, a TAO on team (A) asks the IDS what he has on a bearing of 245 degrees. The IDS replies, "It looks like an unknown contact." A TAO on team (B) asks the same question. The IDS replies, "It is a lower flyer, altitude appears to be 1000 feet, the speed is approximately mach 1.2, there is no IFF signature, and it has not responded to any interrogation messages." The IDS on team (B) supplied much

more vital information and the team member, or team, should be rewarded for this information flow.

Another area where the tact experiment could be enhanced is in the generation of stress between low and high stress scenarios. It is recommended that for high stress conditions, target profiles should be manipulated more. Contacts should have higher speeds, lower altitudes, and more threatening flight paths than low stress scenarios. Adding more contacts to the screen definitely creates more stress when individuals have to try to identify them, the above recommendation should create an extra level of stress that could be used to further separate the two stress conditions.

B. ENHANCEMENTS TO NAVY TRAINING

From experience, CIC teams on Navy ships are mainly taught how to detect threatening contacts and the methods used to thwart them. Subordinates are told to identify these contacts, gain as much information from them as possible, and forward this to other subordinates and the TAO. Regarding communications, there is one main phrase that has probably been heard by every member that has ever participated in a CIC team, "Do not clutter the communication network with unnecessary chatter." This is about the extent of communication strategy training. Although the above statements are very important, it is recommended that CIC teams be taught communication strategies that will enhance overall team performance. Separate training should be conducted to teach team members; how to communicate, when to communicate, what type of communication is important, how and why feedback and backup to others should be conducted, how stress effects a team's performance and how to deal or adapt to it, and how to concentrate on anticipating the needs of others. Many

studies have been conducted that have recognized the important characteristics that make up successful teams; Navy teams should have access to this information and should be taught how to develop or improve these characteristics (separate from the standard CIC team trainer that concentrates of target engagement).

APPENDIX A. OBSERVATION FORMS AND QUESTIONNAIRES

This Appendix contains the observation forms and questionnaires that were used to collect data in the TACT experiment.

TACT EXPERIMENT (TADMUS)

TEAMWORK AND PERFORMANCE: OBSERVER'S RATING FORM

TEAM #_____ SITE_____ DATE_____ OBSERVER_____ SCEN #_____

Instructions for Teamwork Ratings

Circle a number on the scale accompanying the questions on the following pages so that it best describes the behavior of the team you just observed. Consider each team separately. Try not to compare one team to another. Instead strive to rate the behavior of a team on an absolute scale. To help you perform this absolute rating a brief description of the behavior you should observe for the highest rating on the scale and a brief description of the behavior you should observe for the lowest rating on the scale are provided for each question. Read these guides or anchors carefully and refer to them as you rate the team on each item. Feel free to write comments or explanations for any question.

The rating scales or questions for teamwork are organized into six areas. To further help you in your ratings each area is defined below. Please read these definitions carefully.

Team Orientation

Team orientation refers to the commitment team members have and exhibit to working together. It implies that they place the goals and interest of the team ahead of their personal goals. It also refers to the trust each team member has in the other team members, team pride, and esprit de corps.

Communication Behavior

Communication involves the exchange of information between two or more team members in the prescribed manner and by using proper terminology. Often the purpose of communication is to clarify or acknowledge the receipt of information.

Monitoring Behavior

Monitoring refers to observing the activities and performance of other team members. It implies that team members are individually competent and that they may subsequently provide feedback and backup behavior.

Feedback Behavior

Feedback involves the giving, seeking, and receiving of information among members. Giving feedback refers to providing information regarding other member's performance. Seeking feedback refers to requesting input or guidance regarding performance. Receiving feedback refers to accepting positive and negative information regarding performance.

Back-up Behavior

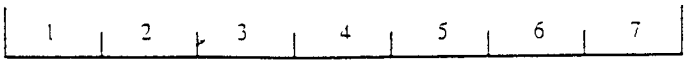
Backup behavior involves assisting the performance of other team members. This implies that team members have an understanding of other member's tasks. It also implies that members are willing to give and seek assistance.

Coordination Behavior

Coordination refers to team members' executing their activities in a timely and integrated manner. It implies that the performance of some team members influence the performance of other team members. This may involve an exchange of information that subsequently influences another member's performance.

Team Orientation

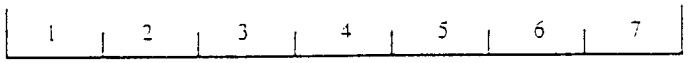
1. To what extent was this team oriented toward teamwork?



7 Good team orientation could be inferred in a situation where a team member places the goals and interests of the team ahead of personal goals. Also may be evident through the display of trust, team pride, and esprit de corps, and an awareness that teamwork is important.

1 Poor team orientation manifests itself when members place their personal concerns above the team's success (e.g., disregarding or refusing to follow procedures; arguments, quarrels, and open resentment; and becoming upset with a member's performance and either ignoring or harassing that member are evidences of poor team orientation).

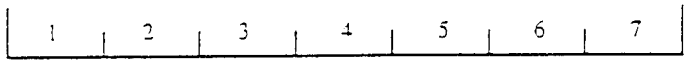
2. To what extent were errors caused by inadequate team communication?



7 Communication within the team was always effective and never responsible for errors or degraded performance.

1 Communication was wholly inadequate and resulted in most of the errors made by the team.

3. To what extent were errors caused by improper individual actions or decisions?



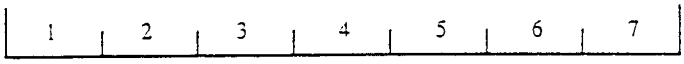
7 No actions or decisions of a single team member resulted in errors or poor team performance.

1 The actions and/or decisions by a single team member very frequently resulted in errors or poor team performance.

Comments:_____

Communication Behavior

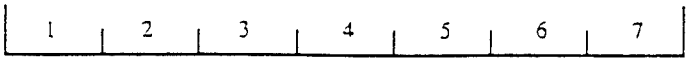
4. How well did team members communicate?



7 Good communication occurs when team members pass on all important information and clarify intentions and planned procedures; members obtain necessary information and acknowledge and repeat messages to ensure correctness; members ensure that their messages are received as intended.

1 Poor communication occurs when team members fail to pass on information or intentions, or pass on incomplete communications; members fail to clarify information; members fail to acknowledge other member's requests or reports; members disregard proper security procedures for communication; members use improper terminology; members tie up the net with irrelevant communications.

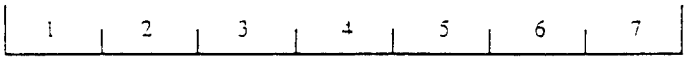
5. To what extent did the TAO provide tactical direction or relevant information to other team members, without the other team members having to ask for it?



7 TAO always provided important direction or information to other team members without being asked.

1 TAO never provided direction or information to other team members unless specifically asked.

6. To what extent did other team members provide relevant tactical information to the TAO, without the TAO having to ask for it?



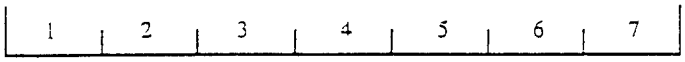
7 Other team members always provided important information to the TAO without being asked.

1 Other team members never provided information to the TAO unless specifically asked.

Comments:_____

Monitoring Behavior

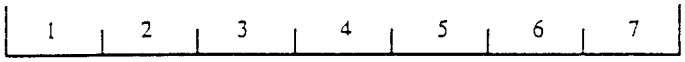
7. To what extent did team members monitor each other's behavior?



7 Good monitoring occurs when team members consistently observe the performance of the others to ensure the efficiency of the team; members notice and are concerned with the performance of the entire team; one member recognizes when other team members perform correctly; members consistently keep track of other team members' performance.

1 Poor monitoring occurs when team members fail to notice other team members' performance on almost all occasions; members rarely notice when other team members perform correctly or make a mistake.

8. To what extent did team members alert each other to impending decisions and actions?



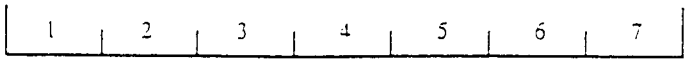
7 Team members always alerted each other to impending decisions and actions; supporting information was actively solicited from other team members.

1 Team members did not keep each other informed of impending decisions and actions; compromises to mission safety or mission effectiveness arose when a team member waited for the other to volunteer significant information.

Comments:_____

Feedback Behavior

9. To what extent did team members provide feedback to one another?



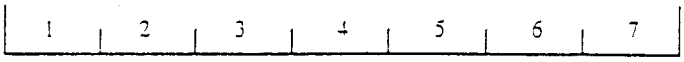
7 Good feedback behavior occurs when team members go over procedures with one another by identifying mistakes and how to correct them; members ask for input regarding mistakes and what needs to be worked on; members are corrected for mistakes and incorporate the suggestions in their procedures.

1 Poor feedback behavior occurs when one or more team members makes sarcastic comments to one or more members when the scenario doesn't go as planned; members resist asking for advice and make guesses on proper procedures; members reject time-saving suggestions offered by other team members.

Comments:_____

Backup Behavior

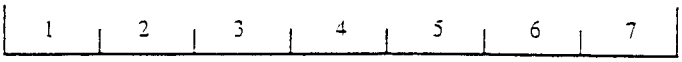
10. To what extent did team members provided backup to one another?



7 Good backup behavior occurs when one team member is having difficulty, makes a mistake, or is unable to perform duties, and one or more members steps in to help, ensuring that the activity is completed properly; one or more members provide critical assistance without neglecting their own assigned duties; the member having difficulty or overburdened displays a willingness to seek assistance rather than struggle and make a mistake.

1 Poor backup behavior occurs when one or more members fail to provide assistance to another member who is having difficulty, makes a mistake, or is unable to perform his duties; while providing assistance, the members tends to neglect their own duties; members are unwilling to ask for help even when it is available; one member provides needed assistance, but does not inform others that he is occupied assisting another or what he has done; one member displays an unwillingness to help others even when asked.

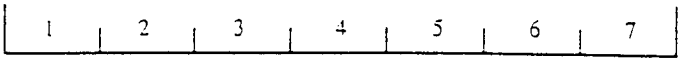
11. To what extent did the TAO anticipate the need to provide (some) assistance to one or more team members?



7 TAO consistently anticipated the need to provide assistance to other team members during critical phases of the mission.

1 TAO never anticipated the need to provide assistance to other team members during critical phases of the mission; the other team members always had to ask.

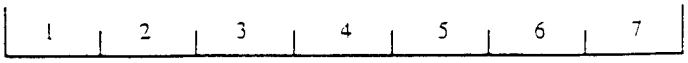
12. To what extend did the other team members anticipate the need to provide assistance to the TAO?



7 Other team members consistently anticipated the need to provide assistance to the TAO during critical phases of the mission.

1 Other team members never anticipated the need to provide assistance to the TAO during critical phases of the mission; the TAO always had to ask.

13. Did the team members adjust individual task responsibilities to prevent overload?



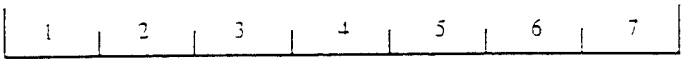
7 Team members were consistently aware of each other's workload buildup and reacted quickly to adjust division of task responsibilities to redistribute workload .

1 Team members were generally unaware of each other's workload buildup; little or no attempt was made to adjust the distribution of task responsibilities before significant compromises to mission safety or mission effectiveness occurred.

Comments:_____

Coordination Behavior

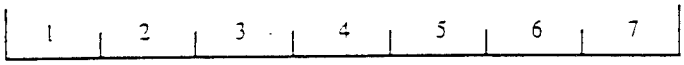
14. To what extent was the team's behavior coordinated?



7 Good coordination behavior occurs when team members consistently pass critical information to the other members, thereby enabling them to accomplish tasks; members consistently carry out tasks quickly or in a timely manner enabling others to carry out their tasks effectively. Team members appear very familiar with the relevant parts of one another's jobs and carry out individual tasks in a synchronized manner.

1 Poor coordination behavior occurs when team members consistently carry out their tasks ineffectively, leading to other team members' failing at their tasks; members carry out their tasks unpredictably, leading to delays in execution of critical tasks; members neglect to pass on critical pieces of information to one another, leading to breakdowns in team performance; team members carry out their tasks with significant delays leading to team errors.

15. How congruent/similar were the TAO's and the other team members' understanding of the mission?



7 TAO and other team members were completely in agreement (i.e., congruent) on goals, tasks, and concepts involving the mission.

1 TAO and other team members were rarely in agreement (i.e., congruent) on goals, tasks, and concepts involving the mission.

Comments:_____

_____

OVERALL AAW TEAM PERFORMANCE ASSESSMENT

Instructions for Performance Ratings

Please assess the performance of the team for the following tasks and/or activities using the scales provided. Note that a score of 7 always denotes effective or superior performance, while a score of 1 always denotes ineffective or very poor performance. The anchors or descriptors associated with the high and low scores are what you should expect to see for very effective and very ineffective team performances, respectively. They are provided as guidance for your ratings.

1. Making radar detection reports. This refers to the report made by any team member who verbally describes the radar contact.

Very Poor 1 2 3 4 5 6 7 Superior

7 The radar detection reports are always accurate, concise, and timely. Proper format (e.g., APP-1, NWP-32) and terminology are always used.

1 Some radar detections are never reported. Many reports are inaccurate and late. Often proper format and terminology are not used.

2. Making ESM detection reports. This refers to verbal reports of ESM detections.

Very Poor 1 2 3 4 5 6 7 Superior

7 The ESM detection reports are always accurate, concise, and timely. Proper format and terminology are always used.

1 Some ESM detections are never reported. Many reports are inaccurate and late. Often proper format and terminology are not used.

3. Identification/Correlation reports. This refers to verbal reports of the correlation and identification of contacts.

Very Poor 1 2 3 4 5 6 7 Superior

7 The ID/Correlation reports are always accurate, concise, and timely. Proper format and terminology are always used.

1 Some ID/Correlations are never made and/or reported. Many reports contain errors and/or are late. Frequently improper format and incorrect terminology are used.

4. Assessment of contacts' hostile intent. This is typically based on input from lower levels within the team and made by the TAO or CO.

Very Poor 1 2 3 4 5 6 7 Superior

7 TAO/CO routinely assess the threat of each new contact and advise the rest of the team accordingly. Assessment is firmly based on information the team has collected (e.g., ESM, ID/Corr, Intel) and on verbal discussions concerned with weapons loads, flight profiles, and attempts at communication with the contact.

1 TAO/CO infrequently assess the threat of new contacts and/or rarely advise the rest of the team as to the contact's threat. Assessment is often not based on available information and verbal discussion about such aspects as weapons load and flight profile have not occurred.

5. Monitoring the threat. This pertains primarily to critical contacts of interest (CCOI).

Very Poor 1 2 3 4 5 6 7 Superior

7 CCOIs are frequently hooked and observation of them are more or less constant. The status of the CCOIs are frequently discussed and appraised - in short the intensity of involvement with these threats is high.

1 CCOIs are frequently neglected or overlooked. The status of CCPIs are not reviewed, discussed, or appraised frequently enough - in short, the intensity of involvement with these threats is low.

6. Taking appropriate action in accordance with ROE. This refers to whether the team decides to take some action against a given CCOI vs. failure to do anything about it.

Very Poor 1 2 3 4 5 6 7 Superior

7 TAO (or CO) and team consistently take effective and appropriate actions to deal with threats. This includes assigning CAP, covering, issuing verbal warnings, increasing readiness/going to GQ, activating doctrine, and determining chaff solutions.

1 TAO (or CO) and team are lax and often fail to take effective or appropriate actions to deal with threats. They tend to over react or fails to react.

7. Planning for the upcoming mission. This refers to all planning activities performed by the TAO or other team members for the upcoming mission.

Very Poor 1 2 3 4 5 6 7 Superior

7 The TAO and/or other team members spend a reasonable amount of time planning for the upcoming mission. Roles are further defined and tasks that are outside normal responsibility assigned. Critical events that might occur are clearly defined and specific responses agreed upon.

1 The TAO and/or other team members spend little or no time planning for the upcoming mission. Roles are not further defined and tasks that are outside normal responsibility are not assigned. Little or no discussion occurs about critical events that might occur. Those events that are mentioned are not defined well nor are responses to the events delineated.

8. Overall performance rating of this team for this scenario.

Very Poor 1 2 3 4 5 6 7 Superior

7 Superior teams have consistently scored well on the above six areas, as well as on other unassessed areas.

1 Poor teams have consistently scored poorly on the above six areas, as well as on other unassessed areas.

9. Performance of critical events. Below are four critical events that occurred in this scenario. Rate how the team performed each on the seven point scales provided.

a. Four Iranian F4s detected .

Very Poor	1	2	3	4	5	6	7	Superior

b. Iranian bogies split into two sections.

Very Poor	1	2	3	4	5	6	7	Superior

c. APQ120 detected (Iranian F4).

Very Poor	1	2	3	4	5	6	7	Superior

d. Low F4s pop-up at 46nm.

Very Poor	1	2	3	4	5	6	7	Superior

TACT EXPERIMENT (TADMUS)
CIC TEAM PRE-MISSION QUESTIONNAIRE

TEAM #_____ SITE_____ DATE_____ TEAM POSITION_____ SCEN #____

1. How much confidence do you place in the ability of the other members of your team to accomplish this mission?

Very Little 1 2 3 4 5 6 7 A Great Deal

2. How much confidence do you think the other team members place in your ability to accomplish this mission?

Very Little 1 2 3 4 5 6 7 A Great Deal

3. To what extent should team members be aware of other team members workload?

Very Little 1 2 3 4 5 6 7 A Great Deal

4. To what extent do highly competent team members experience stress?

Very Little 1 2 3 4 5 6 7 A Great Deal

5. A team member's decision making ability is as good in stressful situations as it is in non- stressful conditions.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

6. Monitoring the TAO's performance for possible mistakes and errors tends to reduce the TAO's stature and authority.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

7. A team member should offer task help to another team member only if he/she is being asked to do so.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

8. To what extent should team members monitor other team members for signs of stress?

Very Little 1 2 3 4 5 6 7 A Great Deal

9. To what extent should team members mention/share their own feelings of stress/workload with other team members during a mission?

Very Little 1 2 3 4 5 6 7 A Great Deal

10. Even when stressed, I perform effectively during critical aspects of the mission.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

11. To what extent should team members change their work strategy in response to high stress/workload?

Very Little 1 2 3 4 5 6 7 A Great Deal

12. Communications among team members are rarely affected by high stress/high workload.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

13. To what extent should team members take account of other team members' personalities for effective crew coordination?

Very Little 1 2 3 4 5 6 7 A Great Deal

14. To what extent can the effectiveness of crew coordination be lowered by stress/workload?

Very Little 1 2 3 4 5 6 7 A Great Deal

15. It is not a good idea to point out an error committed by a team member during a mission.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

16. To what extent are reprimands more effective than discussions in eliminating some elements of a team member's poor task performance?

Very Little 1 2 3 4 5 6 7 A Great Deal

17. To what extent is understanding the TAO's concepts and beliefs about the mission important to a team member's execution of the mission?

Very Little 1 2 3 4 5 6 7 A Great Deal

18. Task overload usually occurs because a team member is not very competent.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

19. Each team member should watch for situations in which external events hinder the performance of other team members.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

20. Team members should be able to anticipate each other's information needs during the mission.

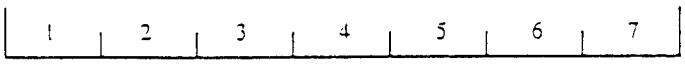
Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

TACT EXPERIMENT (TADMUS)

CIC TEAM POST-MISSION QUESTIONNAIRE

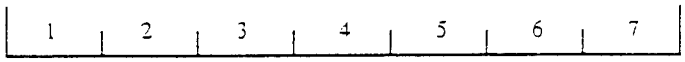
TEAM #_____ SITE_____ DATE_____ TEAM POSITION_____ SCEN #____

1. How much confidence did you have during the mission that the TAO would successfully complete the mission ?



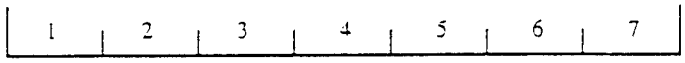
Very Little Moderate A Great Deal

2. How much confidence did you have during the mission that the other team members would successfully complete the mission?



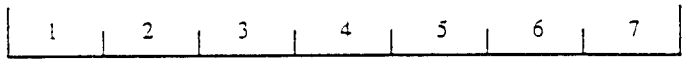
Very Little Moderate A Great Deal

3. How much assistance did you provide to other team members as the mission unfolded?



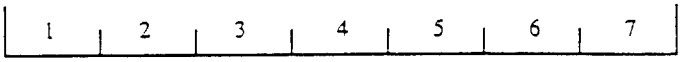
Very Little Moderate A Great Deal

4. To what extent did you cross-monitor the actions of other team member as the mission unfolded?



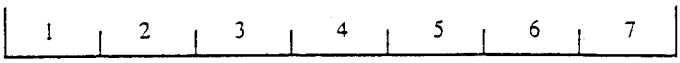
Very Little Moderate A Great Deal

5. To what extent were you able to anticipate (i.e., predict) the actions and decisions of the TAO?



Rarely Half The Time All The Time

6. To what extent were you able to anticipate (i.e., predict) the actions and decisions of the other team members?



Rarely Half The Time All The Time

7a. What was the most critical episode of this mission? _____

_____

b. During this episode to what extent were you thinking and acting "in sync" with the TAO?

1 2 3 4 5 6 7

Very Little Moderate A Great Deal

c. How do you know that? _____

_____

d. During this episode to what extent were you thinking and acting "in sync" with other team members?

1 2 3 4 5 6 7

Very Little Moderate A Great Deal

e. How do you know that? _____

_____

Put an "X" on each of the six scales below, at the point that matches best your workload experience for the mission you have just accomplished.

Mental Demand

Very Low Very High

Physical Demand

Very Low Very High

Temporal Demand (Time Pressure)

Very Low Very High

Performance

Perfect Failure

Effort

Very Low Very High

Frustration

Very Low Very High

TACT EXPERIMENT (TADMUS)

CIC TEAM COMMUNICATION RECORDING FORM: TAO

TEAM #_____ SITE_____ DATE_____ OBSERVER_____ SCEN #____

PERIOD 1 2 3

TYPE & CONTENT		TAO to:					
		TIC	IDS	AAWC	EWS	All	Out
REQUESTS	INFOR-MATION						
	ACTION & TASK						
	PROBLEM SOLVING & PLANNING						
TRANSFERS	INFOR-MATION						
	ACTION & TASK						
	PROBLEM SOLVING & PLANNING						
ACKNOWLEDGMENTS							

Additional notes / Other categories:

TACT EXPERIMENT (TADMUS)

CIC TEAM COMMUNICATION RECORDING FORM: Team

TEAM #_____ SITE_____ DATE_____ OBSERVER_____ SCEN #____

PERIOD 1 2 3

TYPE & CONTENT		TIC to:		IDS to:		AAWC to:		EWS to:		Team to:
		TAO	Team	TAO	Team	TAO	Team	TAO	Team	Out
REQUESTS	INFOR-MATION									
	ACTION & TASK									
	PROBLEM SOLVING & PLANNING									
TRANSFERS	INFOR-MATION									
	ACTION & TASK									
	PROBLEM SOLVING & PLANNING									
ACKNOWLEDGMENTS										

Additional notes / Other categories:

TACT EXPERIMENT (TADMUS)

PARTICIPANT BACKGROUND QUESTIONNAIRE

NAME: _____

TEAM #: _____

TEAM POSITION (Circle One): TAO AAMC TIC IDS EWS

SITE (Circle One): SWOS NPS

GENDER (Circle One) : MALE FEMALE

AGE (Nearest year): _____

BRANCH OF SERVICE (Circle One) : AIR FORCE ARMY MARINES NAVY
OTHER: _____

RANK: _____

EDUCATION (Highest Degree Attained): _____

TRAINING SCHOOLS ATTENDED: _____

_____

LAST TWO JOBS/POSITIONS: 1._____
2._____

LAST COMMAND POSITION:_____

TIME AT SEA: _____

EXPERIENCE IN CIC: _____

Thank You

APPENDIX B. DEPENDENT VARIABLES

The following Appendix displays the dependent variables for the communication measures. All Rates are "per minute".

VARIABLE	VARIABLES DESCRIPTION
AC1	Total Communication (any utterance spoken)
AC2	Total Communication Rate
AC3	TAO Communication Rate
AC4	Subordinate Communication Rate
AC5	TIC Communication Rate
AC6	IDS Communication Rate
AC7	AAWC Communication Rate
AC8	EWS Communication Rate
AC9	Upward Communication Rate (subords to TAO)
AC10	Lateral Communication Rate (subords to subords)
AC11	Downward Communication Rate (TAO to subords)
AC12	Outward Communication Rate (TAO to outside entity)
AC13	Total Request Rate (all requests made by team)
AC14	Total Transfer Rate (all transfers made by team)
AC15	Total Acknowledgment Rate (all acknow by team)
AC16	Total TAO Request Rate (all requests by TAO)
AC17	Total TAO Transfer Rate (all transfers by TAO)
AC18	Total TAO Acknowledgment Rate (all Acknow by TAO)
AC19	Total Subord Request Rate (all Reqs by subords)
AC20	Total Subord Transfer Rate (all Trans by subords)
AC21	Total Subord Acknowledge Rate (all Acknow by subs)
AC22	Total Information Rate (info requests & transfers by the TAO plus info requests & transfers by subs)
AC23	Total Action & Task Rate (A&T requests & transfers by the TAO plus A&T requests & transfers by subs)
AC24	Total Problem Solving & Planning Rate (same as AC22 and AC23, replace with PS&P)
AC25	Information by TAO (info reqs plus trans by TAO)
AC26	Action & Task by TAO (A&T reqs plus trans by TAO)
AC27	Problem Solving & Planning by TAO (PS&P requests plus PS&P transfers by the TAO)
AC28	Information by Subordinates (information requests plus information transfers by subordinates)

AC29	Action & Task by Subordinates (A&T requests plus A&T transfers by subordinates)
AC30	Problem Solving & Planning by Subordinates (PS&P requests plus PS&P transfers by subordinates)
AC31	TAO Information Request Rate
AC32	TAO Information Transfer Rate
AC33	TAO Action & Task Request Rate
AC34	TAO Action & Task Transfers Rate
AC35	Subordinate Information Request Rate from the TAO
AC36	Subordinate Information Transfer to the TAO
AC37	Subordinate A&T Request Rate From the TAO
AC38	Subordinates A&T Transfer Rate to the TAO
AC39	Subord Information Request Rate from Subordinates
AC40	Subord Information Transfer Rate to Subordinates
AC41	Subord A&T Request Rate from Subordinates
AC42	Subord A&T Transfer Rate to Subordinates
AC43	Overall Upward Anticipation Ratio(all msgs sent to the TAO/all msgs sent to subords by the TAO)
AC44	Transfer Vs Request Antic ratio AC14/(AC14 + AC13)
AC45	Transfer Vs Request Anticipation ratio for TAO (TAO transfers to subords/TAO requests to subords, AC17/(AC17 + AC16))
AC46	Transfer Vs Request Anticipation Ratio for Subords (subord transfers to TAO/subord requests to TAO)
AC47	Information Transfer Vs Request Anticipation Ratio for the TAO (TAO info transfer to subs/TAO info requests to subs)
AC48	A&T Transfers Vs Request Antic Ratio for TAO (A&T transfers by TAO to subs/A&T reqs to subs by TAO)
AC49	Anticipation ratio for Information Transfer Vs Request to/from TAO (subord to TAO info transfers/ subord to TAO info requests)
AC50	Anticipation ratio for A&T Transfers Vs Requests to/from TAO (subord to TAO A&T transfers/subord to TAO A&T requests)
AC51	Anticipation Ratio for Information transfers Vs Requests to/from subords (subord to subord info transfers/subord to subord info requests)
AC52	Anticipation Ratio for A&T Transfers Vs A&T Requests to/from subords (subord to subord A&T transfer/subord to subord A&T requests)

AC53 Anticipation Ratio for (subordinate info transfer to the TAO/TAO info requests from subords)

AC54 Anticipation Ratio for (subord A&T transfer to the TAO/TAO A&T request from subordinates)

AC55 Anticipation Ratio for (TAO info transfer to subords/subords info requests from TAO)

AC56 Anticipation Ratio for (TAO A&T transfers to Subords/subords A&T requests from the TAO)

APPENDIX C. DATA SPREADSHEETS

This Appendix displays the coding forms used to interpret the data spreadsheets, followed by the data spreadsheets themselves.

COLUMN	VARIABLE	IDENTIFIER
A	Site	1 = SWOS Newport 2 = NPS Monterey
B	Experimental Condition	1 = Control 2 = TACT 3 = TACT +
C	Team ID	One through six
D	Observation	2 = Posttraining
E	Scenario	One or two
F	Stress Level	1 = Low 2 = High
G	Trial	Three or four

Table 5. Data Coding Scheme for AAW Performance Spreadsheet

COLUMN	VARIABLE	IDENTIFIER
A	Site/Team	11 = SWOS Team 1 12 = SWOS Team 2 13 = SWOS Team 3 14 = SWOS Team 4 15 = SWOS Team 5 24 = NPS Team 4 26 = NPS Team 6
B	Class	1 = Superior 2 = Good
C	Stress Level	1 = Low 2 = High
D	Period	1 = Period 1 2 = Period 2 3 = Period 3

Table 6. Data Coding Scheme for Communications Spreadsheet

COLUMN	VARIABLE	IDENTIFIER
A	Site ID/Team	11 = SWOS Team 1 12 = SWOS Team 2 13 = SWOS Team 3 14 = SWOS Team 4 15 = SWOS Team 5 24 = NPS Team 4 26 = NPS Team 6
B	Class	1 = Superior 2 = Good
C	Stress	1 = Low 2 = High
D	Member	0 = TAO 1 = IDS 2 = TIC 3 = AAWC 4 = EWS
E	Trial	3 OR 4

Table 7. Data Coding Scheme for Post Mission/TLX Data

AAW TEAM PERFORMANCE DATA SPREADSHEET

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	site	exp cond	team ID	pre/post	scenario	stress	trial	Perf 1	Perf 2	Perf 3	Perf 4	Perf 5	Perf 6
2	1	2	1	2	1	1	4	3	4	3.5	2.8	3.5	3.5
3	1	2	1	2	2	2	3	3	3.5	2.5	2	2.3	1.8
4	1	1	2	2	1	1	3	2.5	2.5	3.5	3	3	4
5	1	1	2	2	2	2	4	2	4.3	3	1.8	2	1.5
6	1	3	3	2	1	1	3	4	6	6	6	5.5	6
7	1	3	3	2	2	2	4	5.5	5.8	5.8	5.5	5.5	5.5
8	1	1	4	2	1	1	4	3.3	4.5	4	2.8	3.3	3.5
9	1	1	4	2	2	2	3	2	3	1.8	1.8	1.8	1.5
10	1	3	5	2	1	1	4	6.3	6.5	6.5	6.5	6.3	6.5
11	1	3	5	2	2	2	3	5.5	6	6.3	6.3	5.5	5.8
12	1	2	6	2	1	1	3	4.5	3.5	4.8	4.8	4.5	4.5
13	1	2	6	2	2	2	4	5	3.8	5	5.3	4.8	5.5
14	2	2	1	2	2	1	4	4.3	6	4	5.5	5	5.5
15	2	2	1	2	1	2	3	4	4.5	2.5	5.5	4.5	5
16	2	1	2	2	1	1	3	4.5	5.5	4.3	4.5	3.5	5
17	2	1	2	2	2	2	4	4	5.5	4	5	4.3	5
18	2	2	3	2	1	1	3	5.5	6	4.5	6	6.5	6
19	2	2	3	2	2	2	4	4.5	4.5	4	5	4	5.5
20	2	3	4	2	1	1	3	5.5	6	6	5.5	6	5.5
21	2	3	4	2	2	2	4	5.5	6.5	4.8	5.5	6	5.8
22	2	1	5	2	1	1	4	4.5	5.5	4	5.5	5	5.5
23	2	1	5	2	2	2	3	4.5	6	3	4	5.5	5.5
24	2	3	6	2	1	1	4	6.5	5	6	5.5	5.5	5.5
25	2	3	6	2	2	2	3	5.5	5	4.5	6	5	5.8

AAW TEAM PERFORMANCE DATA SPREADSHEET

	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	Perf 7	Perf 8	Perf 9a	Perf 9b	Perf 9c	Perf 9d	avgperf	-site-	team-ID	avglow	avghigh	totalAVG	Class
2	2.5	2.8	3	2	3.5	2	3.00833	1	1	3.00833	2.475	2.74167	Good
3	2.8	2.3	4	2.5	1.5	1.5	2.475	1	2	2.70833	2.24167	2.475	Good
4	3	3	1.5	1.5	2.5	2.5	2.70833	1	3	5.33333	5.475	5.40417	Superior
5	2	2.3	3	1.5	1.5	2	2.24167	1	4	3.56667	2.00833	2.7875	Good
6	6	6	4	4	6	4.5	5.33333	1	5	6.20833	5.625	5.91667	Superior
7	5.8	5.5	5.3	5.5	4	6	5.475	1	6	4.20833	4.95833	4.58333	
8	2.8	3.5	2.8	3	4	5.3	3.56667	2	1	5.18333	4.44167	4.8125	
9	2.3	2	1.5	2.3	2.8	1.3	2.00833	2	2	4.36667	4.65	4.50833	
10	6.5	6.5	6.3	4	6.3	6.3	6.20833	2	3	5.375	4.58333	4.97917	
11	6	6	6.3	4.3	3.5	6	5.625	2	4	5.46667	5.43333	5.45	Superior
12	5.3	4.5	3.5	3.8	1.5	5.3	4.20833	2	5	4.525	4.58333	4.55417	
13	5.5	5	5.5	3.8	4.8	5.5	4.95833	2	6	5.45833	5.19167	5.325	Superior
14	6	5.3	5.5	4.8	4.8	5.5	5.18333						
15	6	4.5	4.5	3	4.5	4.8	4.44167						
16	4.8	4.3	4.5	3	5	3.5	4.36667						
17	4.5	4.5	4	5	5	5	4.65						
18	5.5	6	6	3	5.5	4	5.375						
19	5.5	5	2	5	5.5	4.5	4.58333						
20	4.8	6.3	4.5	3	6	6.5	5.46667						
21	4.8	5.8	5.5	5.5	4.5	5	5.43333						
22	3	4.8	3	2.5	5	6	4.525						
23	4	4.5	4	5	5.5	3.5	4.58333						
24	4.5	6	6.5	3	5	6.5	5.45833						
25	4.5	5.5	5	4.5	6	5	5.19167						

COMMUNICATION DATA SPREADSHEET

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	site/tm	Class	Stress	Period	ac1	ac2	ac3	ac4	ac5	ac6	ac7	ac8	ac9	ac10	ac11
2	15	1	1	1	43	3.91	1.27	2.64	0.45	0.64	0.64	0.82	0.64	1.91	0.82
3	15	1	1	2	30	5	1.83	3.17	0.83	0.83	0.67	0.83	0.5	2.67	1
4	15	1	1	3	67	4.41	1.58	2.83	0.26	0.66	0.59	1.12	0.66	1.97	1.18
5	15	1	2	1	52	4.73	1	3.73	0.45	1.36	1.09	0.73	0.45	3.18	0.64
6	15	1	2	2	34	5.67	2.33	3.33	0	1.67	0.67	0.83	0.83	2.33	0.5
7	15	1	2	3	81	6.23	2.46	3.77	0.92	0.62	1.08	1.08	1	2.69	1.31
8	24	1	1	1	104	9.45	3.73	5.73	1.55	1.55	0.55	1.55	2.73	2.45	2.82
9	24	1	1	2	38	6.33	2.5	3.83	0.67	1	1	1	1.5	2.17	1.83
10	24	1	1	3	133	8.42	4.43	3.99	1.33	0.7	0.32	1.2	1.84	1.71	2.53
11	24	1	2	1	133	12.09	3.91	8.18	3.64	0.73	0.55	3	2	5.91	2.55
12	24	1	2	2	71	11.83	5.33	6.5	1.67	1.5	0.5	2.17	2	3.83	4
13	24	1	2	3	151	9.68	5.38	4.29	1.03	1.03	0.45	0.96	2.31	1.15	3.46
14	13	1	1	1	52	4.73	1.55	3.18	0.64	0.45	1.09	1	0.45	2.73	0.64
15	13	1	1	2	32	5.33	2	3.33	1.5	0.17	1.33	0.33	1.5	1.83	1.17
16	13	1	1	3	70	4.67	1.27	3.4	0.4	0.93	1.4	0.6	0.73	2.6	0.47
17	13	1	2	1	60	5.45	1.64	3.82	0.82	1	1.18	0.82	0.82	3	0.55
18	13	1	2	2	58	9.67	2.83	6.83	0.5	1.83	3.17	1.17	2.17	4.5	1
19	13	1	2	3	118	8.81	3.28	5.52	1.42	0.82	2.39	0.6	1.19	4.03	1.19
20	26	1	1	1	115	10.45	4.18	6.27	0.18	1.64	2.55	1.73	2.55	3.55	4
21	26	1	1	2	45	7.5	3.17	4.33	1	1	1.5	0.83	1.5	2.83	1.83
22	26	1	1	3	137	8.73	4.33	4.39	0.64	0.57	1.85	1.08	2.55	1.59	3.38
23	26	1	2	1	98	8.91	4	4.91	0.27	0.82	1.91	1.73	1.64	3.09	3.27
24	26	1	2	2	69	11.5	7	4.5	0.17	0.67	2.17	0.83	1.67	2.17	6
25	26	1	2	3	164	10.51	5.19	5.32	0.32	0.9	2.24	1.47	1.67	3.27	2.5
26	14	2	1	1	80	7.27	3.09	4.18	0.27	0.18	3	0.55	2	2	2.18
27	14	2	1	2	29	4.83	1.83	3	0.17	0.17	2.17	0	0.83	1.67	1.17
28	14	2	1	3	103	6.87	2.8	4.07	0.07	0.2	3	0.47	2.13	1.6	2
29	14	2	2	1	71	6.45	2.18	4.27	0.55	0.36	2.73	0.45	1.73	2.36	1.91
30	14	2	2	2	53	8.83	4	4.83	0.5	0	3.33	0.83	2.33	2.33	2.17
31	14	2	2	3	94	7.18	2.29	4.89	0.23	0.08	3.05	1.07	1.68	2.75	1.91
32	11	2	1	1	65	5.91	0.45	5.45	0.55	1	2.45	0.82	0.09	4.73	0.45
33	11	2	1	2	38	6.33	1.33	5	1	1.33	2	0.17	0.5	4	1
34	11	2	1	3	61	5.35	1.32	4.04	1.32	0.53	1.93	0.09	0.35	3.51	1.32
35	11	2	2	1	83	7.55	1.82	5.73	0.82	0.64	2.82	1	0.82	4.45	1.82
36	11	2	2	2	51	8.5	3.17	5.33	1.33	0.33	1.83	0.83	2.17	2.17	3
37	11	2	2	3	79	6.99	3.1	3.89	0.97	0.62	1.42	0.18	1.68	1.5	2.57
38	12	2	1	1	45	4.09	1.18	2.91	0.18	1.45	0.27	0.73	0.45	2.18	0.45
39	12	2	1	2	23	3.83	1.67	2.17	0	1.33	0.67	0.17	1.17	1	1.33
40	12	2	1	3	61	4.18	1.37	2.81	0.41	0.89	0.75	0.34	0.68	1.71	1.1
41	12	2	2	1	74	6.73	1.36	5.36	0.55	1.36	2	0.73	1.27	3.36	1
42	12	2	2	2	32	5.33	1.33	4	0.33	1.67	1	0.33	0.83	2.5	0.67
43	12	2	2	3	86	6.28	2.19	4.09	0.22	0.95	1.97	0.07	0.44	2.77	0.95

COMMUNICATION DATA SPREADSHEET

	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD
1	ac12	ac13	ac14	ac15	ac16	ac17	ac18	ac19	ac20	ac21	ac22	ac23	ac24	ac25	ac26
2	0.55	1.18	2.27	0.45	0.27	0.64	0.36	0.91	1.64	0.09	3.09	0.18	0.18	0.82	0.09
3	0.83	1.33	2.17	1.5	0.67	0.17	1	0.67	2	0.5	3.33	0.17	0	0.67	0.17
4	0.59	1.25	2.5	0.66	0.46	0.66	0.46	0.79	1.84	0.2	3.03	0.46	0.26	0.92	0.13
5	0.45	0.91	2.82	1	0.18	0.18	0.64	0.73	2.64	0.36	2.73	0.91	0.09	0.27	0.09
6	2	1.83	2.67	1.17	0.67	0.5	1.17	1.17	2.17	0	3.83	0.67	0	0.83	0.33
7	1.23	1.38	3.54	1.31	0.85	0.69	0.92	0.54	2.85	0.38	3.92	0.77	0.23	1.15	0.38
8	1.45	2.36	3.55	3.55	1.36	1.18	1.18	1	2.36	2.36	5	0.82	0.09	1.82	0.64
9	0.83	1.33	2.67	2.33	0.67	1.17	0.67	0.67	1.5	1.67	3.67	0.33	0	1.5	0.33
10	2.34	2.03	4.24	2.15	1.2	2.22	1.01	0.82	2.03	1.14	5.19	0.76	0.32	2.47	0.63
11	1.64	2.18	5	4.91	1.45	1.45	1	0.73	3.55	3.91	5.82	1.18	0.18	1.91	0.82
12	2	3.33	4.83	3.67	2.17	1.83	1.33	1.17	3	2.33	6.83	1.33	0	3	1
13	2.76	3.27	4.17	2.24	2.18	1.99	1.22	1.09	2.18	1.03	5.9	1.41	0.13	2.88	1.22
14	0.91	0.82	2.55	1.36	0.36	0.91	0.27	0.45	1.64	1.09	3	0.36	0	1.27	0
15	0.83	1.5	3.17	0.67	1	0.83	0.17	0.5	2.33	0.5	4.33	0.33	0	1.67	0.17
16	0.87	0.93	2.53	1.2	0.33	0.93	0	0.6	1.6	1.2	3	0.47	0	1.13	0.13
17	1.09	0.73	3.18	1.55	0.36	0.73	0.55	0.36	2.45	1	3.27	0.55	0.09	0.82	0.18
18	2	1.83	5.67	2.17	0.5	1.83	0.5	1.33	3.83	1.67	6.5	0.83	0.17	2	0.17
19	2.39	2.24	4.78	1.79	0.75	2.09	0.45	1.49	2.69	1.34	5.67	1.19	0.15	2.31	0.45
20	0.36	2.45	4.82	3.18	1.27	1	1.91	1.18	3.82	1.27	6.36	0.73	0.18	1.91	0.18
21	1.33	1.83	3.17	2.5	0.67	1.17	1.33	1.17	2	1.17	4	0.83	0.17	1.5	0.33
22	1.21	2.23	3.5	2.99	0.89	1.53	1.91	1.34	1.97	1.08	4.08	1.15	0.51	1.46	0.51
23	0.91	2	4.36	2.55	1.27	1.64	1.09	0.73	2.73	1.45	5.73	0.45	0.18	2.36	0.36
24	1.67	4.17	4.67	2.67	2.67	2.33	2	1.5	2.33	0.67	7.5	1.33	0	4	1
25	3.08	3.27	4.36	2.88	1.6	1.99	1.6	1.67	2.37	1.28	6.35	0.96	0.32	2.69	0.71
26	1.09	2.64	2.91	1.73	1.18	0.82	1.09	1.45	2.09	0.64	4.09	1.36	0.09	1.55	0.45
27	1.17	1.5	2.5	0.83	0.33	0.83	0.67	1.17	1.67	0.17	2.67	1.33	0	0.67	0.5
28	1.13	1.73	3.47	1.67	0.6	1.07	1.13	1.13	2.4	0.53	4.2	0.87	0.13	1.27	0.33
29	0.45	2.36	2.18	1.91	0.82	0.18	1.18	1.55	2	0.73	3.09	1.45	0	0.64	0.36
30	2	2.5	5	1.33	1.33	1.83	0.83	1.17	3.17	0.5	5	2.33	0.17	1.67	1.33
31	0.84	2.98	2.98	1.22	1.07	0.53	0.69	1.91	2.44	0.53	3.74	2.21	0	0.92	0.69
32	0.64	2	2.18	1.73	0.27	0.09	0.09	1.73	2.09	1.64	3.36	0.82	0	0.09	0.27
33	0.83	2	3.17	1.17	0.33	0.67	0.33	1.67	2.5	0.83	4.17	1	0	1	0
34	0.18	0.88	3.42	1.05	0.18	0.96	0.18	0.7	2.46	0.88	3.68	0.61	0	0.96	0.18
35	0.45	2.09	2.82	2.64	1	0.55	0.27	1.09	2.27	2.36	3.45	1.45	0	1	0.55
36	1.17	2.17	4	2.33	0.83	1.67	0.67	1.33	2.33	1.67	3.67	2.33	0.17	1.67	0.83
37	1.24	3.01	2.83	1.15	1.33	1.24	0.53	1.68	1.59	0.62	3.54	2.21	0.09	1.86	0.71
38	1	1.09	2.09	0.91	0.36	0.45	0.36	0.73	1.64	0.55	3	0.18	0	0.73	0.09
39	0.33	0.5	2.5	0.83	0.33	0.67	0.67	0.17	1.83	0.17	2.67	0.33	0	0.67	0.33
40	0.68	1.03	2.47	0.68	0.48	0.55	0.34	0.55	1.92	0.34	2.74	0.68	0.07	0.68	0.34
41	1.09	1.64	4.27	0.82	0.55	0.27	0.55	1.09	4	0.27	4.91	1	0	0.55	0.27
42	1.33	2.17	2.67	0.5	0.67	0.33	0.33	1.5	2.33	0.17	3.17	1.5	0.17	0.5	0.5
43	2.12	2.12	3.65	0.51	0.44	1.31	0.44	1.68	2.34	0.07	4.82	0.88	0.07	1.53	0.15

COMMUNICATION DATA SPREADSHEET

	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS
1	ac27	ac28	ac29	ac30	ac31	ac32	ac33	ac34	ac35	ac36	ac37	ac38	ac39	ac40	ac41
2	0	2.27	0.09	0.18	0.18	0.36	0.09	0	0.09	0.55	0	0	0.55	1	0
3	0	2.67	0	0	0.17	0	0.17	0	0.17	0.17	0	0	0.5	1.83	0
4	0.07	2.11	0.33	0.2	0.33	0.26	0.13	0	0.07	0.46	0	0	0.13	1.32	0.26
5	0	2.45	0.82	0.09	0.09	0.18	0	0	0	0.18	0.09	0.18	0.27	1.91	0.27
6	0	3	0.33	0	0.33	0	0	0	0	0.83	0	0	0.67	1.33	0.33
7	0	2.77	0.38	0.23	0.31	0.15	0.23	0	0.08	0.46	0	0.23	0.31	1.85	0.08
8	0.09	3.18	0.18	0	0.64	0.64	0.45	0	0.27	1.36	0	0	0.09	1	0.09
9	0	2.17	0	0	0.33	0.5	0.33	0	0	0.83	0	0	0.5	0.67	0
10	0.32	2.72	0.13	0	0.25	0.82	0.57	0	0.13	1.2	0.06	0	0.19	0.82	0
11	0.18	3.91	0.36	0	0.64	0.64	0.18	0	0	1.18	0.09	0	0.27	2.27	0.09
12	0	3.83	0.33	0	1.17	1	1	0	0	1.33	0.17	0	0.17	1.67	0.17
13	0.06	3.01	0.19	0.06	0.77	0.71	1.03	0	0.19	1.73	0	0	0.06	0.38	0.13
14	0	1.73	0.36	0	0.18	0.36	0	0	0	0	0	0	0.45	1.27	0
15	0	2.67	0.17	0	0.67	0.17	0.17	0	0	1.33	0.17	0	0.33	1	0
16	0	1.87	0.33	0	0.27	0.07	0.07	0.07	0	0.27	0.13	0	0.2	1.33	0.2
17	0.09	2.45	0.36	0	0	0	0	0.09	0.09	0.64	0	0.09	0.09	1.64	0.18
18	0.17	4.5	0.67	0	0.33	0.17	0	0	0.17	1	0	0.33	0.67	2.5	0.33
19	0.07	3.36	0.75	0.07	0.3	0.6	0.15	0	0.07	0.75	0.07	0.07	0.37	1.87	0.6
20	0.18	4.45	0.55	0	1.09	0.82	0.18	0	0	1.82	0	0.09	0.55	1.91	0.45
21	0	2.5	0.5	0.17	0.33	0.33	0.17	0	0	0.83	0.17	0	0.5	1.17	0.33
22	0.45	2.61	0.64	0.06	0.45	0.38	0.25	0.06	0.19	1.34	0.25	0.06	0.25	0.57	0.32
23	0.18	3.36	0.09	0	0.82	1.27	0.27	0	0	0.73	0	0	0.55	1.91	0
24	0	3.5	0.33	0	1.83	1.67	0.5	0.17	0	1.33	0	0	0.83	0.83	0.17
25	0.19	3.65	0.26	0.13	0.64	0.77	0.13	0.06	0.26	0.9	0	0	0.77	1.47	0.13
26	0	2.55	0.91	0.09	0.73	0.18	0.45	0	0.18	1.09	0	0.27	0.36	0.73	0.64
27	0	2	0.83	0	0	0.17	0.33	0	0	0.67	0	0	0	0.83	0.83
28	0.07	2.93	0.53	0.07	0.4	0.33	0.2	0	0.33	1.4	0	0.07	0.13	0.8	0.4
29	0	2.45	1.09	0	0.45	0.18	0.36	0	0.09	0.91	0	0.36	0.55	0.73	0.73
30	0.17	3.33	1	0	0	0.67	1	0	0.17	1.33	0	0.33	0.33	1.5	0.5
31	0	2.82	1.53	0	0.38	0.38	0.61	0	0.15	0.92	0	0.31	0.46	1.15	0.84
32	0	3.27	0.55	0	0	0.09	0.27	0	0	0	0.09	0	0.73	2	0.45
33	0	3.17	1	0	0.33	0.5	0	0	0	0.5	0	0	0.33	2	0.83
34	0	2.72	0.44	0	0	0.96	0.18	0	0	0.26	0	0	0.35	2.11	0.26
35	0	2.45	0.91	0	0.45	0.55	0.55	0	0	0.27	0.18	0	0.18	1.91	0.45
36	0	2	1.5	0.17	0	1.67	0.67	0	0	1	0.17	0.17	0	0.83	0.33
37	0	1.68	1.5	0.09	0.62	0.97	0.62	0	0.09	0.71	0.44	0	0.18	0.71	0.35
38	0	2.27	0.09	0	0.27	0.09	0	0	0.09	0.36	0	0	0.36	1.18	0
39	0	2	0	0	0	0.5	0.33	0	0	1.17	0	0	0.17	0.67	0
40	0	2.05	0.34	0.07	0.14	0.55	0.14	0	0	0.41	0.07	0.14	0.27	0.96	0.07
41	0	4.36	0.73	0	0.27	0.27	0.18	0	0	0.91	0.27	0	0.45	2.36	0.18
42	0	2.67	1	0.17	0	0.33	0.33	0	0	0.67	0.17	0	0.17	1.17	0.83
43	0.07	3.28	0.73	0	0.07	0.51	0.15	0	0.15	0.29	0	0	0.8	1.39	0.44

COMMUNICATION DATA SPREADSHEET

	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH
1	ac42	ac43	ac44	ac45	ac46	ac47	ac48	ac49	ac50	ac51	ac52	ac53	ac54	ac55	ac56
2	0.09	0.44	0.66	0.7	0.64	0.67	0	0.86	*	0.65	1	0.75	0	0.8	*
3	0	0.33	0.62	0.2	0.75	0	0	0.5	*	0.79	*	0.5	0	0	*
4	0	0.36	0.67	0.59	0.7	0.44	0	0.88	*	0.91	0	0.58	0	0.8	*
5	0.27	0.42	0.76	0.5	0.78	0.67	*	1	0.67	0.88	0.5	0.67	1	1	0
6	0	0.63	0.59	0.43	0.65	0	*	1	*	0.67	0	0.71	*	*	*
7	0.08	0.43	0.72	0.45	0.84	0.33	0	0.86	1	0.86	0.5	0.6	0.5	0.67	*
8	0	0.49	0.6	0.46	0.7	0.5	0	0.83	*	0.92	0	0.68	0	0.7	*
9	0	0.45	0.67	0.64	0.69	0.6	0	1	*	0.57	*	0.71	0	1	*
10	0	0.42	0.68	0.65	0.71	0.76	0	0.9	0	0.81	*	0.83	0	0.87	0
11	0.09	0.44	0.7	0.5	0.83	0.5	0	1	0	0.89	0.5	0.65	0	1	0
12	0	0.33	0.59	0.46	0.72	0.46	0	1	0	0.91	0	0.53	0	1	0
13	0	0.4	0.56	0.48	0.67	0.48	0	0.9	*	0.86	0	0.69	0	0.79	*
14	0.36	0.42	0.76	0.71	0.78	0.67	*	*	*	0.74	1	0	*	1	*
15	0	0.56	0.68	0.45	0.82	0.2	0	1	0	0.75	*	0.67	0	1	0
16	0	0.61	0.73	0.74	0.73	0.2	0.5	1	0	0.87	0	0.5	0	1	0.33
17	0.09	0.6	0.81	0.67	0.87	*	1	0.88	1	0.95	0.33	1	1	0	1
18	0	0.68	0.76	0.79	0.74	0.33	*	0.86	1	0.79	0	0.75	1	0.5	*
19	0	0.5	0.68	0.74	0.64	0.67	0	0.91	0.5	0.83	0	0.71	0.33	0.89	0
20	0	0.39	0.66	0.44	0.76	0.43	0	1	1	0.78	0	0.63	0.33	1	*
21	0	0.45	0.63	0.64	0.63	0.5	0	1	0	0.7	0	0.71	0	1	0
22	0	0.43	0.61	0.63	0.6	0.46	0.2	0.88	0.2	0.69	0	0.75	0.2	0.67	0.2
23	0.09	0.33	0.69	0.56	0.79	0.61	0	1	*	0.78	1	0.47	0	1	*
24	0	0.22	0.53	0.47	0.61	0.48	0.25	1	*	0.5	0	0.42	0	1	1
25	0	0.4	0.57	0.55	0.59	0.55	0.33	0.78	*	0.66	0	0.58	0	0.75	1
26	0	0.48	0.52	0.41	0.59	0.2	0	0.86	1	0.67	0	0.6	0.38	0.5	*
27	0	0.42	0.63	0.71	0.59	1	0	1	*	1	0	1	0	1	*
28	0	0.52	0.67	0.64	0.68	0.45	0	0.81	1	0.86	0	0.78	0.25	0.5	*
29	0	0.48	0.48	0.18	0.56	0.29	0	0.91	1	0.57	0	0.67	0.5	0.67	*
30	0	0.52	0.67	0.58	0.73	1	0	0.89	1	0.82	0	1	0.25	0.8	*
31	0.08	0.47	0.5	0.33	0.56	0.5	0	0.86	1	0.71	0.08	0.71	0.33	0.71	*
32	0	0.17	0.52	0.25	0.55	1	0	*	0	0.73	0	*	0	1	0
33	0	0.33	0.61	0.67	0.6	0.6	*	1	*	0.86	0	0.6	*	1	*
34	0.09	0.21	0.8	0.85	0.78	1	0	1	*	0.86	0.25	1	0	1	*
35	0	0.31	0.57	0.35	0.68	0.55	0	1	0	0.91	0	0.38	0	1	0
36	0	0.42	0.65	0.67	0.64	1	0	1	0.5	1	0	1	0.2	1	0
37	0	0.4	0.48	0.48	0.49	0.61	0	0.89	0	0.8	0	0.53	0	0.92	0
38	0.09	0.5	0.66	0.56	0.69	0.25	*	0.8	*	0.76	1	0.57	*	0.5	*
39	0	0.47	0.83	0.67	0.92	1	0	1	*	0.8	*	1	0	1	*
40	0.07	0.38	0.71	0.53	0.78	0.8	0	1	0.67	0.78	0.5	0.75	0.5	1	0
41	0.18	0.56	0.72	0.33	0.79	0.5	0	1	0	0.84	0.5	0.77	0	1	0
42	0	0.56	0.55	0.33	0.61	1	0	1	0	0.88	0	1	0	1	0
43	0.07	0.32	0.63	0.75	0.58	0.88	0	0.67	*	0.63	0.14	0.8	0	0.78	*

POST MISSION TLX DATA SPREADSHEET

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	site/tm	class	stress	member	trial	post1	post2	post5	post6	post7b	post7d	mental	physical	temporal	perform	effort	frustrat
2	15	1	1	0	4	6	6	7	6	7	6	4	1	6	8	8	4
3	15	1	2	0	3	6	6	7	6	7	4	11	1	7	10	10.5	8
4	15	1	1	1	4	6	6	6	5	5	6	10	11	12	11	9	8
5	15	1	2	1	3	6	6	5	6	5	5	11	8	12	10	12	8
6	15	1	1	2	4	6	6	5	5	6	5	17	15	15	6	16	6
7	15	1	2	2	3	6	6	5	6	5	5	17	15	15	7.5	16	9
8	15	1	1	3	4	6	6	6	5	7	4	11	6.5	8.5	14.5	10.5	5
9	15	1	2	3	3	5	5	4	4	4	4	14	10.5	12	8.5	10	11
10	15	1	1	4	4	6	6	6	6	6	6	13	11.5	13.5	7.5	13.5	7
11	15	1	2	4	3	6	6	6	6	5	6	12	11.5	11	9.5	11	8
12	24	1	1	0	3	6	7	7	6	*	6	12	9	14	4	17	15
13	24	1	2	0	4	6	7	7	6	7	6	17	12	11	10	17	11
14	24	1	1	1	3	5	5	5	5	4	5	13	7	16	10	14	15
15	24	1	2	1	4	5	5	5	5	4	5	14	5	13	13	12	15
16	24	1	1	2	3	6	6	6	5	5	6	13	6	13	8	13	4
17	24	1	2	2	4	6	6	5	5	6	6	14	3	7	9	7	2
18	24	1	1	3	3	7	6	6	6	6	6	17	9	14	13	12	8
19	24	1	2	3	4	7	7	6	6	6	6	17	7	18	15	11	8
20	24	1	1	4	3	7	7	7	7	7	7	1	1	3	1	1	1
21	24	1	2	4	4	7	7	7	7	7	7	6	3	8	3	5	4
22	13	1	1	0	3	5	6	*	5	5	*	9	9	12	6	9	6
23	13	1	2	0	4	3	4	*	3	2	*	9	12	19	17	17.5	19
24	13	1	1	1	3	7	7	6	6	7	6	5	2	3	9	4	1
25	13	1	2	1	4	7	7	6	6	6	6	3	2	5	6	3	2
26	13	1	1	2	3	6	6	6	6	6	6	11.5	7.5	12	5.5	13	2
27	13	1	2	2	4	5	5	5	4	3	3	19	11	19.5	9.5	19.5	8
28	13	1	1	3	3	7	7	5	5	7	7	7.5	7.5	7.5	6	8	5.5
29	13	1	2	3	4	6	6	6	6	6	6	14	11.5	14	9.5	13.5	13
30	13	1	1	4	3	6	6	5	5	5	5	10	5	8	8	9	7
31	13	1	2	4	4	5	6	5	5	5	5	10	5	7	9	5	8
32	26	1	1	0	4	7	7	7	6	7	7	12.5	11.5	14.5	2.5	12.5	5.5
33	26	1	2	0	3	6	6	7	5	7	7	15.5	12	15.5	16.5	14.5	10.5
34	26	1	1	1	4	7	7	6	6	6	7	17	2	16	4	17	16
35	26	1	2	1	3	7	7	5	5	6	6	18	4	19	6	17	18

POST MISSION TLX DATA SPREADSHEET

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
36	26	1	1	2	4	7	7	6	6	6	6	11.5	9	11	4.5	13.5	5.5
37	26	1	2	2	3	6	6	5	5	3	3	15.5	11	15.5	13.5	16	15.5
38	26	1	1	3	4	7	7	7	5	7	6	14	9	8	4	15	2
39	26	1	2	3	3	7	5	5	3	5	5	14	10	13	6	13	10
40	26	1	1	4	4	7	7	6	5	6	6	7	5.5	7.5	2	9.5	1
41	26	1	2	4	3	7	7	5	6	7	5	10	9.5	9.5	7	9.5	5
42	14	2	1	0	4	5	6	*	6	*	6	17.5	9.5	13	9	17	11
43	14	2	2	0	3	3	5	*	6	*	6	19	9.5	19	3.5	17.5	5
44	14	2	1	1	4	6	6	6	5	6	6	8	5	4	4	5	4
45	14	2	2	1	3	6	6	5	6	6	5	9	7	6	7	7	7
46	14	2	1	2	4	7	7	6	7	6	6	4	4	3	5	5	3
47	14	2	2	2	3	7	7	6	6	6	6	6	2	5	7	6	2
48	14	2	1	3	4	6	6	6	6	6	5	11	10	9	7	8	8
49	14	2	2	3	3	5	5	3	4	5	5	15	13	16	10	15	15
50	14	2	1	4	4	6	6	6	5	6.5	6.5	4	1.5	4	5.5	11	2.5
51	14	2	2	4	3	5	5	4	4	6	3	10	2	10	12.5	12.5	12.5
52	11	2	1	0	4	*	*	*	*	*	*	*	*	*	*	*	*
53	11	2	2	0	3	6	7	7	6	7	6	19	11	20	11	19	*
54	11	2	1	1	4	6	6	5	6	6	7	17.5	11.5	17.5	3.5	19.5	9.5
55	11	2	2	1	3	6	6	5	4	4	4	17.5	9.5	17.5	9.5	17.5	11.5
56	11	2	1	2	4	*	*	*	*	*	*	*	*	*	*	*	*
57	11	2	2	2	3	6.5	6.5	6.5	6.5	6	6	15.5	1.5	13.5	5.5	17	9
58	11	2	1	3	4	*	*	*	*	*	*	*	*	*	*	*	*
59	11	2	2	3	3	6	5	6	5	5	4	17	2	17	13	16	19
60	11	2	1	4	4	7	7	6	6	5	5	1	1	1	10.5	16.5	1
61	11	2	2	4	3	7	7	6	5	6	6	1	1	1	10.5	15.5	1
62	12	2	1	0	3	7	6	7	5	7	6	7	4	4	5	19	3
63	12	2	2	0	4	6	5	7	4	7	1	18	11	11	20	19	18
64	12	2	1	1	3	6	6	6	6	6	6	9.5	6	8	8	10	4.5
65	12	2	2	1	4	4	4	5	5	5	5	14	10.5	11.5	10.5	16.5	15
66	12	2	1	2	3	5	5	5	6	6	6	5	5	5	7	8	7
67	12	2	2	2	4	3	3	2	2	2	4	14	12	14	14	14	18
68	12	2	1	3	3	6	6	6	5	6	6	9	7	8	7	10	10
69	12	2	2	3	4	5	5	5	5	4	5	13	5	13	11	11	13
70	12	2	1	4	3	6	6	6	6	6	6	7	1	6	5	5	5
71	12	2	2	4	4	6	6	5	5	5	6	4	1	1	4	6	4

TEAMWORK DATA SPREADSHEET

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	site/tm	class	stress	scenario	trial	atmwk1	atmwk2	atmwk3	atmwk4	atmwk5	atmwk6	atmwk7	atmwk8	atmwk9	atmwk10	atmwk11	atmwk12	atmwk13	atmwk14	atmwk15
2	15	1	1	1	4	6.3	6	6.3	6.3	5.5	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3
3	15	1	2	2	3	5.0	5.3	4.0	5.5	4.5	5.3	5	5.3	6.3	6.3	4.0	6.3	6.3	6	5.5
4	24	1	1	1	3	5.3	5.5	5	6	6	5.5	5	5.5	3.5	4.5	5	4	4	6	6
5	24	1	2	2	4	5	4.5	5	5.5	6	5	4.5	4.0	3.5	4	4.5	4.5	4.5	5.5	5
6	13	1	1	1	3	6.3	5.0	5.0	6.3	6.3	5.5	5.0	6.3	6.3	5.0	6.3	5.3	6	6.3	6.3
7	13	1	2	2	4	6.3	5	5.3	6	6	5.0	5.0	6.3	5.0	5.0	5.5	6	5.5	5.5	5.0
8	26	1	1	1	4	5.5	5.5	5.5	5.5	5.0	5.0	5	5	4	4.5	4	6	4.5	6	5.5
9	26	1	2	2	3	5.5	5	4	6	6	5.5	4	4.5	3.5	4	4	4	4	5.0	5
10	14	2	1	1	4	3.3	2.0	3.3	2.0	3.3	3.3	3.3	3.5	3.3	3.5	5	3.0	3.3	3.0	3.3
11	14	2	2	2	3	2.5	1.0	1.3	1.0	2.3	3	2	2	1.5	2	2	2	2.5	1.0	1.0
12	11	2	1	1	4	3.0	2.0	2.0	3.3	3	4	3.0	3.3	2.0	3.5	2	4	3	3.0	2.3
13	11	2	2	2	3	2.0	2.5	2.5	3	2.3	3.5	2.5	3.5	2.0	2.3	2	2.5	2	2	3.3
14	12	2	1	1	3	3	2.5	2	2.5	2.0	3.5	2.5	2.5	3	3	2.5	4.5	3	3	3
15	12	2	2	2	4	1	1	6	2	2.3	2.3	3	2.0	3.5	3.5	2.0	2.0	2	2.3	2.3

APPENDIX D. BACKGROUND QUESTIONNAIRE DATA

Teams	Training Schools	Last two jobs	Last command	Sea	CIC
SWOS 5					
TAO	swos divo/DH	1st LT, MCMO, Engineer	N/A	47	18
IDS	Service selected	engineering, ops/planning	Comcmgru 1	38	11
TIC	swos Divo/DH	NROTC, MPA, DCA	N/A	42	03
AAWC	swos Divo/DH, Eoow	Auxiliary officer, Commo	N/A	34	02
EWS	swos Divo/DH, Eoow	XO reserve cntr, FF-1093	XO	39	12
NPS 4					
TAO	STWO, E-2 CDR, Jots	E-2C NFO, flight student	YAW-125	14	0
IDS	N/A	Engineer, Tech	N/A	0	0
TIC	Multiple AirForce	Comm syst staff Off, inspector	N/A	0	0
AAWC	Comm-syst Off course	project mngr, chief of maint	N/A	0	0
EWS	Flight School	Helo Det maint/training	Aircraft CDR	0	0
SWOS 3					
TAO	swos Divo	NPS, Research	CG-29	48	48
IDS	swos Divo	CICO, ASW Officer	N/A	36	36
TIC	swos Divo/DH, Nuc schl	reactor divo, radar divo	N/A	36	01
AAWC	swos Divo/DH, ntds, asw	ASW Officer, Navigator	ASW Officer	54	54
EWS	NPS, Nuc school	staff warfare center, R&D	N/A	102	12
NPS 6					
TAO	swos Divo, FWC/SWC	FCO, Main Engine Officer	CG-22	36	07
IDS	Cas3, airborne, comsec	Company CDR, mse/mcs Off	4th ID, co cdr	0	0
TIC	Basic Comm Officer	Asst Commo, battalion commo	platoon cdr	10	0
AAWC	fire/air sprt coord, tacair	Asst ops, oic air control Detach	Mar air supp sqdr	12	0
EWS	swos Divo, ASW Officer	Auxiliary Officer, ASW Off	N/A	76	much
SWOS 4					
TAO	swos Divo/DH, Eoow	NPS, navigator	NPS	36	2
IDS	None	M2LCPO, Company CDR	M division LCPO	84	0
TIC	swos Divo/DH, Eoow	navigator, A Div, E Div	AE-23	96	cico
AAWC	thwk, ntds, comm, terrier	1st LT, BCO	N/A	54	54
EWS	swos Divo/DH	Boilers Officer, SMMO	Eoow	54	limit
SWOS 1					
TAO	swos Divo/DH	staff, Divo	staff, admin	48	0
IDS	Mine Warfare Off, DCA	XO mine Div, instructor trng	operations Officer	34	34
TIC	swos Divo/DH, sas, como	Aide, Navigation, admin	Aide	36	little
AAWC	commo afloat	Oinc mildet, mpa	Oinc mildet	48	cicwo
EWS	swos Divo/DH, sup corp	Nav, admin, staff Suppo	N/A	51	2
SWOS 2					
TAO	swos Divo/DH	Scheduler, deck Officer	N/A	36	24
IDS	None	Instructor, 1st LT	N/A	75	24
TIC	swos Divo/DH	radar Officer, Ops	Ops	50	MCM
AAWC	Flght sch, swos Divo/DH	R division, rase division	cicwo, OOD	24	8
EWS	nuc sch, swos Divo/DH	Sima Divo, Mildet Oinc	N/A	66	limit

APPENDIX E. UNIVARIATE ANALYSIS OF VARIANCE FOR COMMUNICATION VARIABLES (GENERAL LINEAR MODEL)

The following Appendix displays the p-values for the communication variables with regards to the independent variables; Class, Stress, and Period.

Analysis of Variance for ac1

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	3632.2	3632.2	3632.2	5.43	0.027
Stress	1	2768.6	2583.1	2583.1	3.86	0.059
Period	2	23211.6	21424.0	10712.0	16.01	0.000
Class*Stress	1	77.0	77.0	77.0	0.12	0.737
Class*Period	2	1277.7	1277.7	638.9	0.96	0.396
Stress*Period	2	235.6	178.8	89.4	0.13	0.875
Class*Stress*Period	2	187.2	187.2	93.6	0.14	0.870
Error	30	20066.3	20066.3	668.9		
Total	41	51456.1				

Analysis of Variance for ac2

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	20.655	20.655	20.655	4.36	0.045
Stress	1	40.671	38.429	38.429	8.11	0.008
Period	2	0.302	0.232	0.116	0.02	0.976
Class*Stress	1	0.624	0.624	0.624	0.13	0.719
Class*Period	2	0.421	0.421	0.211	0.04	0.957
Stress*Period	2	9.291	8.278	4.139	0.87	0.428
Class*Stress*Period	2	1.262	1.262	0.631	0.13	0.876
Error	30	142.068	142.068	4.736		
Total	41	215.294				

Analysis of Variance for ac3

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	13.554	13.554	13.554	7.53	0.010
Stress	1	8.514	7.908	7.908	4.39	0.045
Period	2	4.130	3.824	1.912	1.06	0.359
Class*Stress	1	0.282	0.282	0.282	0.16	0.695
Class*Period	2	0.189	0.189	0.094	0.05	0.949
Stress*Period	2	4.505	4.011	2.006	1.11	0.342
Class*Stress*Period	2	0.485	0.485	0.242	0.13	0.875
Error	30	54.028	54.028	1.801		
Total	41	85.687				

Analysis of Variance for ac4

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.738	0.738	0.738	0.48	0.496
Stress	1	11.915	11.421	11.421	7.36	0.011
Period	2	3.066	3.084	1.542	0.99	0.382
Class*Stress	1	0.067	0.067	0.067	0.04	0.837
Class*Period	2	0.130	0.130	0.065	0.04	0.959
Stress*Period	2	0.999	0.926	0.463	0.30	0.744
Class*Stress*Period	2	0.208	0.208	0.104	0.07	0.935
Error	30	46.584	46.584	1.553		
Total	41	63.707				

Analysis of Variance for ac5

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	1.1524	1.1524	1.1524	2.40	0.132
Stress	1	0.2577	0.2579	0.2579	0.54	0.469
Period	2	0.0829	0.0519	0.0259	0.05	0.948
Class*Stress	1	0.0014	0.0014	0.0014	0.00	0.957
Class*Period	2	0.1645	0.1645	0.0822	0.17	0.843
Stress*Period	2	0.5758	0.4539	0.2269	0.47	0.628
Class*Stress*Period	2	0.6746	0.6746	0.3373	0.70	0.503
Error	30	14.4076	14.4076	0.4803		
Total	41	17.3170				

Analysis of Variance for ac6

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.5674	0.5674	0.5674	2.35	0.135
Stress	1	0.0721	0.0342	0.0342	0.14	0.709
Period	2	0.7058	0.6891	0.3446	1.43	0.255
Class*Stress	1	0.3205	0.3205	0.3205	1.33	0.258
Class*Period	2	0.0129	0.0129	0.0064	0.03	0.974
Stress*Period	2	0.2198	0.1415	0.0708	0.29	0.748
Class*Stress*Period	2	0.4554	0.4554	0.2277	0.94	0.400
Error	30	7.2308	7.2308	0.2410		
Total	41	9.5847				

Analysis of Variance for ac7

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	5.5503	5.5503	5.5503	6.53	0.016
Stress	1	1.4560	1.4863	1.4863	1.75	0.196
Period	2	0.0240	0.0666	0.0333	0.04	0.962
Class*Stress	1	0.0303	0.0303	0.0303	0.04	0.851
Class*Period	2	0.5369	0.5369	0.2685	0.32	0.732
Stress*Period	2	0.0939	0.0548	0.0274	0.03	0.968
Class*Stress*Period	2	0.3708	0.3708	0.1854	0.22	0.805
Error	30	25.5149	25.5149	0.8505		
Total	41	33.5772				

Analysis of Variance for ac8

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	4.4053	4.4053	4.4053	18.83	0.000
Stress	1	0.7072	0.6791	0.6791	2.90	0.099
Period	2	1.3553	1.2872	0.6436	2.75	0.080
Class*Stress	1	0.0034	0.0034	0.0034	0.01	0.906
Class*Period	2	0.0173	0.0173	0.0087	0.04	0.964
Stress*Period	2	0.3831	0.3832	0.1916	0.82	0.451
Class*Stress*Period	2	0.0711	0.0711	0.0356	0.15	0.860
Error	30	7.0189	7.0189	0.2340		
Total	41	13.9616				

Analysis of Variance for ac9

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.8016	0.8016	0.8016	1.32	0.259
Stress	1	0.6815	0.8584	0.8584	1.42	0.243
Period	2	0.1291	0.1510	0.0755	0.12	0.883
Class*Stress	1	0.5870	0.5870	0.5870	0.97	0.333
Class*Period	2	0.0813	0.0813	0.0407	0.07	0.935
Stress*Period	2	0.8430	0.8150	0.4075	0.67	0.518
Class*Stress*Period	2	0.1987	0.1987	0.0994	0.16	0.850
Error	30	18.1776	18.1776	0.6059		
Total	41	21.4998				

Analysis of Variance for ac10

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.454	0.454	0.454	0.42	0.521
Stress	1	3.981	3.267	3.267	3.04	0.091
Period	2	5.579	5.616	2.808	2.61	0.090
Class*Stress	1	1.368	1.368	1.368	1.27	0.268
Class*Period	2	0.473	0.473	0.236	0.22	0.804
Stress*Period	2	0.239	0.237	0.118	0.11	0.896
Class*Stress*Period	2	0.001	0.001	0.000	0.00	1.000
Error	30	32.218	32.218	1.074		
Total	41	44.313				

Analysis of Variance for ac11

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	2.853	2.853	2.853	1.71	0.201
Stress	1	2.526	2.557	2.557	1.53	0.225
Period	2	0.501	0.517	0.258	0.16	0.857
Class*Stress	1	0.033	0.033	0.033	0.02	0.888
Class*Period	2	0.141	0.141	0.071	0.04	0.959
Stress*Period	2	2.328	1.899	0.949	0.57	0.572
Class*Stress*Period	2	0.971	0.971	0.485	0.29	0.749
Error	30	49.995	49.995	1.666		
Total	41	59.348				

Analysis of Variance for ac12

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	1.6687	1.6687	1.6687	6.38	0.017
Stress	1	3.8766	3.4867	3.4867	13.32	0.001
Period	2	2.8102	2.4107	1.2053	4.61	0.018
Class*Stress	1	0.3251	0.3251	0.3251	1.24	0.274
Class*Period	2	0.7670	0.7670	0.3835	1.47	0.247
Stress*Period	2	1.8807	1.8818	0.9409	3.60	0.040
Class*Stress*Period	2	0.0199	0.0199	0.0099	0.04	0.963
Error	30	7.8513	7.8513	0.2617		
Total	41	19.1994				

Analysis of Variance for ac13

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.0045	0.0045	0.0045	0.01	0.926
Stress	1	5.7720	5.8674	5.8674	11.59	0.002
Period	2	0.6636	0.4606	0.2303	0.45	0.639
Class*Stress	1	0.0967	0.0967	0.0967	0.19	0.665
Class*Period	2	0.9566	0.9566	0.4783	0.94	0.400
Stress*Period	2	3.6303	3.4639	1.7319	3.42	0.046
Class*Stress*Period	2	0.3904	0.3904	0.1952	0.39	0.683
Error	30	15.1881	15.1881	0.5063		
Total	41	26.7022				

Analysis of Variance for ac14

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	3.3565	3.3565	3.3565	4.52	0.042
Stress	1	8.2371	7.5020	7.5020	10.10	0.003
Period	2	0.6407	0.7745	0.3872	0.52	0.599
Class*Stress	1	0.5060	0.5060	0.5060	0.68	0.416
Class*Period	2	0.4395	0.4395	0.2198	0.30	0.746
Stress*Period	2	1.6804	1.6380	0.8190	1.10	0.345
Class*Stress*Period	2	0.5616	0.5616	0.2808	0.38	0.688
Error	30	22.2791	22.2791	0.7426		
Total	41	37.7010				

Analysis of Variance for ac15

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	6.980	6.980	6.980	6.96	0.013
Stress	1	1.227	1.082	1.082	1.08	0.307
Period	2	1.718	1.778	0.889	0.89	0.423
Class*Stress	1	0.156	0.156	0.156	0.16	0.696
Class*Period	2	0.092	0.092	0.046	0.05	0.955
Stress*Period	2	0.392	0.417	0.208	0.21	0.814
Class*Stress*Period	2	0.085	0.085	0.043	0.04	0.959
Error	30	30.092	30.092	1.003		
Total	41	40.742				

Analysis of Variance for ac16

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	1.0496	1.0496	1.0496	3.49	0.071
Stress	1	2.1398	2.0854	2.0854	6.94	0.013
Period	2	0.1801	0.1232	0.0616	0.21	0.816
Class*Stress	1	0.0007	0.0007	0.0007	0.00	0.963
Class*Period	2	0.2424	0.2424	0.1212	0.40	0.672
Stress*Period	2	0.7449	0.6744	0.3372	1.12	0.339
Class*Stress*Period	2	0.0535	0.0535	0.0267	0.09	0.915
Error	30	9.0122	9.0122	0.3004		
Total	41	13.4232				

Analysis of Variance for ac17

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	2.1476	2.1476	2.1476	7.13	0.012
Stress	1	1.0498	0.9360	0.9360	3.11	0.088
Period	2	2.2738	2.2958	1.1479	3.81	0.034
Class*Stress	1	0.1063	0.1063	0.1063	0.35	0.557
Class*Period	2	0.2678	0.2678	0.1339	0.44	0.645
Stress*Period	2	0.8667	0.8406	0.4203	1.39	0.264
Class*Stress*Period	2	0.0012	0.0012	0.0006	0.00	0.998
Error	30	9.0413	9.0413	0.3014		
Total	41	15.7546				

Analysis of Variance for ac18

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	1.4272	1.4272	1.4272	5.14	0.031
Stress	1	0.1907	0.1650	0.1650	0.59	0.447
Period	2	0.0480	0.0365	0.0183	0.07	0.936
Class*Stress	1	0.0330	0.0330	0.0330	0.12	0.733
Class*Period	2	0.0426	0.0426	0.0213	0.08	0.926
Stress*Period	2	0.1402	0.0966	0.0483	0.17	0.841
Class*Stress*Period	2	0.2004	0.2004	0.1002	0.36	0.700
Error	30	8.3249	8.3249	0.2775		
Total	41	10.4071				

Analysis of Variance for ac19

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.9061	0.9061	0.9061	7.00	0.013
Stress	1	0.8889	0.9629	0.9629	7.44	0.011
Period	2	0.1876	0.1377	0.0689	0.53	0.593
Class*Stress	1	0.1137	0.1137	0.1137	0.88	0.356
Class*Period	2	0.2512	0.2512	0.1256	0.97	0.391
Stress*Period	2	1.1360	1.1566	0.5783	4.47	0.020
Class*Stress*Period	2	0.3201	0.3201	0.1601	1.24	0.305
Error	30	3.8841	3.8841	0.1295		
Total	41	7.6877				

Analysis of Variance for ac20

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.1360	0.1360	0.1360	0.40	0.533
Stress	1	3.3887	3.1209	3.1209	9.10	0.005
Period	2	0.6438	0.5578	0.2789	0.81	0.453
Class*Stress	1	0.1502	0.1502	0.1502	0.44	0.513
Class*Period	2	0.1154	0.1154	0.0577	0.17	0.846
Stress*Period	2	0.3567	0.4419	0.2210	0.64	0.532
Class*Stress*Period	2	0.5560	0.5560	0.2780	0.81	0.454
Error	30	10.2829	10.2829	0.3428		
Total	41	15.6298				

Analysis of Variance for ac21

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	2.0816	2.0816	2.0816	3.08	0.089
Stress	1	0.4443	0.3961	0.3961	0.59	0.450
Period	2	2.0205	2.0138	1.0069	1.49	0.241
Class*Stress	1	0.0451	0.0451	0.0451	0.07	0.798
Class*Period	2	0.0089	0.0089	0.0044	0.01	0.993
Stress*Period	2	0.2677	0.2814	0.1407	0.21	0.813
Class*Stress*Period	2	0.1278	0.1278	0.0639	0.09	0.910
Error	30	20.2615	20.2615	0.6754		
Total	41	25.2574				

Analysis of Variance for ac22

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	10.432	10.432	10.432	8.13	0.008
Stress	1	10.281	8.947	8.947	6.97	0.013
Period	2	0.730	0.529	0.264	0.21	0.815
Class*Stress	1	1.631	1.631	1.631	1.27	0.269
Class*Period	2	0.995	0.995	0.498	0.39	0.682
Stress*Period	2	4.111	3.332	1.666	1.30	0.288
Class*Stress*Period	2	1.643	1.643	0.821	0.64	0.534
Error	30	38.516	38.516	1.284		
Total	41	68.338				

Analysis of Variance for ac23

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	2.5217	2.5217	2.5217	15.81	0.000
Stress	1	4.1297	4.5126	4.5126	28.30	0.000
Period	2	0.4861	0.5274	0.2637	1.65	0.208
Class*Stress	1	0.6251	0.6251	0.6251	3.92	0.057
Class*Period	2	0.3188	0.3188	0.1594	1.00	0.380
Stress*Period	2	0.4337	0.4647	0.2323	1.46	0.249
Class*Stress*Period	2	0.0754	0.0754	0.0377	0.24	0.791
Error	30	4.7842	4.7842	0.1595		
Total	41	13.3747				

Analysis of Variance for ac24

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.069302	0.069302	0.069302	8.40	0.007
Stress	1	0.001050	0.002024	0.002024	0.25	0.624
Period	2	0.084233	0.063868	0.031934	3.87	0.032
Class*Stress	1	0.008176	0.008176	0.008176	0.99	0.328
Class*Period	2	0.088525	0.088525	0.044262	5.36	0.010
Stress*Period	2	0.023957	0.028055	0.014028	1.70	0.200
Class*Stress*Period	2	0.021246	0.021246	0.010623	1.29	0.291
Error	30	0.247608	0.247608	0.008254		
Total	41	0.544098				

Analysis of Variance for ac25

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	5.4147	5.4147	5.4147	10.34	0.003
Stress	1	2.2867	2.0470	2.0470	3.91	0.057
Period	2	1.7706	1.6740	0.8370	1.60	0.219
Class*Stress	1	0.2130	0.2130	0.2130	0.41	0.529
Class*Period	2	0.1040	0.1040	0.0520	0.10	0.906
Stress*Period	2	1.7199	1.5307	0.7653	1.46	0.248
Class*Stress*Period	2	0.1968	0.1968	0.0984	0.19	0.830
Error	30	15.7173	15.7173	0.5239		
Total	41	27.4230				

Analysis of Variance for ac26

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.00423	0.00423	0.00423	0.05	0.827
Stress	1	0.94500	0.94294	0.94294	10.89	0.003
Period	2	0.28663	0.28564	0.14282	1.65	0.209
Class*Stress	1	0.00389	0.00389	0.00389	0.04	0.834
Class*Period	2	0.12101	0.12101	0.06051	0.70	0.505
Stress*Period	2	0.20933	0.22764	0.11382	1.31	0.284
Class*Stress*Period	2	0.05332	0.05332	0.02666	0.31	0.737
Error	30	2.59878	2.59878	0.08663		
Total	41	4.22219				

Analysis of Variance for ac27

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.047834	0.047834	0.047834	5.87	0.022
Stress	1	0.000000	0.000057	0.000057	0.01	0.934
Period	2	0.033390	0.024996	0.012498	1.53	0.232
Class*Stress	1	0.002810	0.002810	0.002810	0.34	0.561
Class*Period	2	0.030862	0.030862	0.015431	1.89	0.168
Stress*Period	2	0.029886	0.024593	0.012297	1.51	0.237
Class*Stress*Period	2	0.013584	0.013584	0.006792	0.83	0.444
Error	30	0.244425	0.244425	0.008147		
Total	41	0.402790				

Analysis of Variance for ac28

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.8112	0.8112	0.8112	1.66	0.207
Stress	1	2.8392	2.4084	2.4084	4.94	0.034
Period	2	0.4750	0.4729	0.2364	0.48	0.621
Class*Stress	1	0.6572	0.6572	0.6572	1.35	0.255
Class*Period	2	0.4669	0.4669	0.2335	0.48	0.624
Stress*Period	2	0.5551	0.3987	0.1994	0.41	0.668
Class*Stress*Period	2	0.7468	0.7468	0.3734	0.77	0.474
Error	30	14.6358	14.6358	0.4879		
Total	41	21.1873				

Analysis of Variance for ac29

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	2.33022	2.33022	2.33022	27.48	0.000
Stress	1	1.13029	1.33818	1.33818	15.78	0.000
Period	2	0.03527	0.04515	0.02257	0.27	0.768
Class*Stress	1	0.53560	0.53560	0.53560	6.32	0.018
Class*Period	2	0.09494	0.09494	0.04747	0.56	0.577
Stress*Period	2	0.04775	0.06081	0.03041	0.36	0.702
Class*Stress*Period	2	0.13430	0.13430	0.06715	0.79	0.462
Error	30	2.54419	2.54419	0.08481		
Total	41	6.85256				

Analysis of Variance for ac30

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.001716	0.001716	0.001716	0.39	0.534
Stress	1	0.000688	0.001000	0.001000	0.23	0.635
Period	2	0.014948	0.012262	0.006131	1.41	0.260
Class*Stress	1	0.001572	0.001572	0.001572	0.36	0.552
Class*Period	2	0.014319	0.014319	0.007160	1.65	0.209
Stress*Period	2	0.006005	0.007092	0.003546	0.82	0.452
Class*Stress*Period	2	0.024006	0.024006	0.012003	2.76	0.079
Error	30	0.130358	0.130358	0.004345		
Total	41	0.193612				

Analysis of Variance for ac31

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.7873	0.7873	0.7873	6.61	0.015
Stress	1	0.1749	0.1434	0.1434	1.20	0.281
Period	2	0.0283	0.0362	0.0181	0.15	0.860
Class*Stress	1	0.0609	0.0609	0.0609	0.51	0.480
Class*Period	2	0.5098	0.5098	0.2549	2.14	0.135
Stress*Period	2	0.1857	0.1294	0.0647	0.54	0.586
Class*Stress*Period	2	0.3327	0.3327	0.1664	1.40	0.263
Error	30	3.5737	3.5737	0.1191		
Total	41	5.6534				

Analysis of Variance for ac32

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.0000	0.0000	0.0000	0.00	0.999
Stress	1	0.5060	0.5073	0.5073	2.98	0.095
Period	2	0.1809	0.2707	0.1353	0.79	0.461
Class*Stress	1	0.0033	0.0033	0.0033	0.02	0.890
Class*Period	2	0.4848	0.4848	0.2424	1.42	0.257
Stress*Period	2	0.3495	0.3421	0.1711	1.00	0.379
Class*Stress*Period	2	0.0700	0.0700	0.0350	0.21	0.815
Error	30	5.1151	5.1151	0.1705		
Total	41	6.7096				

Analysis of Variance for ac33

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.10487	0.10487	0.10487	1.43	0.241
Stress	1	0.28834	0.33583	0.33583	4.58	0.041
Period	2	0.15625	0.14669	0.07335	1.00	0.379
Class*Stress	1	0.11310	0.11310	0.11310	1.54	0.224
Class*Period	2	0.05599	0.05599	0.02799	0.38	0.686
Stress*Period	2	0.13411	0.13634	0.06817	0.93	0.406
Class*Stress*Period	2	0.00716	0.00716	0.00358	0.05	0.952
Error	30	2.19837	2.19837	0.07328		
Total	41	3.05819				

Analysis of Variance for ac34

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.003616	0.003616	0.003616	3.12	0.087
Stress	1	0.000860	0.000645	0.000645	0.56	0.461
Period	2	0.000400	0.000300	0.000150	0.13	0.879
Class*Stress	1	0.000645	0.000645	0.000645	0.56	0.461
Class*Period	2	0.000300	0.000300	0.000150	0.13	0.879
Stress*Period	2	0.002133	0.001600	0.000800	0.69	0.509
Class*Stress*Period	2	0.001600	0.001600	0.000800	0.69	0.509
Error	30	0.034725	0.034725	0.001158		
Total	41	0.044279				

Analysis of Variance for ac35

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.000229	0.000229	0.000229	0.03	0.872
Stress	1	0.000002	0.000001	0.000001	0.00	0.992
Period	2	0.055714	0.055108	0.027554	3.19	0.055
Class*Stress	1	0.000287	0.000287	0.000287	0.03	0.857
Class*Period	2	0.000555	0.000555	0.000278	0.03	0.968
Stress*Period	2	0.021733	0.021191	0.010595	1.23	0.307
Class*Stress*Period	2	0.003419	0.003419	0.001710	0.20	0.821
Error	30	0.258767	0.258767	0.008626		
Total	41	0.340707				

Analysis of Variance for ac36

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.2944	0.2944	0.2944	1.19	0.284
Stress	1	0.1001	0.1057	0.1057	0.43	0.518
Period	2	0.3267	0.3558	0.1779	0.72	0.495
Class*Stress	1	0.0072	0.0072	0.0072	0.03	0.866
Class*Period	2	0.0545	0.0545	0.0273	0.11	0.896
Stress*Period	2	0.2047	0.1644	0.0822	0.33	0.720
Class*Stress*Period	2	0.2195	0.2195	0.1097	0.44	0.646
Error	30	7.4172	7.4172	0.2472		
Total	41	8.6242				

Analysis of Variance for ac37

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.007622	0.007622	0.007622	0.78	0.383
Stress	1	0.012002	0.020317	0.020317	2.09	0.159
Period	2	0.003233	0.002491	0.001245	0.13	0.880
Class*Stress	1	0.057003	0.057003	0.057003	5.86	0.022
Class*Period	2	0.009719	0.009719	0.004860	0.50	0.612
Stress*Period	2	0.010890	0.008134	0.004067	0.42	0.662
Class*Stress*Period	2	0.008562	0.008562	0.004281	0.44	0.648
Error	30	0.291750	0.291750	0.009725		
Total	41	0.400783				

Analysis of Variance for ac38

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.02362	0.02362	0.02362	1.72	0.199
Stress	1	0.04937	0.04980	0.04980	3.63	0.066
Period	2	0.00096	0.00118	0.00059	0.04	0.958
Class*Stress	1	0.00052	0.00052	0.00052	0.04	0.847
Class*Period	2	0.00075	0.00075	0.00038	0.03	0.973
Stress*Period	2	0.01330	0.01570	0.00785	0.57	0.570
Class*Stress*Period	2	0.00636	0.00636	0.00318	0.23	0.794
Error	30	0.41136	0.41136	0.01371		
Total	41	0.50623				

Analysis of Variance for ac39

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.04072	0.04072	0.04072	0.96	0.336
Stress	1	0.03486	0.03254	0.03254	0.76	0.389
Period	2	0.03640	0.03642	0.01821	0.43	0.656
Class*Stress	1	0.00094	0.00094	0.00094	0.02	0.883
Class*Period	2	0.43756	0.43756	0.21878	5.14	0.012
Stress*Period	2	0.16785	0.16503	0.08252	1.94	0.162
Class*Stress*Period	2	0.01526	0.01526	0.00763	0.18	0.837
Error	30	1.27769	1.27769	0.04259		
Total	41	2.01128				

Analysis of Variance for ac40

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.1413	0.1413	0.1413	0.44	0.512
Stress	1	0.9182	0.7238	0.7238	2.26	0.144
Period	2	1.0027	0.9592	0.4796	1.49	0.241
Class*Stress	1	0.4669	0.4669	0.4669	1.45	0.237
Class*Period	2	0.0650	0.0650	0.0325	0.10	0.904
Stress*Period	2	0.2842	0.3089	0.1544	0.48	0.623
Class*Stress*Period	2	0.0427	0.0427	0.0213	0.07	0.936
Error	30	9.6287	9.6287	0.3210		
Total	41	12.5498				

Analysis of Variance for ac41

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.74298	0.76614	0.76614	13.46	0.001
Stress	1	0.04951	0.01213	0.01213	0.21	0.649
Period	2	0.00053	0.00352	0.00176	0.03	0.970
Class*Stress	1	0.03570	0.01366	0.01366	0.24	0.629
Class*Period	2	0.06429	0.09239	0.04619	0.81	0.457
Stress*Period	2	0.12002	0.13723	0.06861	1.21	0.319
Class*Stress*Period	2	0.03342	0.03342	0.01671	0.29	0.748
Error	22	1.25224	1.25224	0.05692		
Total	33	2.29870				

Analysis of Variance for ac42

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.001572	0.001572	0.001572	0.31	0.581
Stress	1	0.001488	0.001367	0.001367	0.27	0.607
Period	2	0.059443	0.049996	0.024998	4.95	0.014
Class*Stress	1	0.000072	0.000072	0.000072	0.01	0.906
Class*Period	2	0.025643	0.025643	0.012822	2.54	0.096
Stress*Period	2	0.001176	0.001234	0.000617	0.12	0.885
Class*Stress*Period	2	0.000443	0.000443	0.000222	0.04	0.957
Error	30	0.151442	0.151442	0.005048		
Total	41	0.241279				

Analysis of Variance for ac43

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.00883	0.00883	0.00883	0.60	0.446
Stress	1	0.00829	0.01077	0.01077	0.73	0.400
Period	2	0.00996	0.01192	0.00596	0.40	0.672
Class*Stress	1	0.00917	0.00917	0.00917	0.62	0.437
Class*Period	2	0.00578	0.00578	0.00289	0.20	0.824
Stress*Period	2	0.00493	0.00514	0.00257	0.17	0.841
Class*Stress*Period	2	0.00034	0.00034	0.00017	0.01	0.988
Error	30	0.44392	0.44392	0.01480		
Total	41	0.49124				

Analysis of Variance for ac44

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.017738	0.017738	0.017738	2.90	0.099
Stress	1	0.012002	0.015891	0.015891	2.60	0.117
Period	2	0.000476	0.000103	0.000051	0.01	0.992
Class*Stress	1	0.015224	0.015224	0.015224	2.49	0.125
Class*Period	2	0.040560	0.040560	0.020280	3.32	0.050
Stress*Period	2	0.042590	0.045348	0.022674	3.71	0.036
Class*Stress*Period	2	0.006929	0.006929	0.003464	0.57	0.574
Error	30	0.183492	0.183492	0.006116		
Total	41	0.319012				

Analysis of Variance for ac45

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.02019	0.02019	0.02019	0.95	0.337
Stress	1	0.05647	0.06930	0.06930	3.27	0.081
Period	2	0.11624	0.14808	0.07404	3.49	0.043
Class*Stress	1	0.03859	0.03859	0.03859	1.82	0.187
Class*Period	2	0.17813	0.17813	0.08906	4.20	0.025
Stress*Period	2	0.01343	0.01029	0.00514	0.24	0.786
Class*Stress*Period	2	0.01106	0.01106	0.00553	0.26	0.772
Error	30	0.63581	0.63581	0.02119		
Total	41	1.06991				

Analysis of Variance for ac46

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.039114	0.039114	0.039114	5.34	0.028
Stress	1	0.002438	0.004464	0.004464	0.61	0.441
Period	2	0.015576	0.011873	0.005936	0.81	0.454
Class*Stress	1	0.015779	0.015779	0.015779	2.16	0.152
Class*Period	2	0.021615	0.021615	0.010808	1.48	0.245
Stress*Period	2	0.055433	0.060389	0.030195	4.12	0.026
Class*Stress*Period	2	0.020475	0.020475	0.010237	1.40	0.263
Error	30	0.219617	0.219617	0.007321		
Total	41	0.390048				

Analysis of Variance for ac47

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.60467	0.57400	0.57400	11.63	0.002
Stress	1	0.00046	0.00140	0.00140	0.03	0.867
Period	2	0.03627	0.07591	0.03795	0.77	0.473
Class*Stress	1	0.00001	0.00072	0.00072	0.01	0.905
Class*Period	2	0.88155	0.87971	0.43985	8.92	0.001
Stress*Period	2	0.00869	0.01384	0.00692	0.14	0.870
Class*Stress*Period	2	0.03379	0.03379	0.01689	0.34	0.713
Error	29	1.43076	1.43076	0.04934		
Total	40	2.99621				

Analysis of Variance for ac48

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.11552	0.12057	0.12057	3.06	0.093
Stress	1	0.03453	0.03149	0.03149	0.80	0.381
Period	2	0.02319	0.01441	0.00721	0.18	0.834
Class*Stress	1	0.02363	0.03149	0.03149	0.80	0.381
Class*Period	2	0.01642	0.01441	0.00721	0.18	0.834
Stress*Period	2	0.08818	0.06843	0.03422	0.87	0.433
Class*Stress*Period	2	0.06843	0.06843	0.03422	0.87	0.433
Error	24	0.94709	0.94709	0.03946		
Total	35	1.31700				

Analysis of Variance for ac49

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.00065	0.00014	0.00014	0.01	0.914
Stress	1	0.00160	0.00189	0.00189	0.17	0.686
Period	2	0.03110	0.03421	0.01711	1.51	0.239
Class*Stress	1	0.00813	0.00504	0.00504	0.44	0.510
Class*Period	2	0.01429	0.01682	0.00841	0.74	0.486
Stress*Period	2	0.05789	0.06245	0.03123	2.75	0.081
Class*Stress*Period	2	0.01527	0.01527	0.00764	0.67	0.518
Error	28	0.31764	0.31764	0.01134		
Total	39	0.44658				

Analysis of Variance for ac50

Source	Model DF	Reduced DF	Seq SS
Class	1	1	0.06377
Stress	1	1	0.07501
Period	2	2	0.12762
Class*Stress	1	1	0.48601
Class*Period	2	2	0.32384
Stress*Period	2	2	0.22338
Class*Stress*Period	2	1+	0.41926
Error	13	14	3.39205
Total	24	24	5.11094

+ Rank deficiency due to empty cells, unbalanced nesting or collinearity.
  No storage of results or further analysis will be done.

Analysis of Variance for ac51

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.00534	0.00534	0.00534	0.45	0.506
Stress	1	0.00137	0.00062	0.00062	0.05	0.820
Period	2	0.00030	0.00187	0.00093	0.08	0.924
Class*Stress	1	0.00672	0.00672	0.00672	0.57	0.456
Class*Period	2	0.13520	0.13520	0.06760	5.75	0.008
Stress*Period	2	0.03576	0.03709	0.01854	1.58	0.223
Class*Stress*Period	2	0.00436	0.00436	0.00218	0.19	0.832
Error	30	0.35267	0.35267	0.01176		
Total	41	0.54171				

Analysis of Variance for ac52

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.08505	0.03280	0.03280	0.34	0.565
Stress	1	0.04758	0.00410	0.00410	0.04	0.838
Period	2	1.08085	0.93096	0.46548	4.83	0.017
Class*Stress	1	0.06959	0.06743	0.06743	0.70	0.411
Class*Period	2	0.28282	0.26801	0.13401	1.39	0.267
Stress*Period	2	0.00468	0.00218	0.00109	0.01	0.989
Class*Stress*Period	2	0.02919	0.02919	0.01459	0.15	0.860
Error	25	2.40738	2.40738	0.09629		
Total	36	4.00713				

Analysis of Variance for ac53

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.21029	0.17857	0.17857	5.42	0.027
Stress	1	0.00160	0.00325	0.00325	0.10	0.756
Period	2	0.15044	0.20441	0.10221	3.10	0.060
Class*Stress	1	0.00737	0.00432	0.00432	0.13	0.720
Class*Period	2	0.16767	0.16882	0.08441	2.56	0.094
Stress*Period	2	0.06848	0.06467	0.03234	0.98	0.387
Class*Stress*Period	2	0.06094	0.06094	0.03047	0.93	0.408
Error	29	0.95477	0.95477	0.03292		
Total	40	1.62156				

Analysis of Variance for ac54

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.02095	0.02792	0.02792	0.30	0.589
Stress	1	0.26264	0.18814	0.18814	2.02	0.168
Period	2	0.11778	0.08861	0.04431	0.47	0.627
Class*Stress	1	0.22249	0.19988	0.19988	2.14	0.155
Class*Period	2	0.05711	0.05663	0.02831	0.30	0.741
Stress*Period	2	0.09293	0.09337	0.04668	0.50	0.612
Class*Stress*Period	2	0.01867	0.01867	0.00934	0.10	0.905
Error	26	2.42741	2.42741	0.09336		
Total	37	3.21997				

Analysis of Variance for ac55

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Class	1	0.02805	0.02653	0.02653	0.34	0.565
Stress	1	0.00008	0.00017	0.00017	0.00	0.963
Period	2	0.03658	0.05172	0.02586	0.33	0.721
Class*Stress	1	0.01480	0.01455	0.01455	0.19	0.670
Class*Period	2	0.08653	0.07888	0.03944	0.50	0.610
Stress*Period	2	0.00996	0.01529	0.00764	0.10	0.907
Class*Stress*Period	2	0.10618	0.10618	0.05309	0.68	0.516
Error	29	2.27163	2.27163	0.07833		
Total	40	2.55382				

Analysis of Variance for ac56

Source	Model DF	Reduced DF	Seq SS
Class	1	1	0.382571
Stress	1	1	0.203710
Period	2	2	0.031686
Class*Stress	1	1	0.106279
Class*Period	2	2	0.029859
Stress*Period	2	2	0.017024
Class*Stress*Period	2	0+	0.000000
Error	7	9	1.721933
Total	18	18	2.493063

+ Rank deficiency due to empty cells, unbalanced nesting or collinearity.
No storage of results or further analysis will be done.

APPENDIX F. TWO SAMPLE T-TEST FOR COMMUNICATION VARIABLES

The following Appendix displays the results of the Two sample t-test for the communication variables. The results below are only those that contradicted the Univariate analysis of variance results. Some t-test results contradict in favor of a significant difference and some contradict against a significant difference. These contradictions were discussed in Chapter 4.

Two Sample T-Test and Confidence Interval

```
Twosample T for ac1
Class   N      Mean      StDev   SE Mean
1      24      81.5       41.0       8.4
2      18      62.7       23.2       5.5

95% C.I. for mu 1 - mu 2: ( -1.5,  39.1)
T-Test mu 1 = mu 2 (vs not =): T= 1.88  P=0.068  DF=  37


Twosample T for ac1
Stress   N      Mean      StDev   SE Mean
1       21      65.3       34.5       7.5
2       21      81.5       35.2       7.7

95% C.I. for mu 1 - mu 2: ( -38.0,  5.5)
T-Test mu 1 = mu 2 (vs not =): T= -1.51  P=0.14  DF=  39


Twosample T for ac10
Stress   N      Mean      StDev   SE Mean
1       21      2.40      0.914      0.20
2       21      3.02       1.09      0.24

95% C.I. for mu 1 - mu 2: ( -1.24,  0.01)
T-Test mu 1 = mu 2 (vs not =): T= -1.99  P=0.054  DF=  38


Twosample T for ac15
Stress   N      Mean      StDev   SE Mean
1       21      1.578      0.90      0.20
2       21      1.92       1.08      0.24

95% C.I. for mu 1 - mu 2: ( -0.96,  0.28)
T-Test mu 1 = mu 2 (vs not =): T= -1.11  P=0.27  DF=  38


Twosample T for ac16
Class   N       Mean      StDev   SE Mean
1      24      0.992      0.659      0.13
2      18      0.672      0.376     0.089

95% C.I. for mu 1 - mu 2: ( -0.01,  0.646)
T-Test mu 1 = mu 2 (vs not =): T= 1.98  P=0.055  DF=  37
```

Twosample T for ac17

Stress	N	Mean	StDev	SE Mean
1	21	0.882	0.456	0.10
2	21	1.198	0.726	0.16

95% C.I. for mu 1 - mu 2: (-0.70, 0.06)
T-Test mu 1 = mu 2 (vs not =): T= -1.69 P=0.10 DF= 33

Twosample T for ac21

Class	N	Mean	StDev	SE Mean
1	24	1.154	0.856	0.17
2	18	0.704	0.609	0.14

Twosample T for ac33

Stress	N	Mean	StDev	SE Mean
1	21	0.213	0.154	0.034
2	21	0.379	0.339	0.074

95% C.I. for mu 1 - mu 2: (-0.332, 0.001)
T-Test mu 1 = mu 2 (vs not =): T= -2.04 P=0.051 DF= 27

Twosample T for ac38

Stress	N	Mean	StDev	SE Mean
1	21	0.030	0.067	0.015
2	21	0.099	0.135	0.030

95% C.I. for mu 1 - mu 2: (-0.136, -0.001)
T-Test mu 1 = mu 2 (vs not =): T= -2.08 P=0.047 DF= 29

Twosample T for ac40

Stress	N	Mean	StDev	SE Mean
1	21	1.199	0.492	0.11
2	21	1.494	0.583	0.13

95% C.I. for mu 1 - mu 2: (-0.63, 0.04)
T-Test mu 1 = mu 2 (vs not =): T= -1.78 P=0.084 DF= 38

Twosample T for ac46

Class	N	Mean	StDev	SE Mean
1	24	0.718	0.080	0.016
2	18	0.657	0.109	0.026

95% C.I. for mu 1 - mu 2: (-0.001, 0.124)
T-Test mu 1 = mu 2 (vs not =): T= 2.02 P=0.053 DF= 29

APPENDIX G. UNIVARIATE ANALYSIS OF VARIANCE FOR TEAMWORK

The following Appendix displays the p-values for the dependent variables of teamwork across the independent variables of Class and Stress.

General Linear Model

Factor	Levels	Values
class	2	1 2
stress	2	1 2

Analysis of Variance for atmwk1

Source	DF	Seq SS	Adj SS	Adj MS	F	P
class	1	31.201	31.201	31.201	79.87	0.000
stress	1	1.511	1.844	1.844	4.72	0.055
class*stress	1	0.975	0.975	0.975	2.50	0.145
Error	10	3.907	3.907	0.391		
Total	13	37.594				

Analysis of Variance for atmwk2

Source	DF	Seq SS	Adj SS	Adj MS	F	P
class	1	32.772	32.772	32.772	193.15	0.000
stress	1	2.403	2.429	2.429	14.32	0.004
class*stress	1	0.029	0.029	0.029	0.17	0.689
Error	10	1.697	1.697	0.170		
Total	13	36.900				

Analysis of Variance for atmwk3

Source	DF	Seq SS	Adj SS	Adj MS	F	P
class	1	17.037	17.037	17.037	11.67	0.007
stress	1	0.231	0.081	0.081	0.06	0.818
class*stress	1	1.781	1.781	1.781	1.22	0.295
Error	10	14.604	14.604	1.460		
Total	13	33.654				

Analysis of Variance for atmwk4

Source	DF	Seq SS	Adj SS	Adj MS	F	P
class	1	37.810	37.810	37.810	206.52	0.000
stress	1	0.601	0.656	0.656	3.58	0.088
class*stress	1	0.091	0.091	0.091	0.49	0.498
Error	10	1.831	1.831	0.183		
Total	13	40.332				

Analysis of Variance for atmwk5

Source	DF	Seq SS	Adj SS	Adj MS	F	P
class	1	32.860	32.860	32.860	152.54	0.000
stress	1	0.778	0.871	0.871	4.05	0.072
class*stress	1	0.180	0.180	0.180	0.84	0.382
Error	10	2.154	2.154	0.215		
Total	13	35.972				

Analysis of Variance for atmwk6

Source	DF	Seq SS	Adj SS	Adj MS	F	P
class	1	18.4672	18.4672	18.4672	105.28	0.000
stress	1	0.8750	0.9301	0.9301	5.30	0.044
class*stress	1	0.0729	0.0729	0.0729	0.42	0.534
Error	10	1.7542	1.7542	0.1754		
Total	13	21.1693				

Analysis of Variance for atmwk7

Source	DF	Seq SS	Adj SS	Adj MS	F	P
class	1	18.5336	18.5336	18.5336	42.56	0.000
stress	1	1.7150	1.6800	1.6800	3.86	0.078
class*stress	1	0.0000	0.0000	0.0000	0.00	1.000
Error	10	4.3550	4.3550	0.4355		
Total	13	24.6036				

Analysis of Variance for atmwk8

Source	DF	Seq SS	Adj SS	Adj MS	F	P
class	1	22.5867	22.5867	22.5867	47.24	0.000
stress	1	0.7314	0.6688	0.6688	1.40	0.264
class*stress	1	0.0402	0.0402	0.0402	0.08	0.778
Error	10	4.7817	4.7817	0.4782		
Total	13	28.1400				

Analysis of Variance for atmwk9

Source	DF	Seq SS	Adj SS	Adj MS	F	P
class	1	14.881	14.881	14.881	9.64	0.011
stress	1	0.378	0.400	0.400	0.26	0.622
class*stress	1	0.029	0.029	0.029	0.02	0.894
Error	10	15.442	15.442	1.544		
Total	13	30.729				

Analysis of Variance for atmwk10

Source	DF	Seq SS	Adj SS	Adj MS	F	P
class	1	16.3438	16.3438	16.3438	19.73	0.001
stress	1	0.7314	0.8288	0.8288	1.00	0.341
class*stress	1	0.2002	0.2002	0.2002	0.24	0.634
Error	10	8.2817	8.2817	0.8282		
Total	13	25.5571				

Analysis of Variance for atmwk11

Source	DF	Seq SS	Adj SS	Adj MS	F	P
class	1	18.667	18.667	18.667	17.76	0.002
stress	1	2.161	2.194	2.194	2.09	0.179
class*stress	1	0.034	0.034	0.034	0.03	0.860
Error	10	10.513	10.513	1.051		
Total	13	31.375				

Analysis of Variance for atmwk12

Source	DF	Seq SS	Adj SS	Adj MS	F	P
class	1	14.1752	14.1752	14.1752	18.88	0.001
stress	1	2.4029	2.9867	2.9867	3.98	0.074
class*stress	1	1.8438	1.8438	1.8438	2.46	0.148
Error	10	7.5067	7.5067	0.7507		
Total	13	25.9286				

Analysis of Variance for atmwk13

Source	DF	Seq SS	Adj SS	Adj MS	F	P
class	1	21.5001	21.5001	21.5001	29.97	0.000
stress	1	0.7779	0.9601	0.9601	1.34	0.274
class*stress	1	0.5601	0.5601	0.5601	0.78	0.398
Error	10	7.1742	7.1742	0.7174		
Total	13	30.0121				

Analysis of Variance for atmwk14

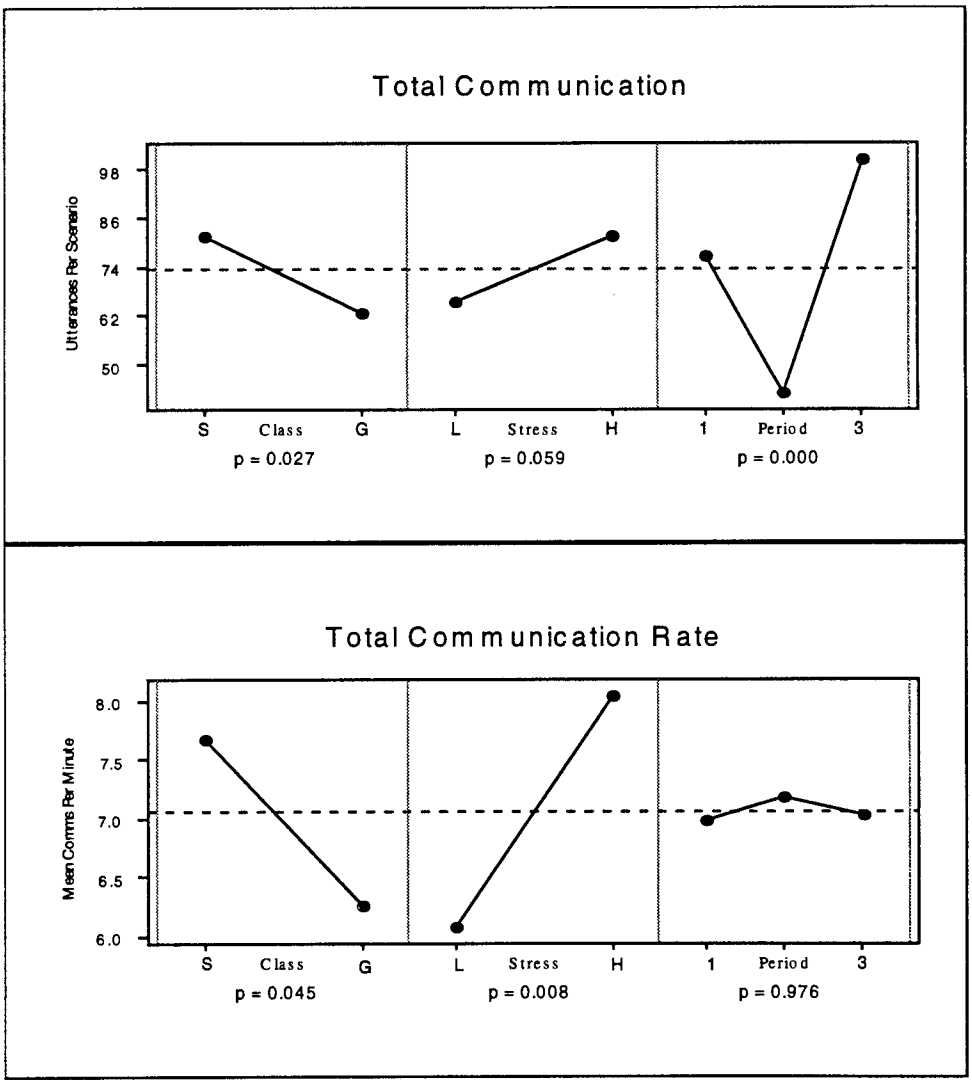
Source	DF	Seq SS	Adj SS	Adj MS	F	P
class	1	33.840	33.840	33.840	411.02	0.000
stress	1	2.835	3.259	3.259	39.59	0.000
class*stress	1	0.945	0.945	0.945	11.48	0.007
Error	10	0.823	0.823	0.082		
Total	13	38.444				

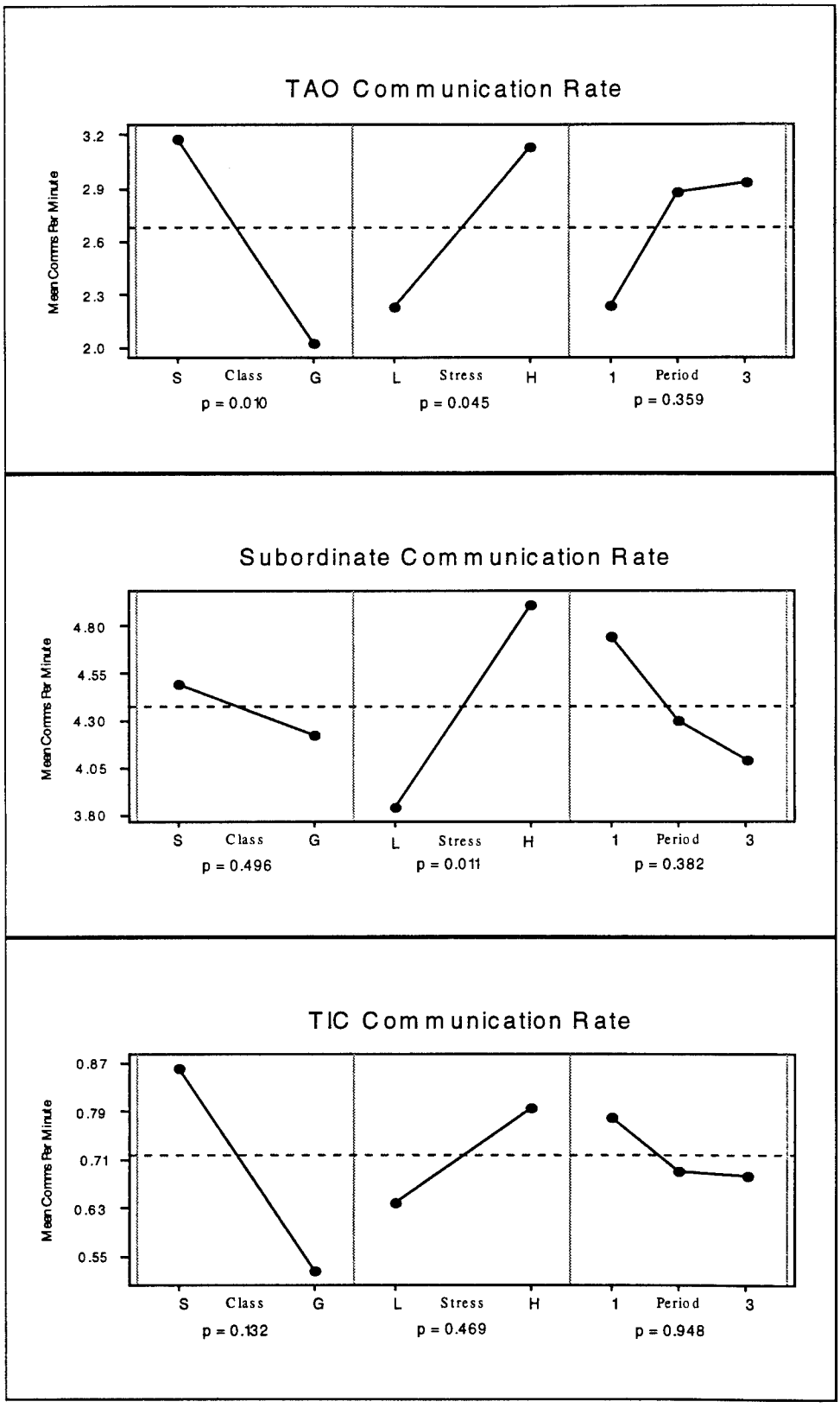
Analysis of Variance for atmwk15

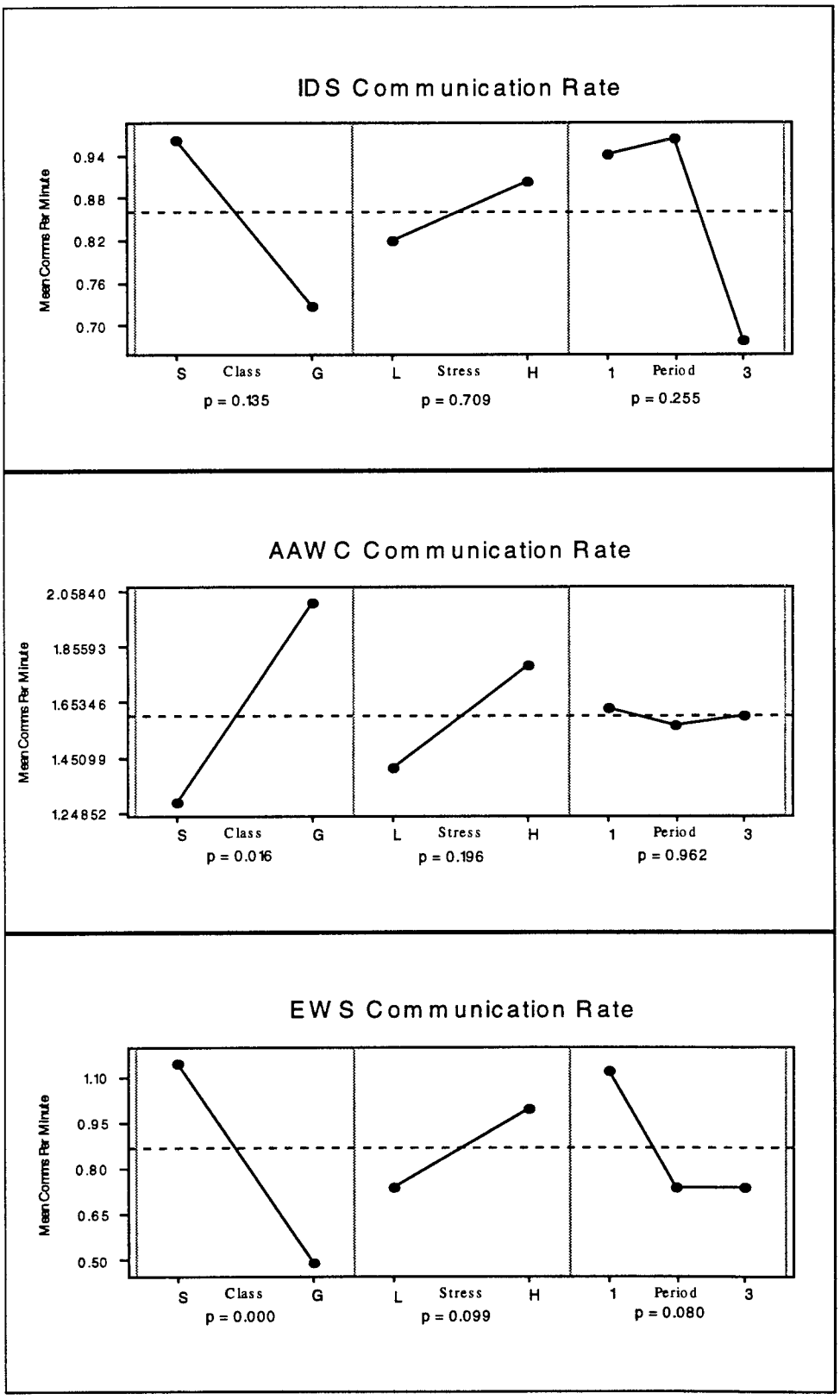
Source	DF	Seq SS	Adj SS	Adj MS	F	P
class	1	31.029	31.029	31.029	119.88	0.000
stress	1	1.143	1.037	1.037	4.01	0.073
class*stress	1	0.077	0.077	0.077	0.30	0.597
Error	10	2.588	2.588	0.259		
Total	13	34.837				

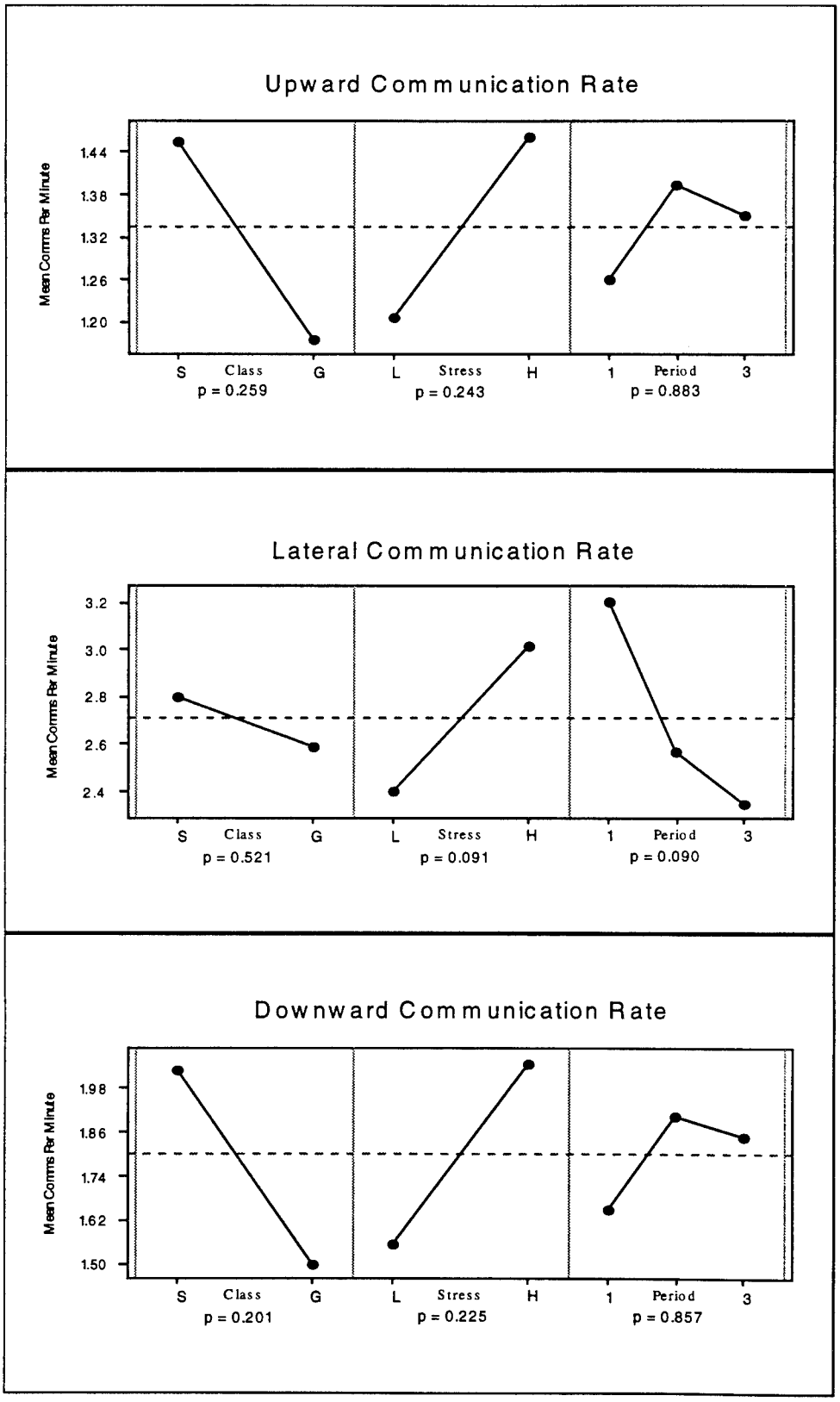
APPENDIX H. MAIN EFFECTS PLOTS FOR COMMUNICATION VARIABLES

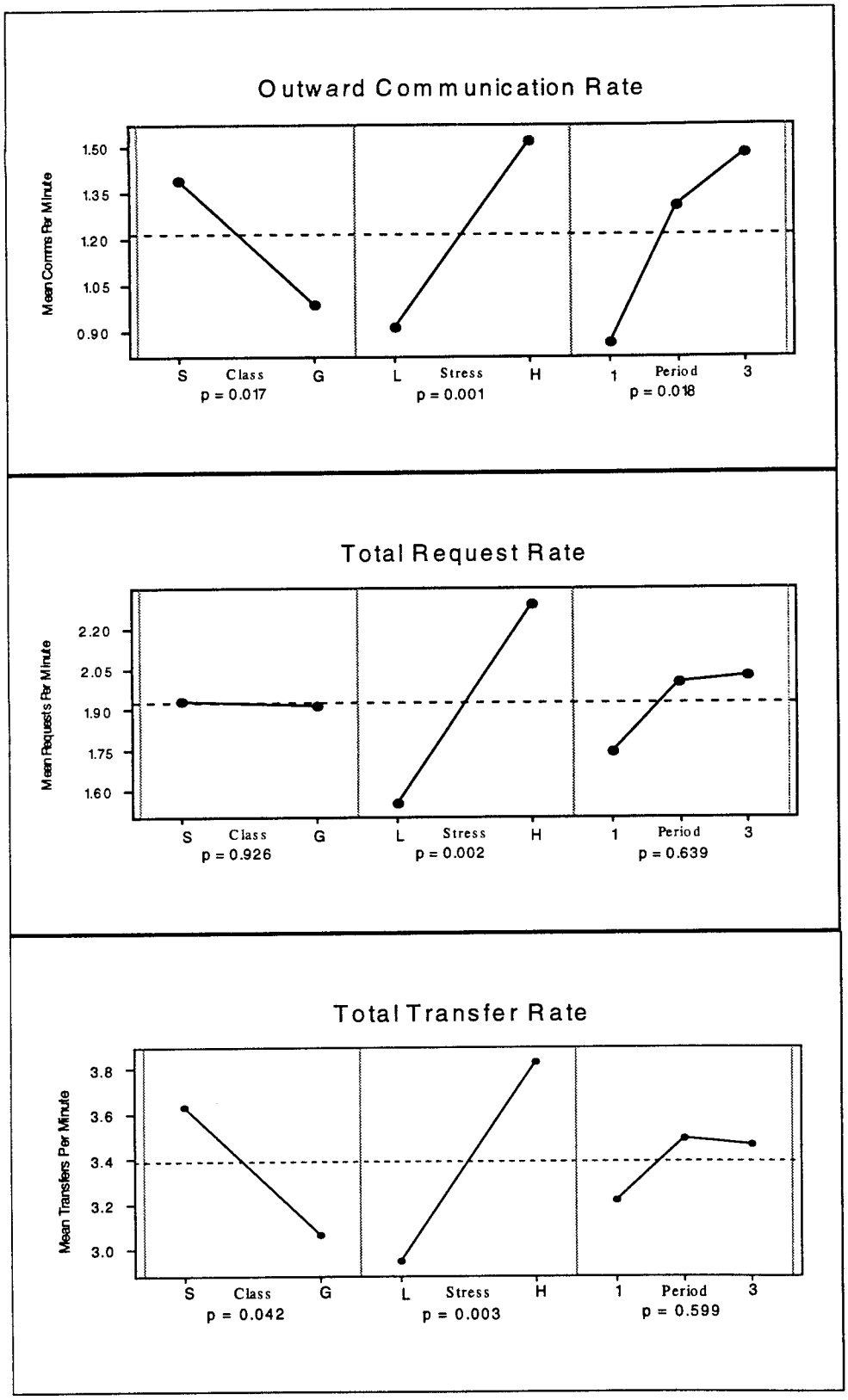
This Appendix displays the main effects plots for the communication variables with regards to class, stress, and period.

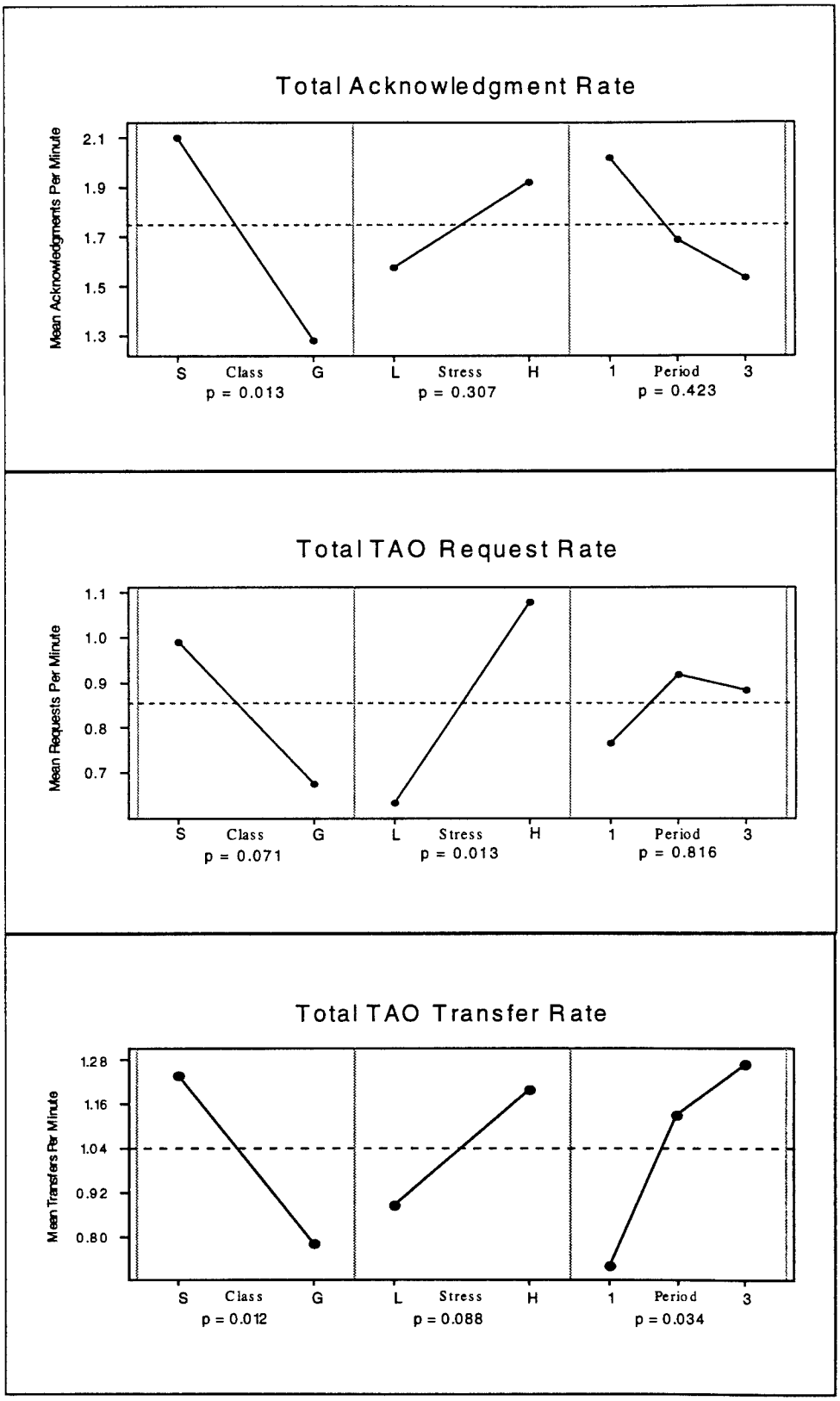


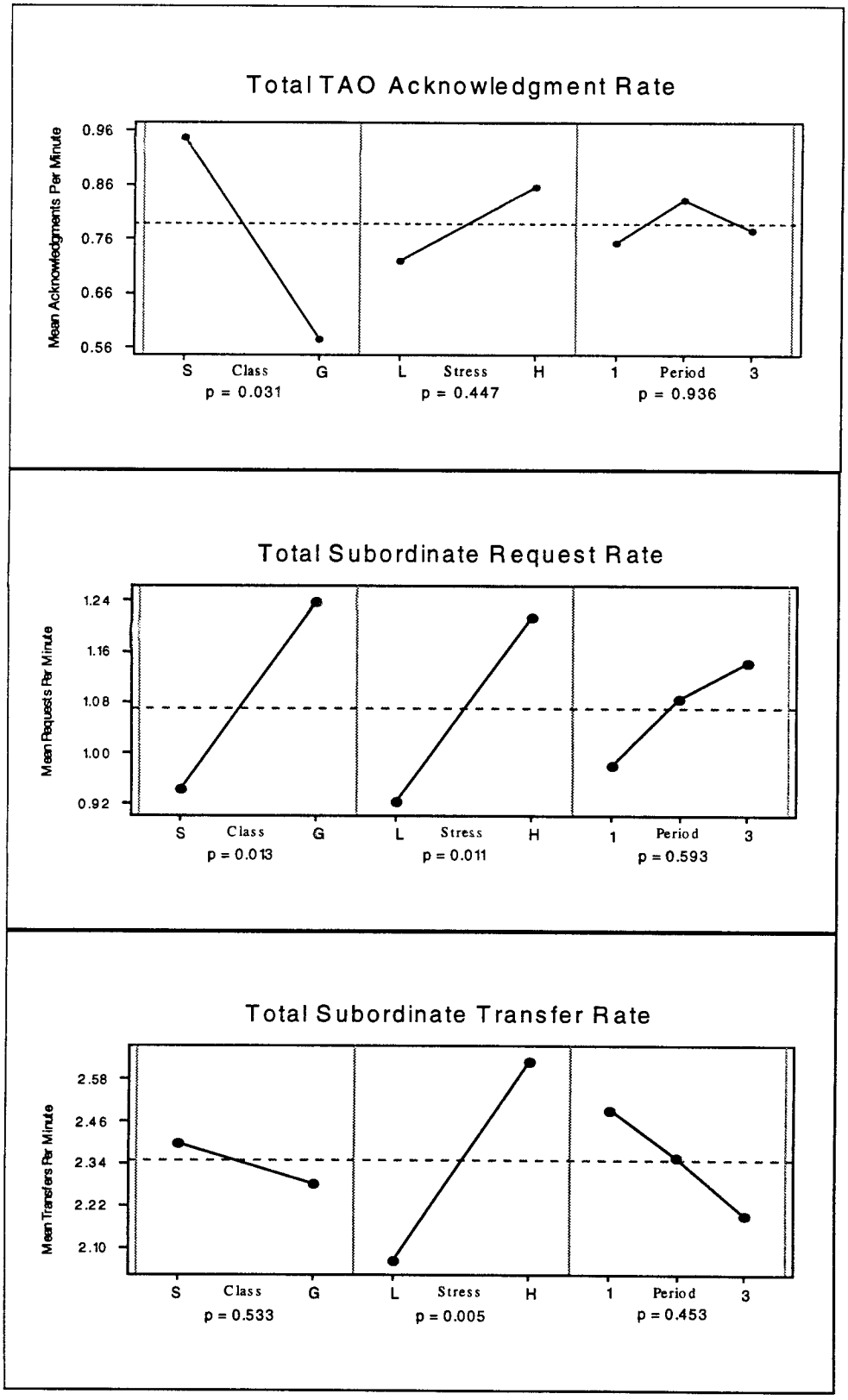

TAO Communication Rate
Mean Comms Per Minute
3.2
2.9
2.6
2.3
2.0
S
Class
G
p = 0.010
L
Stress
H
p = 0.045
1
Period
3
p = 0.359
Subordinate Communication Rate
Mean Comms Per Minute
4.80
4.55
4.30
4.05
3.80
S
Class
G
p = 0.496
L
Stress
H
p = 0.011
1
Period
3
p = 0.382
TIC Communication Rate
Mean Comms Per Minute
0.87
0.79
0.71
0.63
0.55
S
Class
G
p = 0.132
L
Stress
H
p = 0.469
1
Period
3
p = 0.948

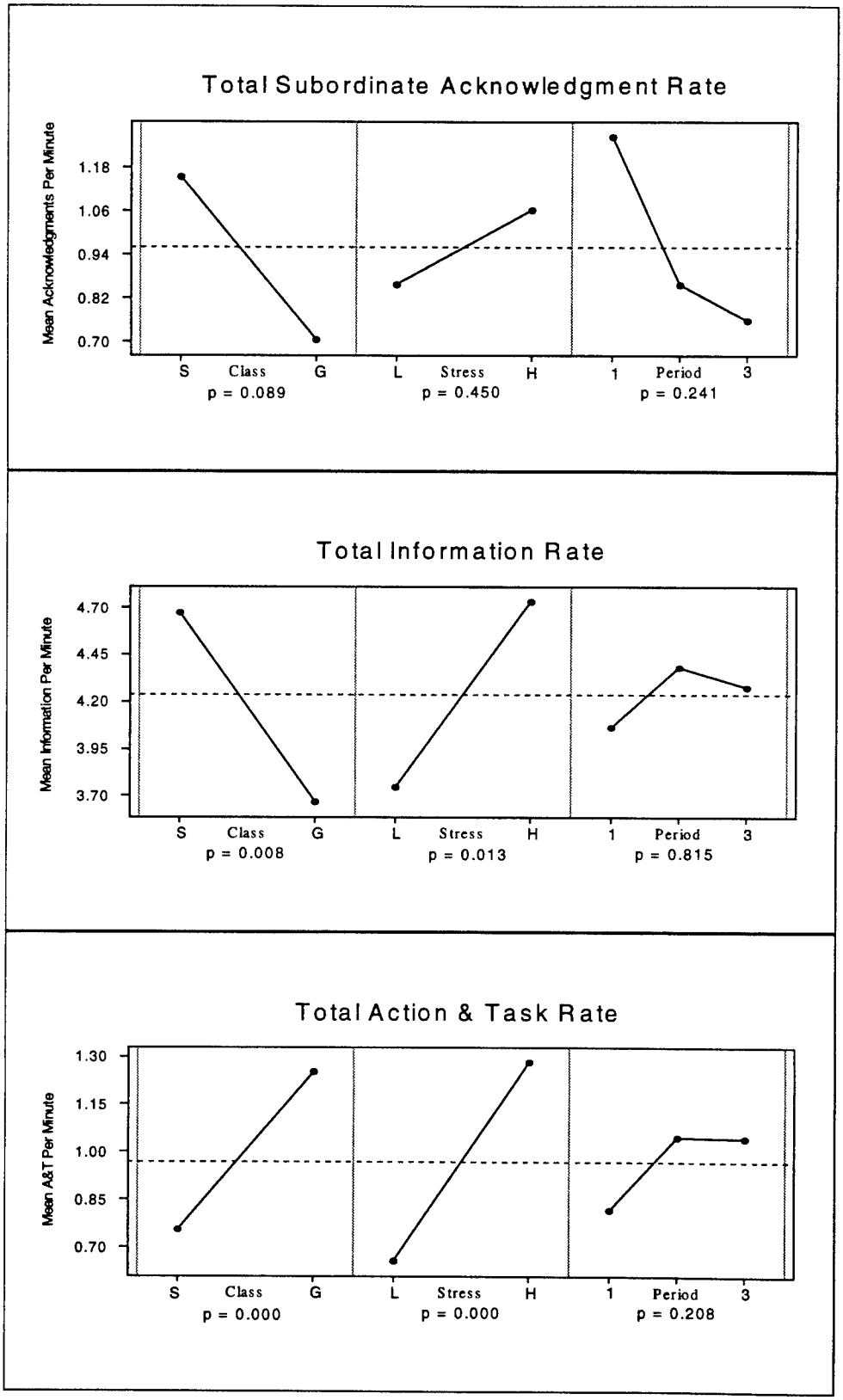

IDS Communication Rate
Mean Comms Per Minute
0.94
0.88
0.82
0.76
0.70
S
Class
G
p = 0.135
L
Stress
H
p = 0.709
1
Period
3
p = 0.255
AAWC Communication Rate
Mean Comms Per Minute
2.05840
1.85593
1.65346
1.45099
1.24852
S
Class
G
p = 0.016
L
Stress
H
p = 0.196
1
Period
3
p = 0.962
EWS Communication Rate
Mean Comms Per Minute
1.10
0.95
0.80
0.65
0.50
S
Class
G
p = 0.000
L
Stress
H
p = 0.099
1
Period
3
p = 0.080

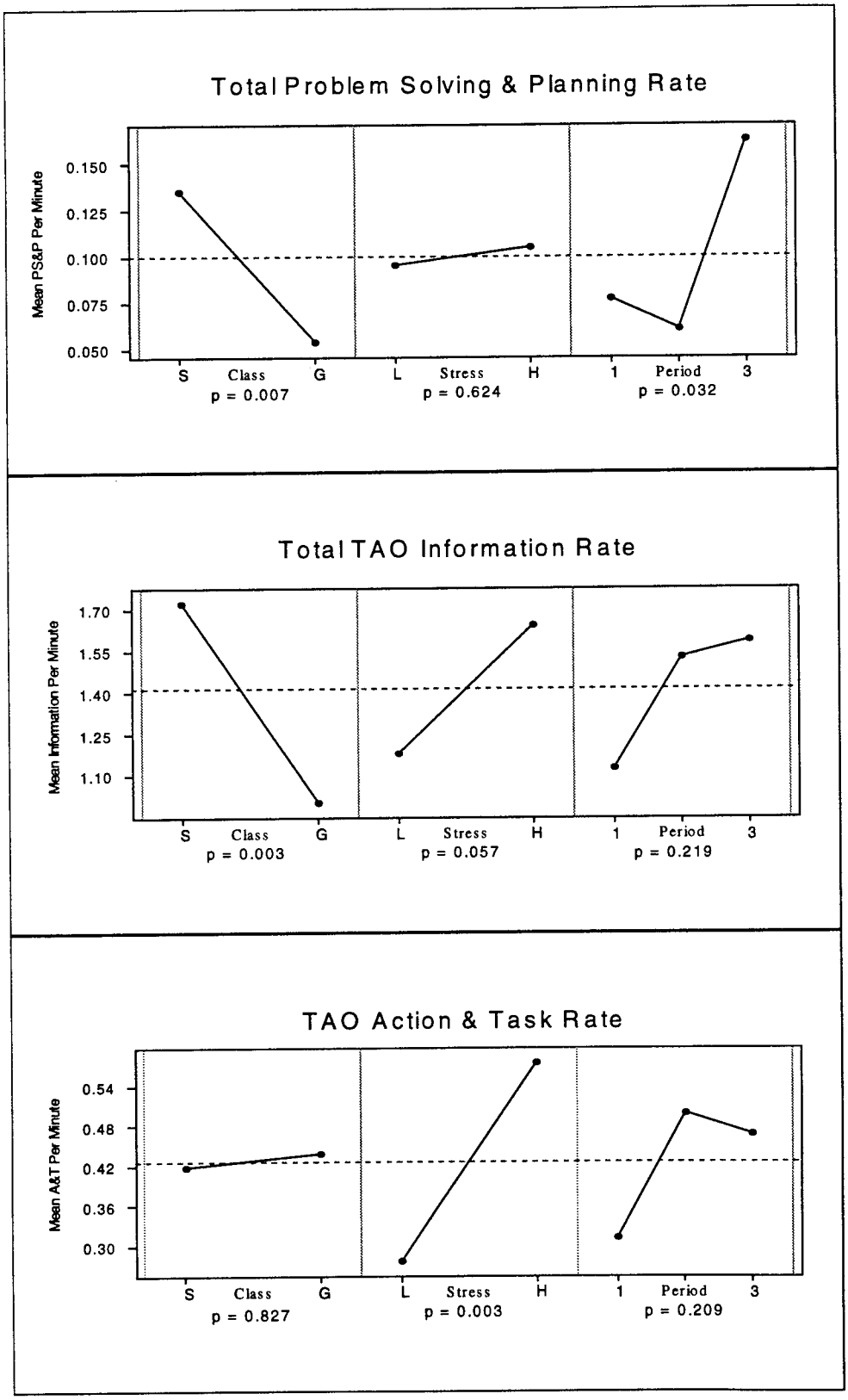

Upward Communication Rate
Mean Comms Per Minute
1.44
1.38
1.32
1.26
1.20
S Class G
p = 0.259
L Stress H
p = 0.243
1 Period 3
p = 0.883
Lateral Communication Rate
Mean Comms Per Minute
3.2
3.0
2.8
2.6
2.4
S Class G
p = 0.521
L Stress H
p = 0.091
1 Period 3
p = 0.090
Downward Communication Rate
Mean Comms Per Minute
1.98
1.86
1.74
1.62
1.50
S Class G
p = 0.201
L Stress H
p = 0.225
1 Period 3
p = 0.857

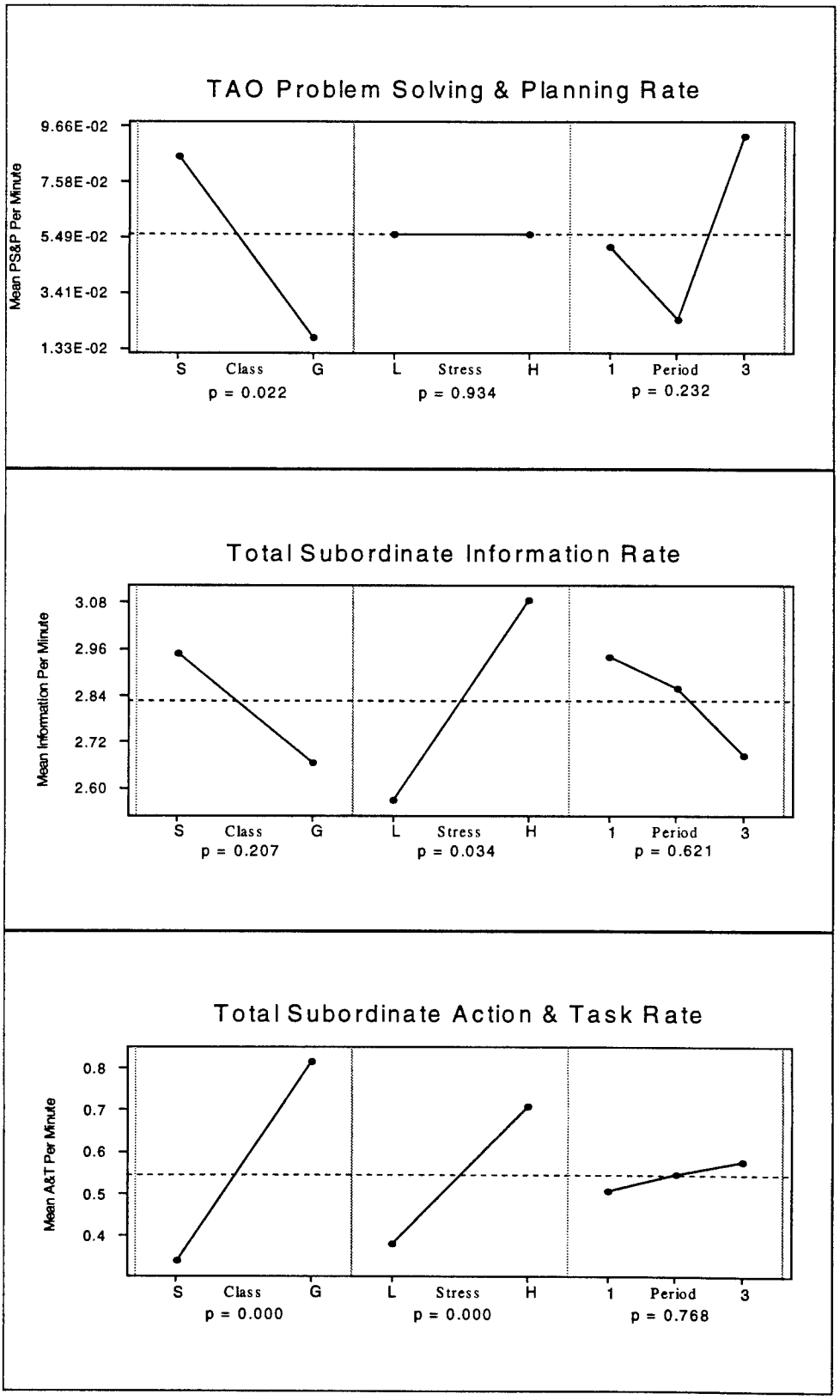

Outward Communication Rate
Mean Comms Per Minute
1.50
1.35
1.20
1.05
0.90
S Class G
p = 0.017
L Stress H
p = 0.001
1 Period 3
p = 0.018
Total Request Rate
Mean Requests Per Minute
2.20
2.05
1.90
1.75
1.60
S Class G
p = 0.926
L Stress H
p = 0.002
1 Period 3
p = 0.639
Total Transfer Rate
Mean Transfers Per Minute
3.8
3.6
3.4
3.2
3.0
S Class G
p = 0.042
L Stress H
p = 0.003
1 Period 3
p = 0.599

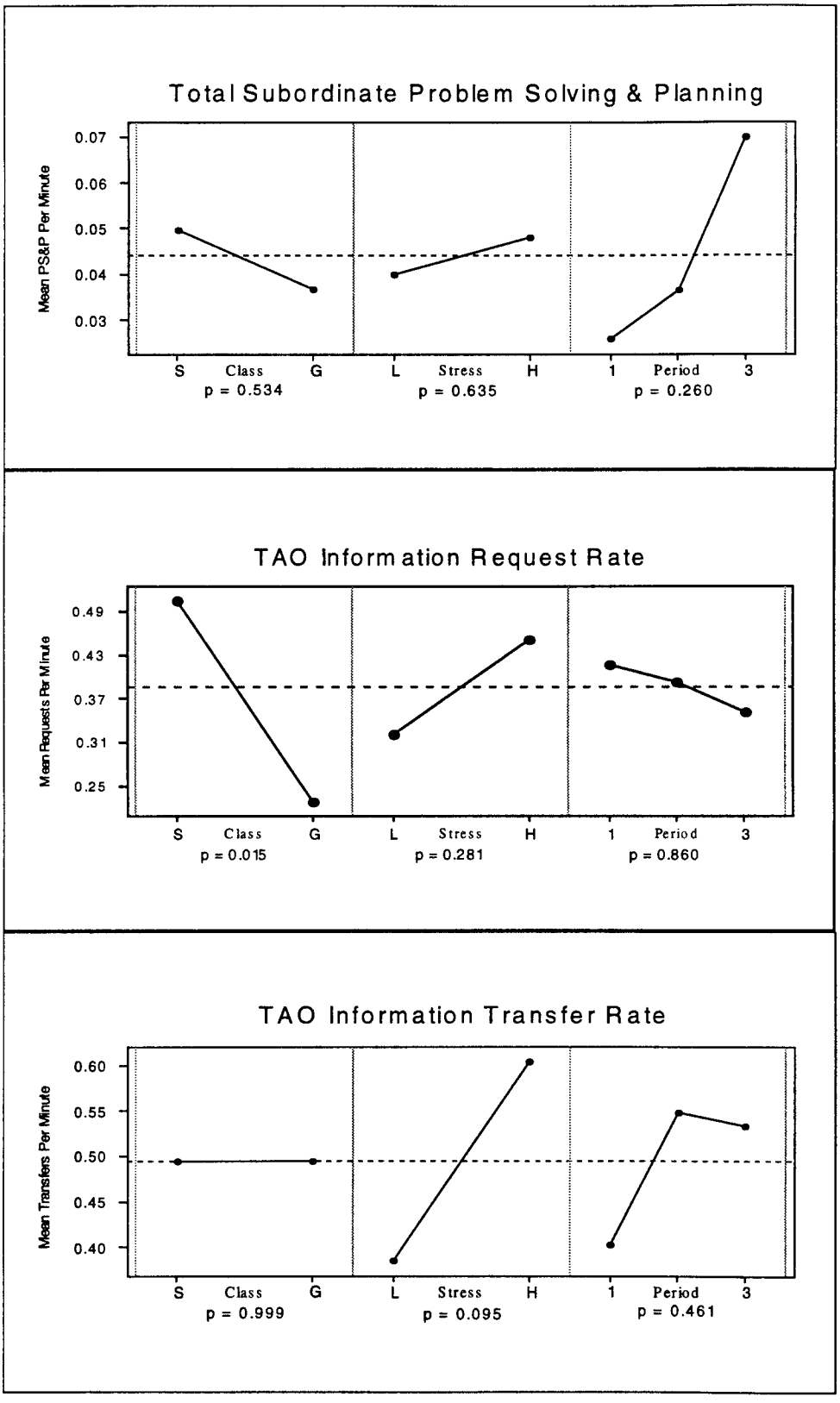

Total Acknowledgment Rate
Mean Acknowledgments Per Minute
2.1
1.9
1.7
1.5
1.3
S Class G
p = 0.013
L Stress H
p = 0.307
1 Period 3
p = 0.423
Total TAO Request Rate
Mean Requests Per Minute
1.1
1.0
0.9
0.8
0.7
S Class G
p = 0.071
L Stress H
p = 0.013
1 Period 3
p = 0.816
Total TAO Transfer Rate
Mean Transfers Per Minute
1.28
1.16
1.04
0.92
0.80
S Class G
p = 0.012
L Stress H
p = 0.088
1 Period 3
p = 0.034

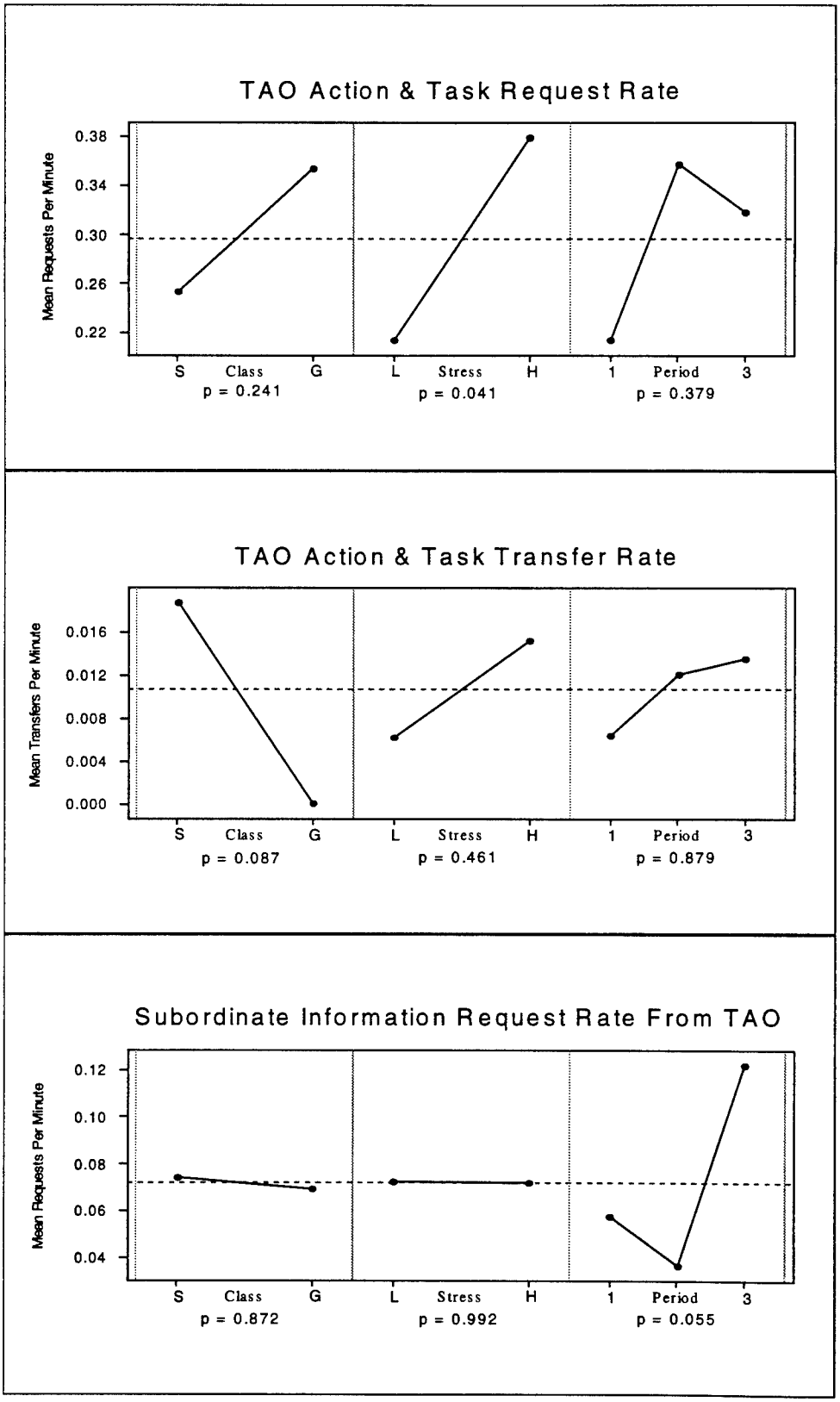

Total TAO Acknowledgment Rate
Mean Acknowledgments Per Minute
0.96
0.86
0.76
0.66
0.56
S Class G
p = 0.031
L Stress H
p = 0.447
1 Period 3
p = 0.936
Total Subordinate Request Rate
Mean Requests Per Minute
1.24
1.16
1.08
1.00
0.92
S Class G
p = 0.013
L Stress H
p = 0.011
1 Period 3
p = 0.593
Total Subordinate Transfer Rate
Mean Transfers Per Minute
2.58
2.46
2.34
2.22
2.10
S Class G
p = 0.533
L Stress H
p = 0.005
1 Period 3
p = 0.453

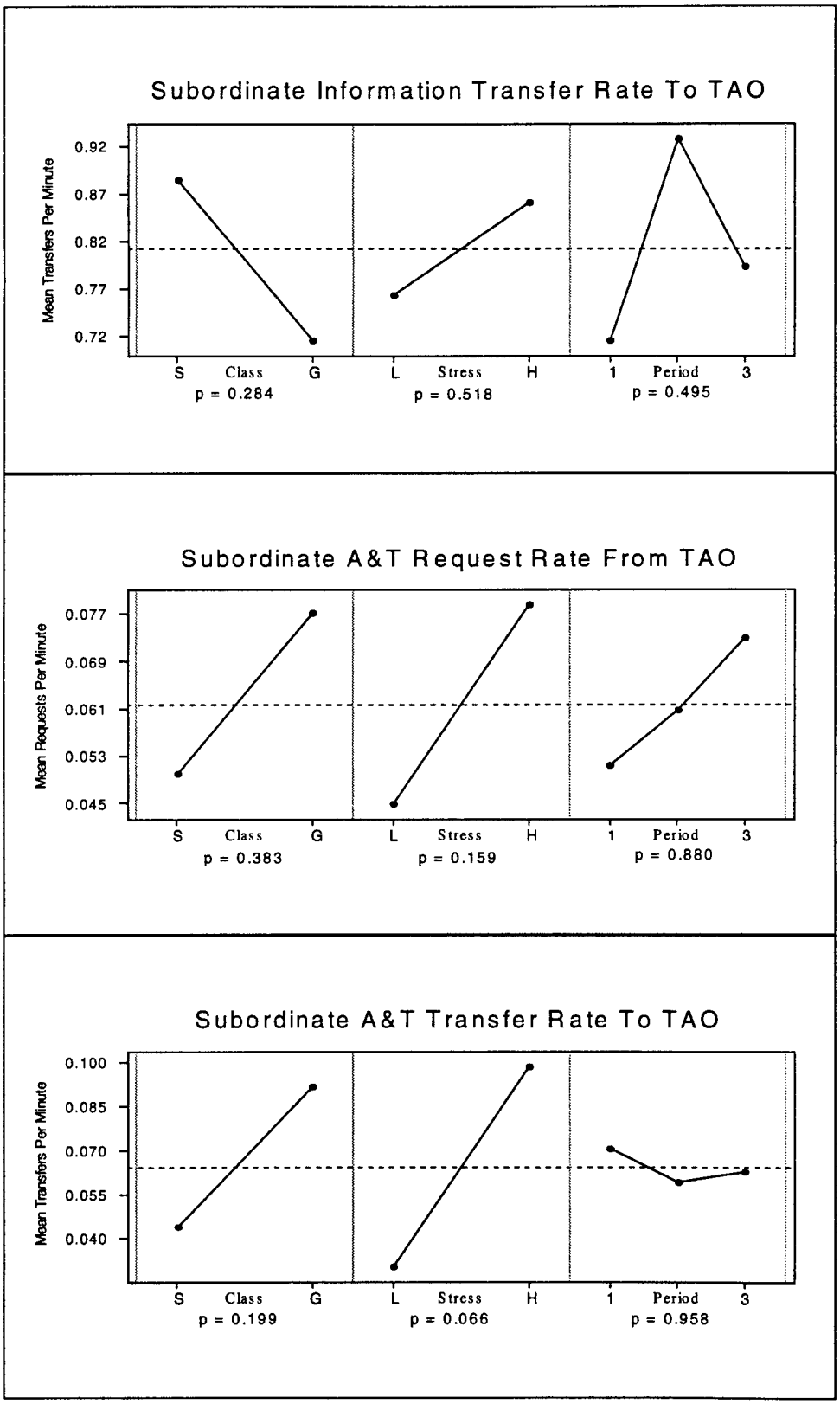

Total Subordinate Acknowledgment Rate
Mean Acknowledgments Per Minute
1.18
1.06
0.94
0.82
0.70
S Class G
p = 0.089
L Stress H
p = 0.450
1 Period 3
p = 0.241
Total Information Rate
Mean Information Per Minute
4.70
4.45
4.20
3.95
3.70
S Class G
p = 0.008
L Stress H
p = 0.013
1 Period 3
p = 0.815
Total Action & Task Rate
Mean A&T Per Minute
1.30
1.15
1.00
0.85
0.70
S Class G
p = 0.000
L Stress H
p = 0.000
1 Period 3
p = 0.208

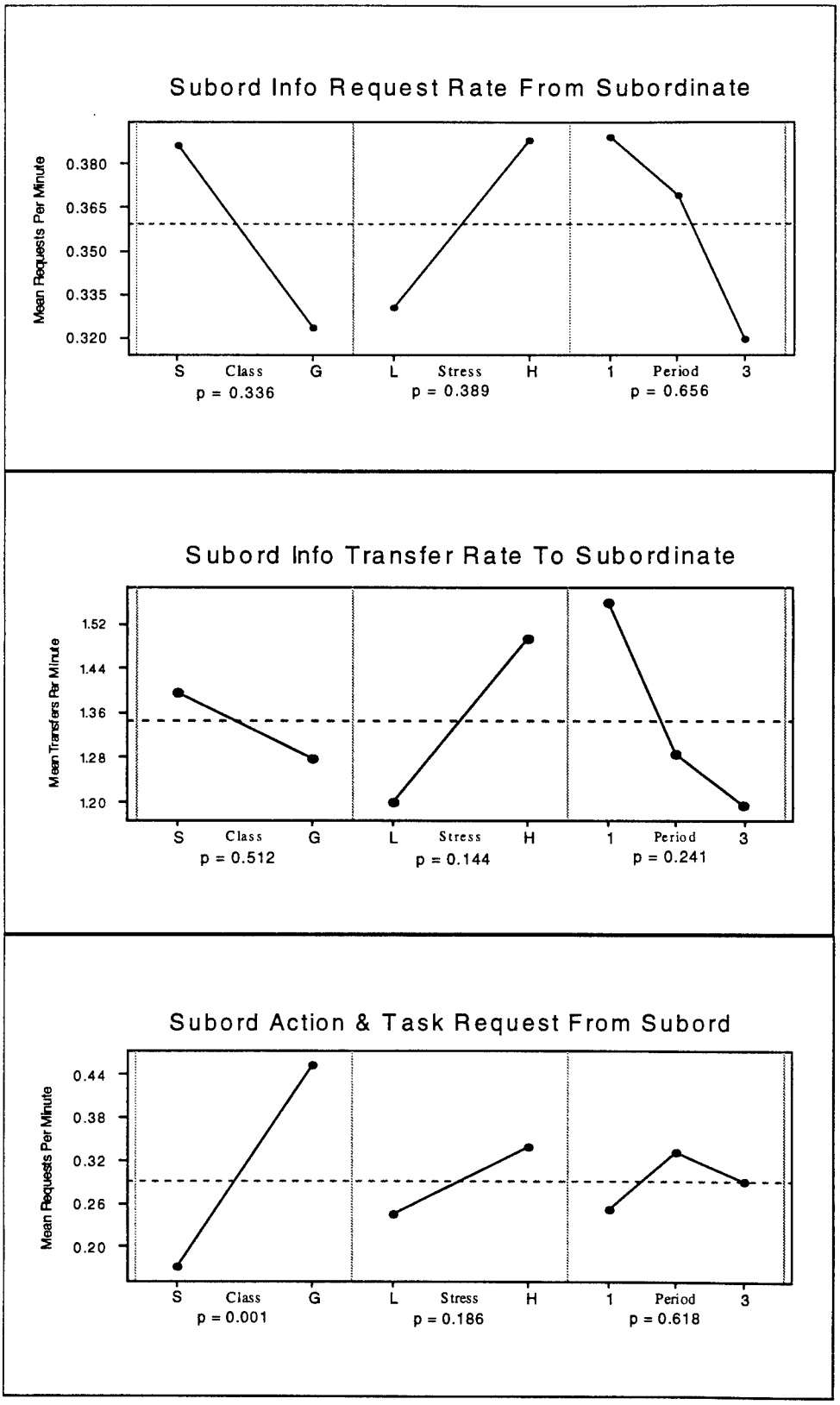

Total Problem Solving & Planning Rate
Mean PS&P Per Minute
0.150
0.125
0.100
0.075
0.050
S Class G
p = 0.007
L Stress H
p = 0.624
1 Period 3
p = 0.032
Total TAO Information Rate
Mean Information Per Minute
1.70
1.55
1.40
1.25
1.10
S Class G
p = 0.003
L Stress H
p = 0.057
1 Period 3
p = 0.219
TAO Action & Task Rate
Mean A&T Per Minute
0.54
0.48
0.42
0.36
0.30
S Class G
p = 0.827
L Stress H
p = 0.003
1 Period 3
p = 0.209

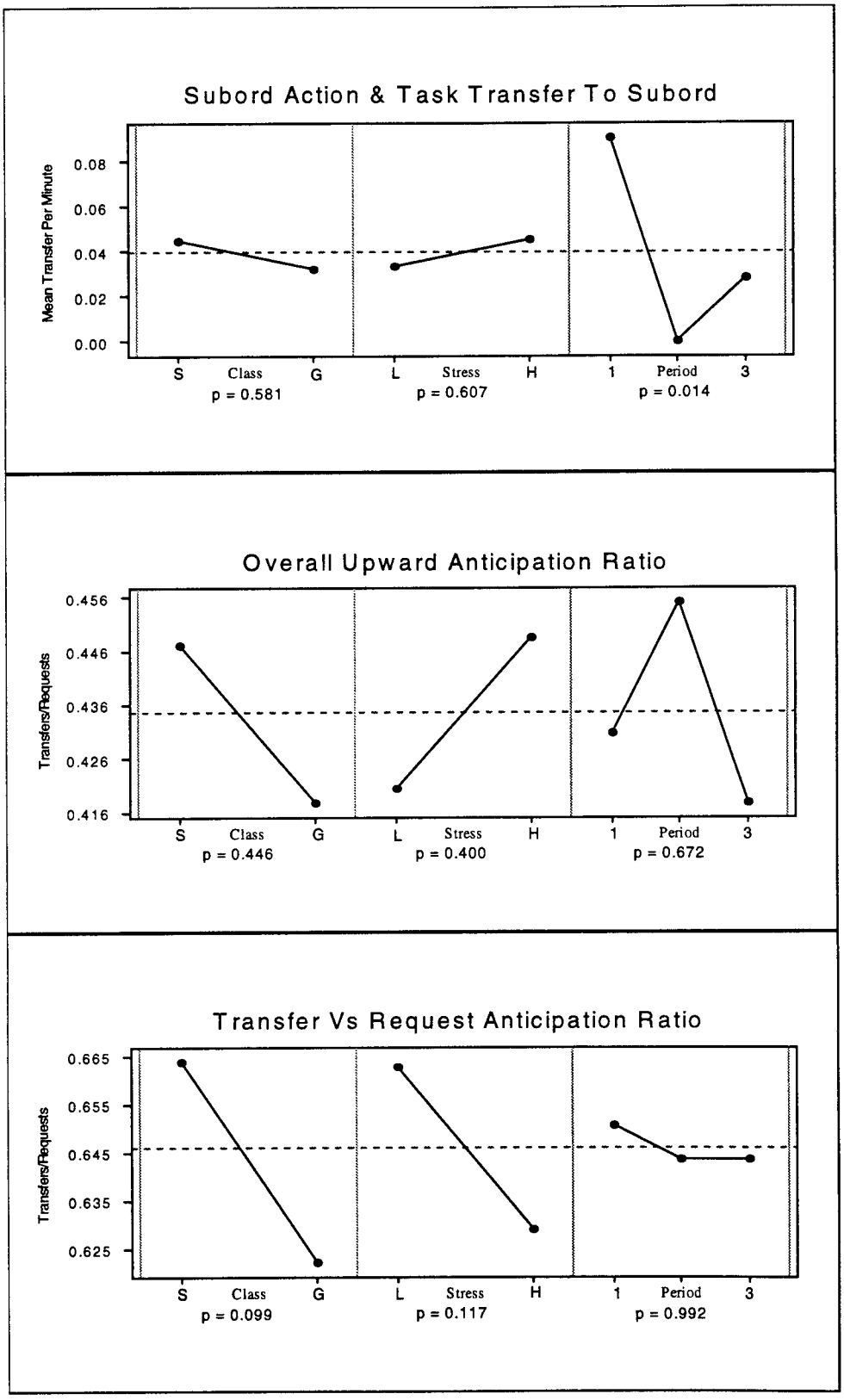

TAO Problem Solving & Planning Rate
Mean PS&P Per Minute
9.66E-02
7.58E-02
5.49E-02
3.41E-02
1.33E-02
S Class G
p = 0.022
L Stress H
p = 0.934
1 Period 3
p = 0.232
Total Subordinate Information Rate
Mean Information Per Minute
3.08
2.96
2.84
2.72
2.60
S Class G
p = 0.207
L Stress H
p = 0.034
1 Period 3
p = 0.621
Total Subordinate Action & Task Rate
Mean A&T Per Minute
0.8
0.7
0.6
0.5
0.4
S Class G
p = 0.000
L Stress H
p = 0.000
1 Period 3
p = 0.768

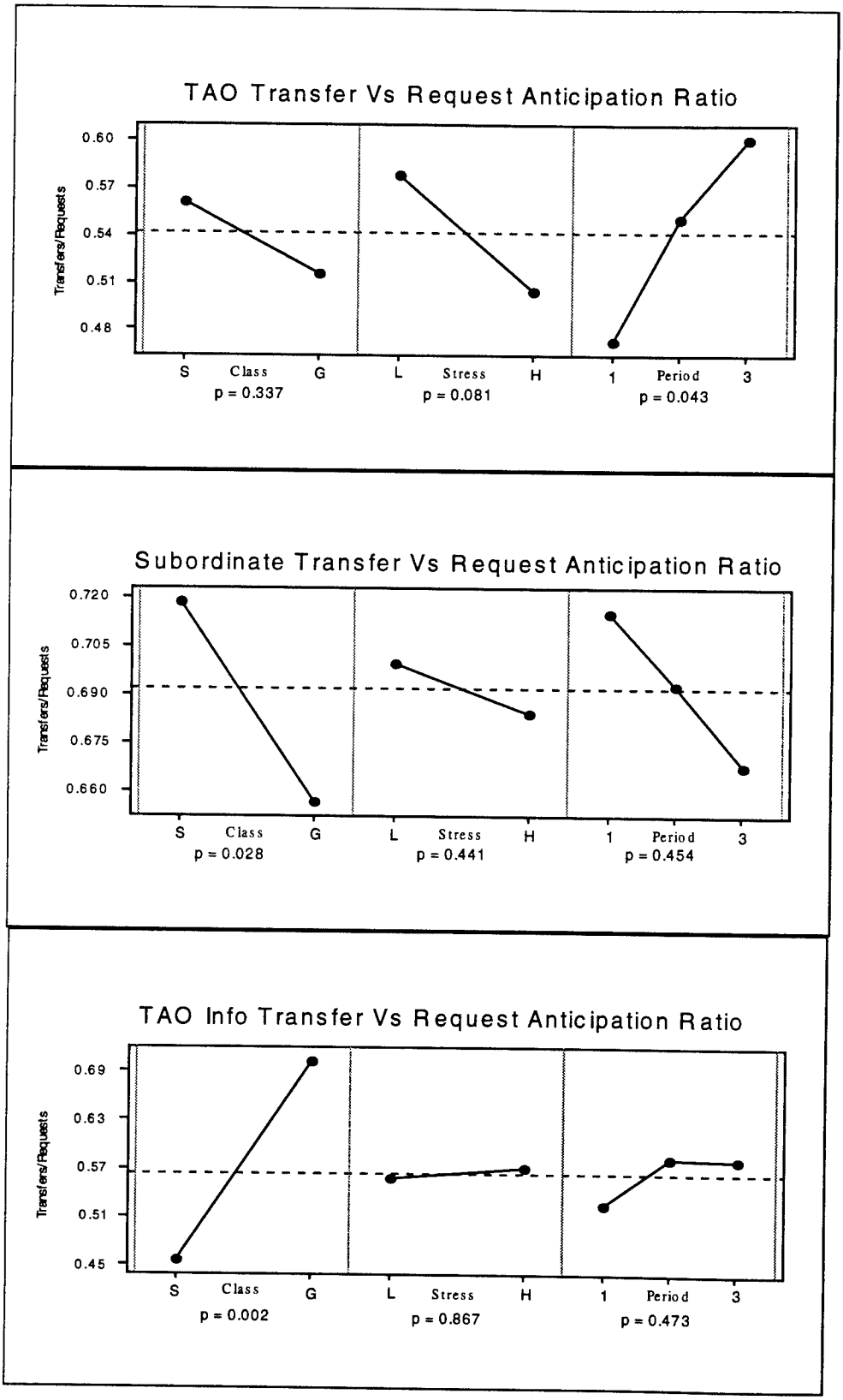

Total Subordinate Problem Solving & Planning
Mean PS&P Per Minute
0.07
0.06
0.05
0.04
0.03
S Class G
p = 0.534
L Stress H
p = 0.635
1 Period 3
p = 0.260
TAO Information Request Rate
Mean Requests Per Minute
0.49
0.43
0.37
0.31
0.25
S Class G
p = 0.015
L Stress H
p = 0.281
1 Period 3
p = 0.860
TAO Information Transfer Rate
Mean Transfers Per Minute
0.60
0.55
0.50
0.45
0.40
S Class G
p = 0.999
L Stress H
p = 0.095
1 Period 3
p = 0.461

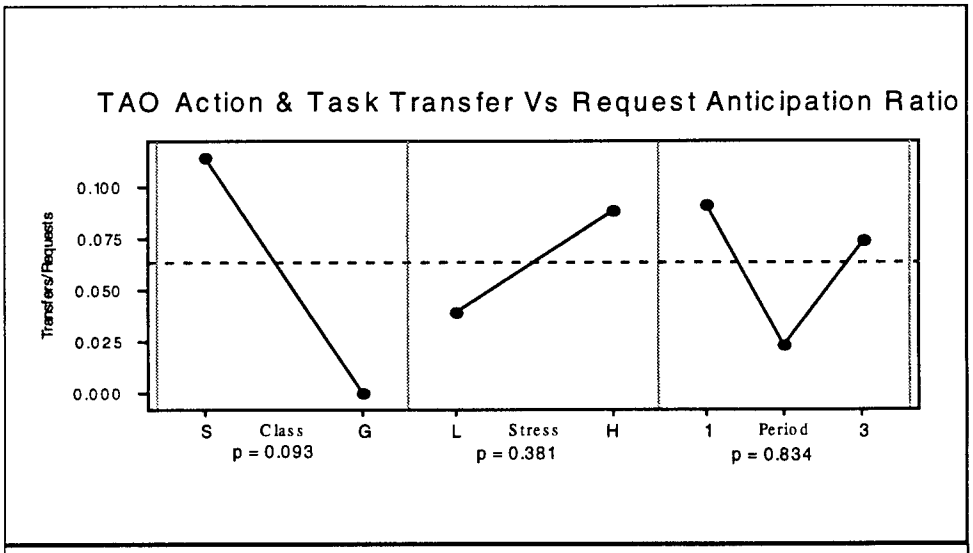

TAO Action & Task Request Rate
Mean Requests Per Minute
0.38
0.34
0.30
0.26
0.22
S Class G
p = 0.241
L Stress H
p = 0.041
1 Period 3
p = 0.379
TAO Action & Task Transfer Rate
Mean Transfers Per Minute
0.016
0.012
0.008
0.004
0.000
S Class G
p = 0.087
L Stress H
p = 0.461
1 Period 3
p = 0.879
Subordinate Information Request Rate From TAO
Mean Requests Per Minute
0.12
0.10
0.08
0.06
0.04
S Class G
p = 0.872
L Stress H
p = 0.992
1 Period 3
p = 0.055

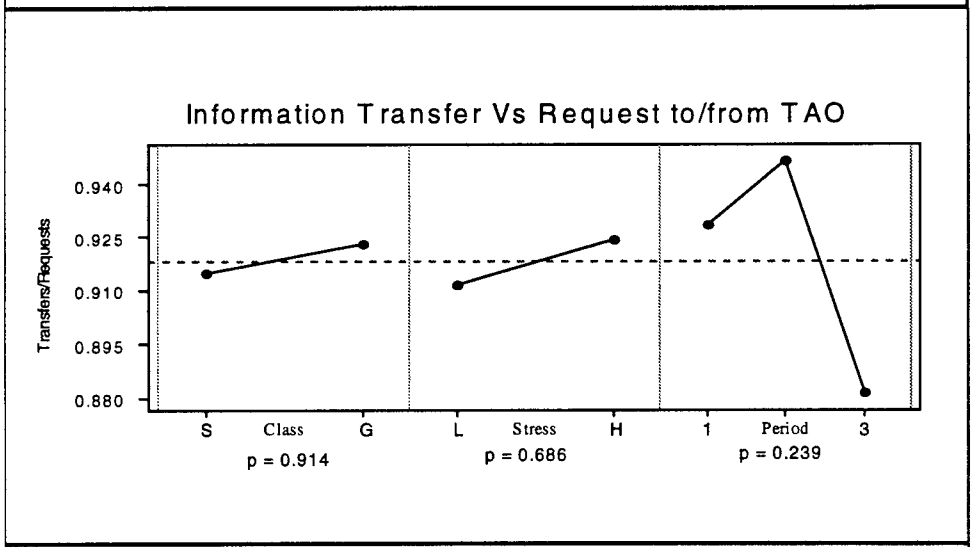

Subordinate Information Transfer Rate To TAO
Mean Transfers Per Minute
0.92
0.87
0.82
0.77
0.72
S Class G
p = 0.284
L Stress H
p = 0.518
1 Period 3
p = 0.495
Subordinate A&T Request Rate From TAO
Mean Requests Per Minute
0.077
0.069
0.061
0.053
0.045
S Class G
p = 0.383
L Stress H
p = 0.159
1 Period 3
p = 0.880
Subordinate A&T Transfer Rate To TAO
Mean Transfers Per Minute
0.100
0.085
0.070
0.055
0.040
S Class G
p = 0.199
L Stress H
p = 0.066
1 Period 3
p = 0.958

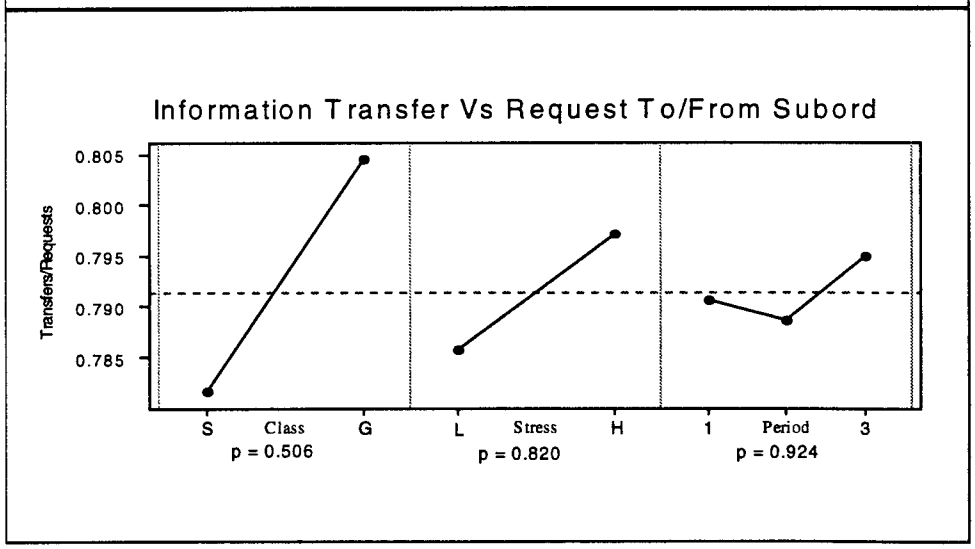

Subord Info Request Rate From Subordinate
Mean Requests Per Minute
0.380
0.365
0.350
0.335
0.320
S Class G
p = 0.336
L Stress H
p = 0.389
1 Period 3
p = 0.656
Subord Info Transfer Rate To Subordinate
Mean Transfers Per Minute
1.52
1.44
1.36
1.28
1.20
S Class G
p = 0.512
L Stress H
p = 0.144
1 Period 3
p = 0.241
Subord Action & Task Request From Subord
Mean Requests Per Minute
0.44
0.38
0.32
0.26
0.20
S Class G
p = 0.001
L Stress H
p = 0.186
1 Period 3
p = 0.618

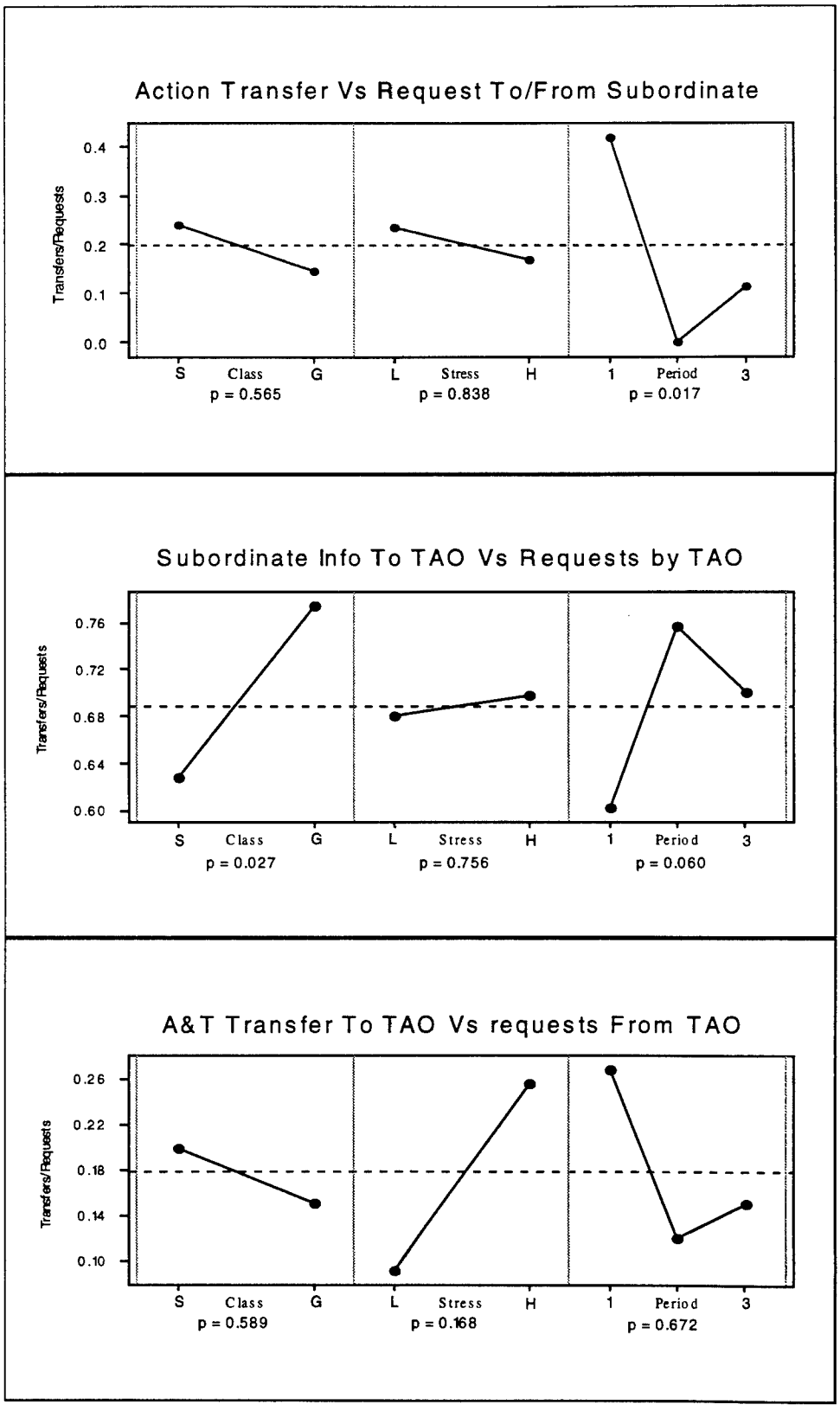

Subord Action & Task Transfer To Subord
Mean Transfer Per Minute
0.08
0.06
0.04
0.02
0.00
S Class G
p = 0.581
L Stress H
p = 0.607
1 Period 3
p = 0.014
Overall Upward Anticipation Ratio
Transfers/Requests
0.456
0.446
0.436
0.426
0.416
S Class G
p = 0.446
L Stress H
p = 0.400
1 Period 3
p = 0.672
Transfer Vs Request Anticipation Ratio
Transfers/Requests
0.665
0.655
0.645
0.635
0.625
S Class G
p = 0.099
L Stress H
p = 0.117
1 Period 3
p = 0.992

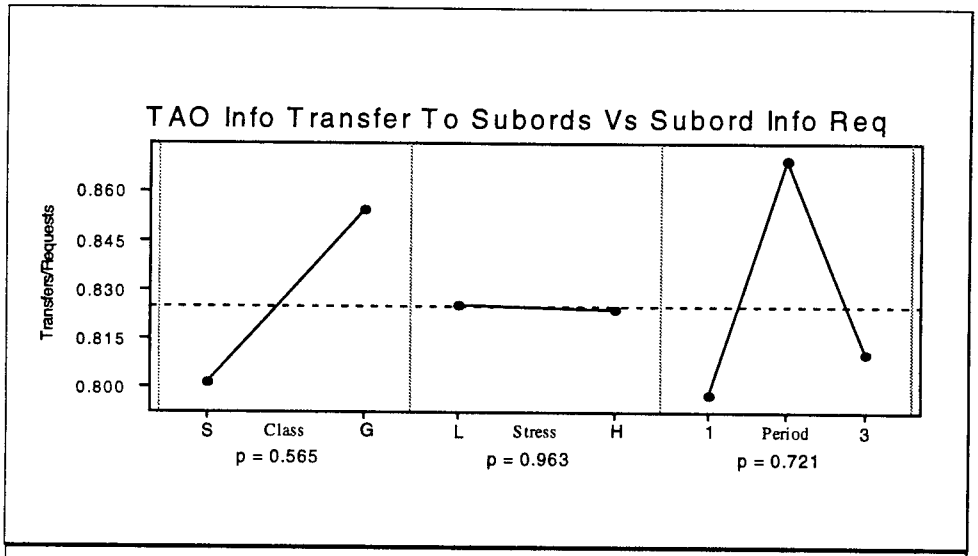

TAO Transfer Vs Request Anticipation Ratio
Transfers/Requests
0.60
0.57
0.54
0.51
0.48
S Class G
p = 0.337
L Stress H
p = 0.081
1 Period 3
p = 0.043
Subordinate Transfer Vs Request Anticipation Ratio
Transfers/Requests
0.720
0.705
0.690
0.675
0.660
S Class G
p = 0.028
L Stress H
p = 0.441
1 Period 3
p = 0.454
TAO Info Transfer Vs Request Anticipation Ratio
Transfers/Requests
0.69
0.63
0.57
0.51
0.45
S Class G
p = 0.002
L Stress H
p = 0.867
1 Period 3
p = 0.473

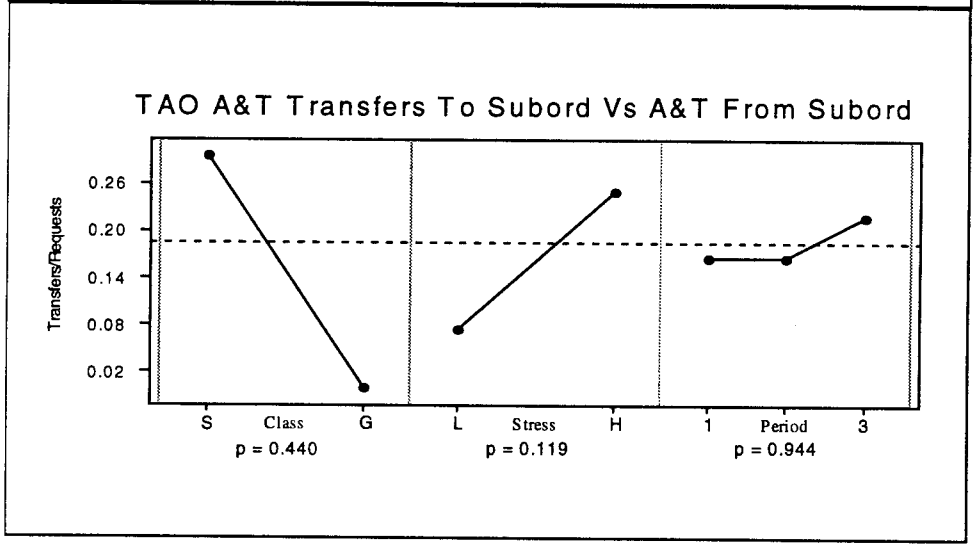

TAO Action & Task Transfer Vs Request Anticipation Ratio
Transfers/Requests
0.100
0.075
0.050
0.025
0.000
S
Class
G
p = 0.093
L
Stress
H
p = 0.381
1
Period
3
p = 0.834


Information Transfer Vs Request to/from TAO
Transfers/Requests
0.940
0.925
0.910
0.895
0.880
S
Class
G
p = 0.914
L
Stress
H
p = 0.686
1
Period
3
p = 0.239

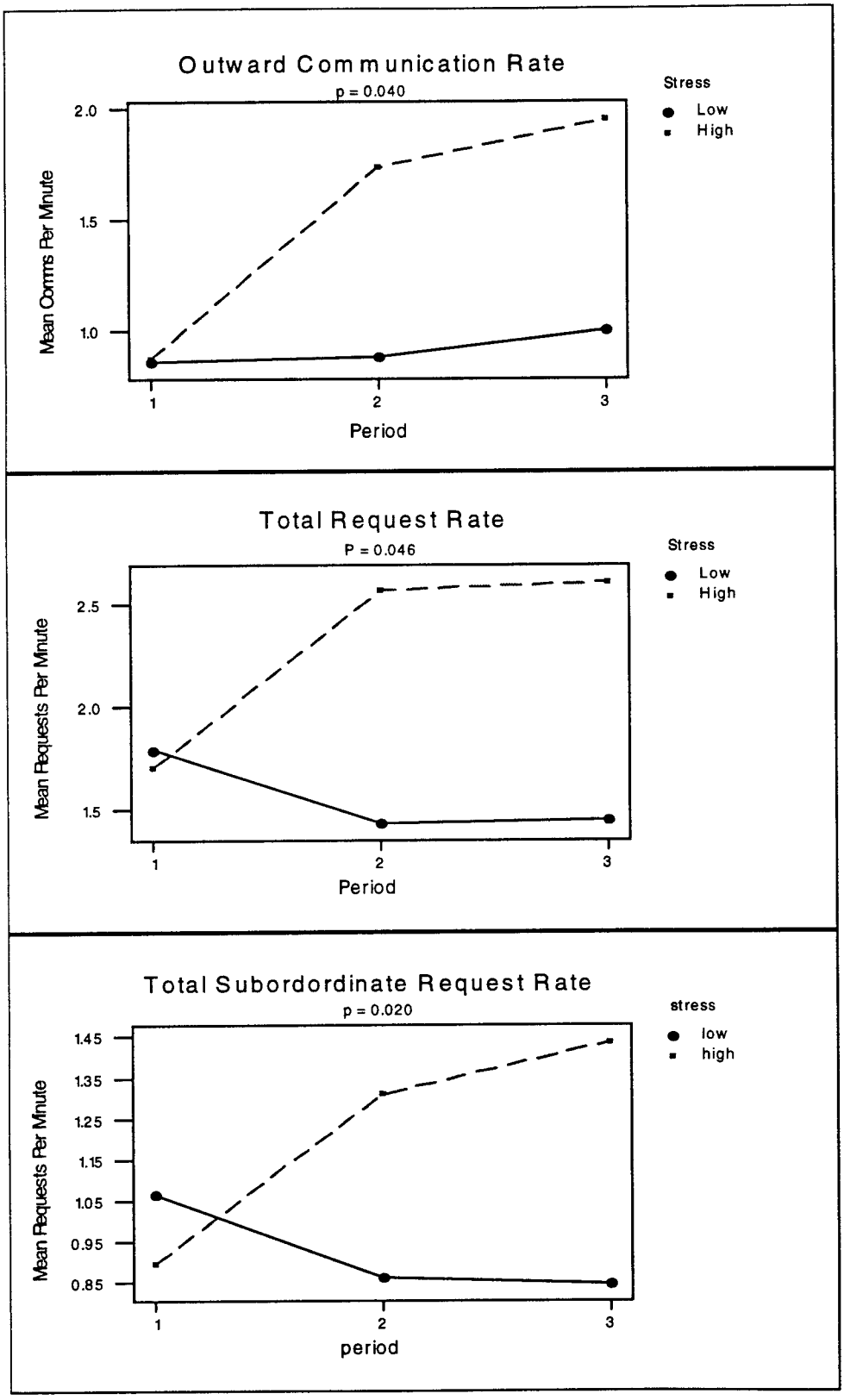

Information Transfer Vs Request To/From Subord
Transfers/Requests
0.805
0.800
0.795
0.790
0.785
S
Class
G
p = 0.506
L
Stress
H
p = 0.820
1
Period
3
p = 0.924

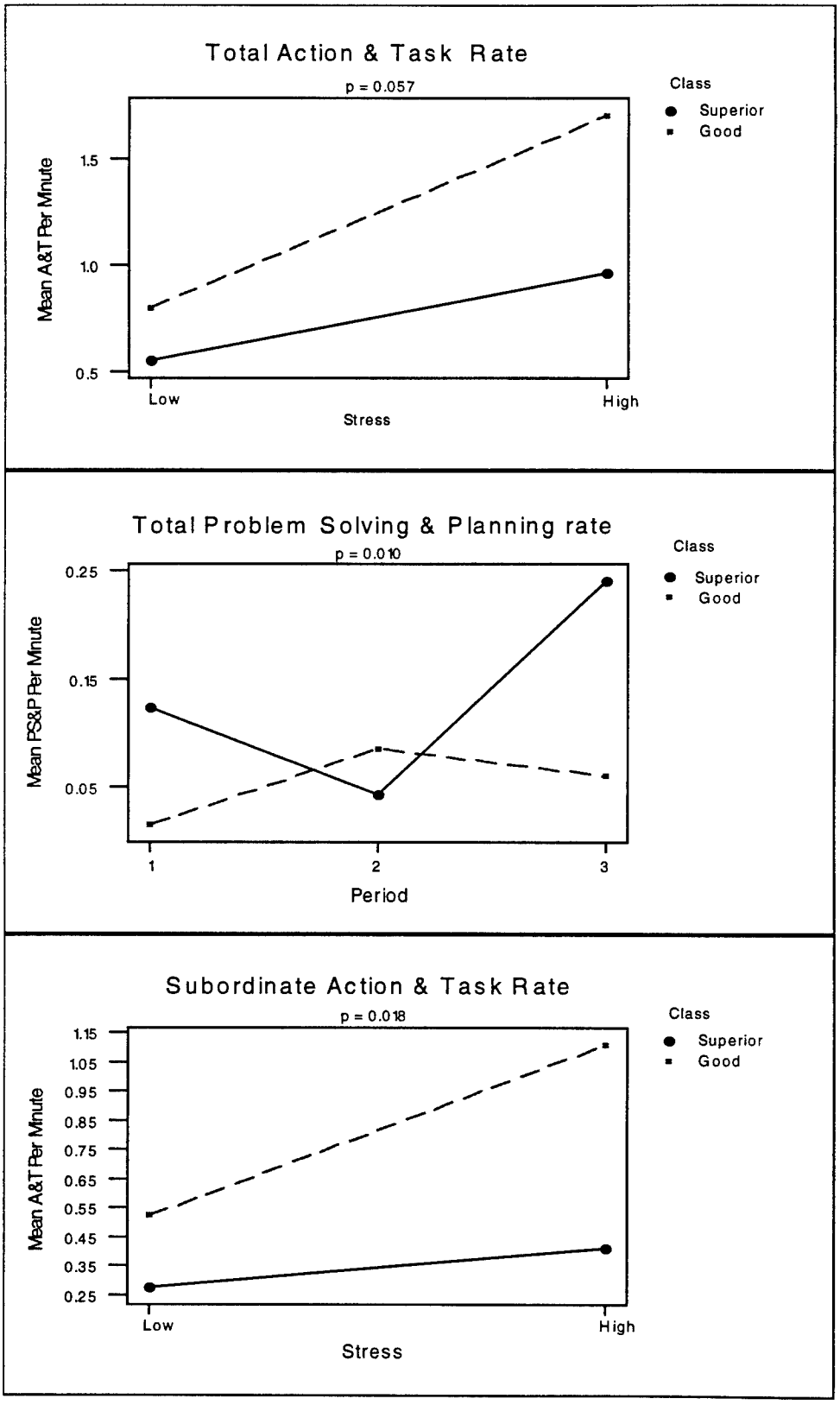

Action Transfer Vs Request To/From Subordinate
Transfers/Requests
0.4
0.3
0.2
0.1
0.0
S
Class
G
L
Stress
H
1
Period
3
p = 0.565
p = 0.838
p = 0.017
Subordinate Info To TAO Vs Requests by TAO
Transfers/Requests
0.76
0.72
0.68
0.64
0.60
S
Class
G
L
Stress
H
1
Period
3
p = 0.027
p = 0.756
p = 0.060
A&T Transfer To TAO Vs requests From TAO
Transfers/Requests
0.26
0.22
0.18
0.14
0.10
S
Class
G
L
Stress
H
1
Period
3
p = 0.589
p = 0.168
p = 0.672

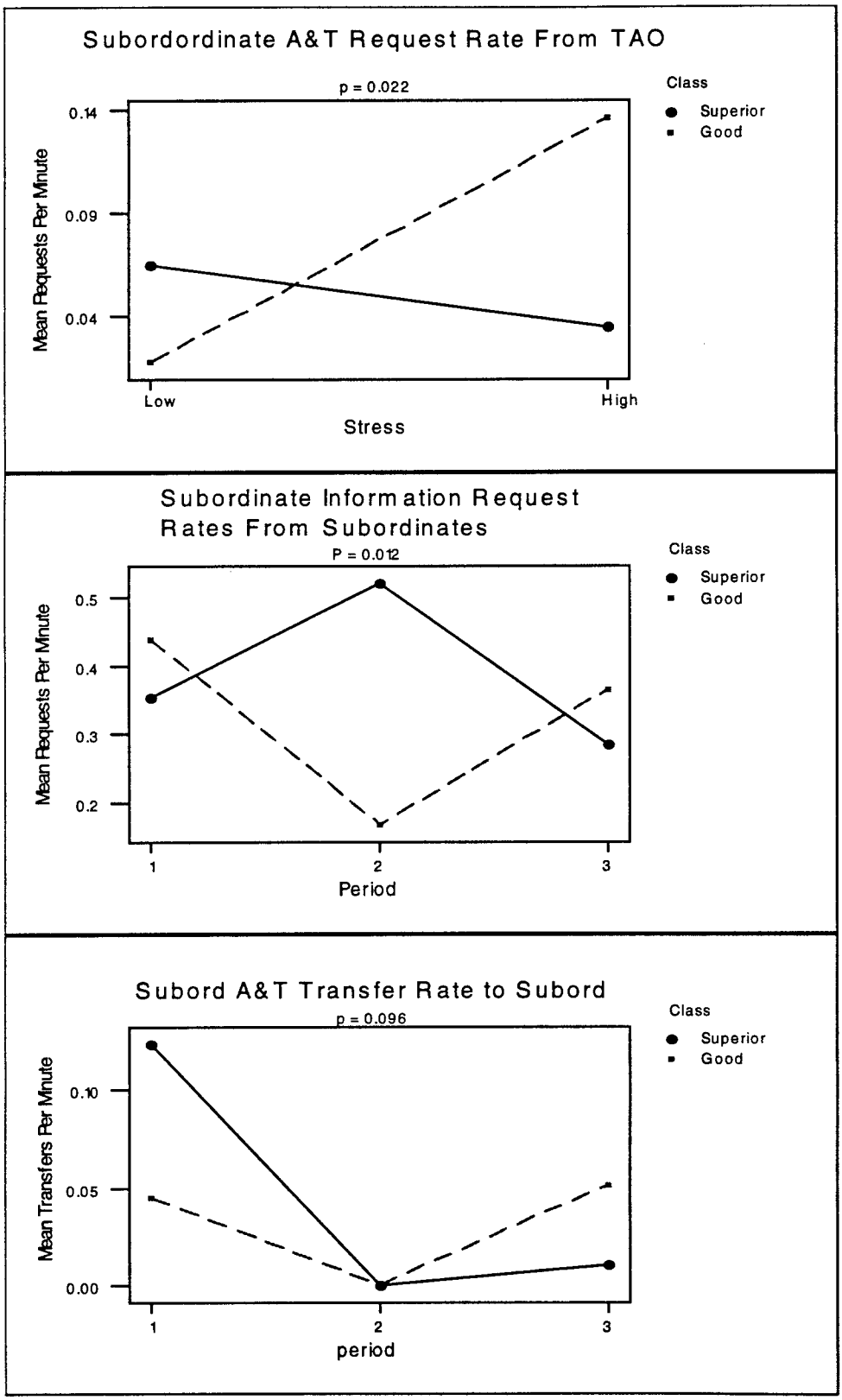

TAO Info Transfer To Subords Vs Subord Info Req
Transfers/Requests
0.860
0.845
0.830
0.815
0.800
S
Class
G
p = 0.565
L
Stress
H
p = 0.963
1
Period
3
p = 0.721

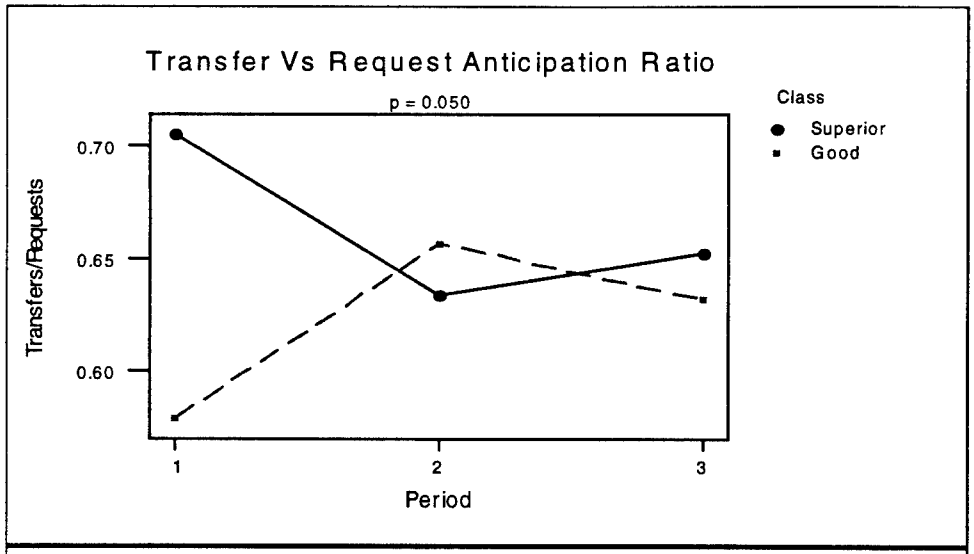

TAO A&T Transfers To Subord Vs A&T From Subord
Transfers/Requests
0.26
0.20
0.14
0.08
0.02
S
Class
G
p = 0.440
L
Stress
H
p = 0.119
1
Period
3
p = 0.944

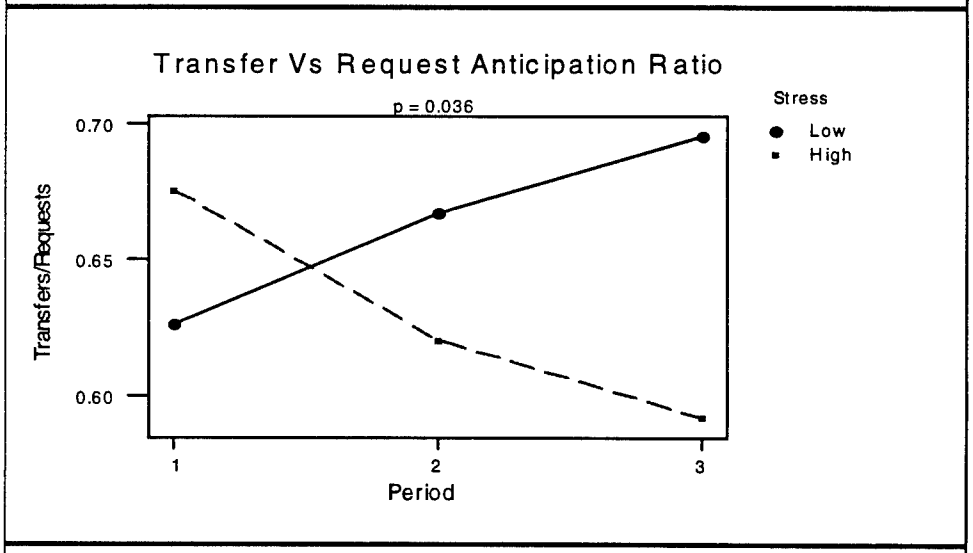
APPENDIX I. INTERACTION PLOTS FOR COMMUNICATION VARIABLES

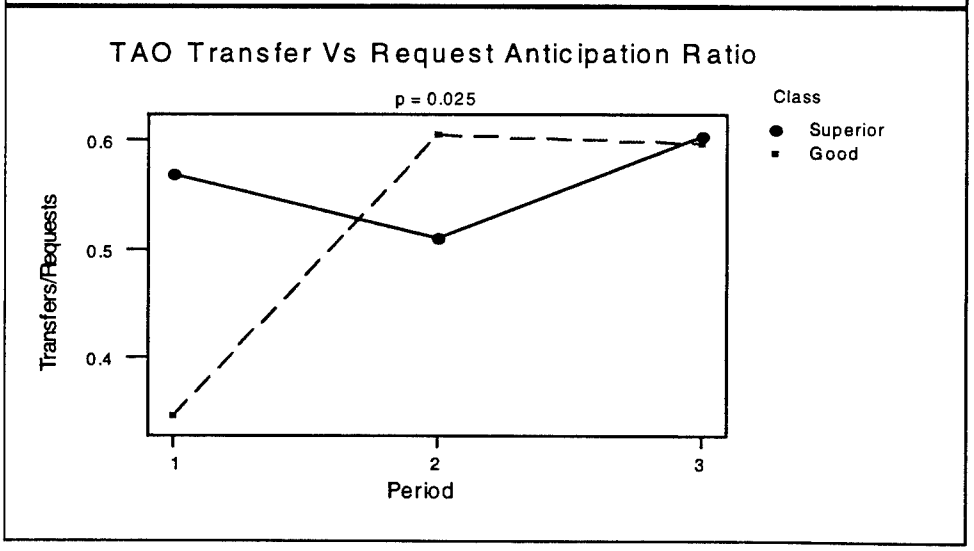


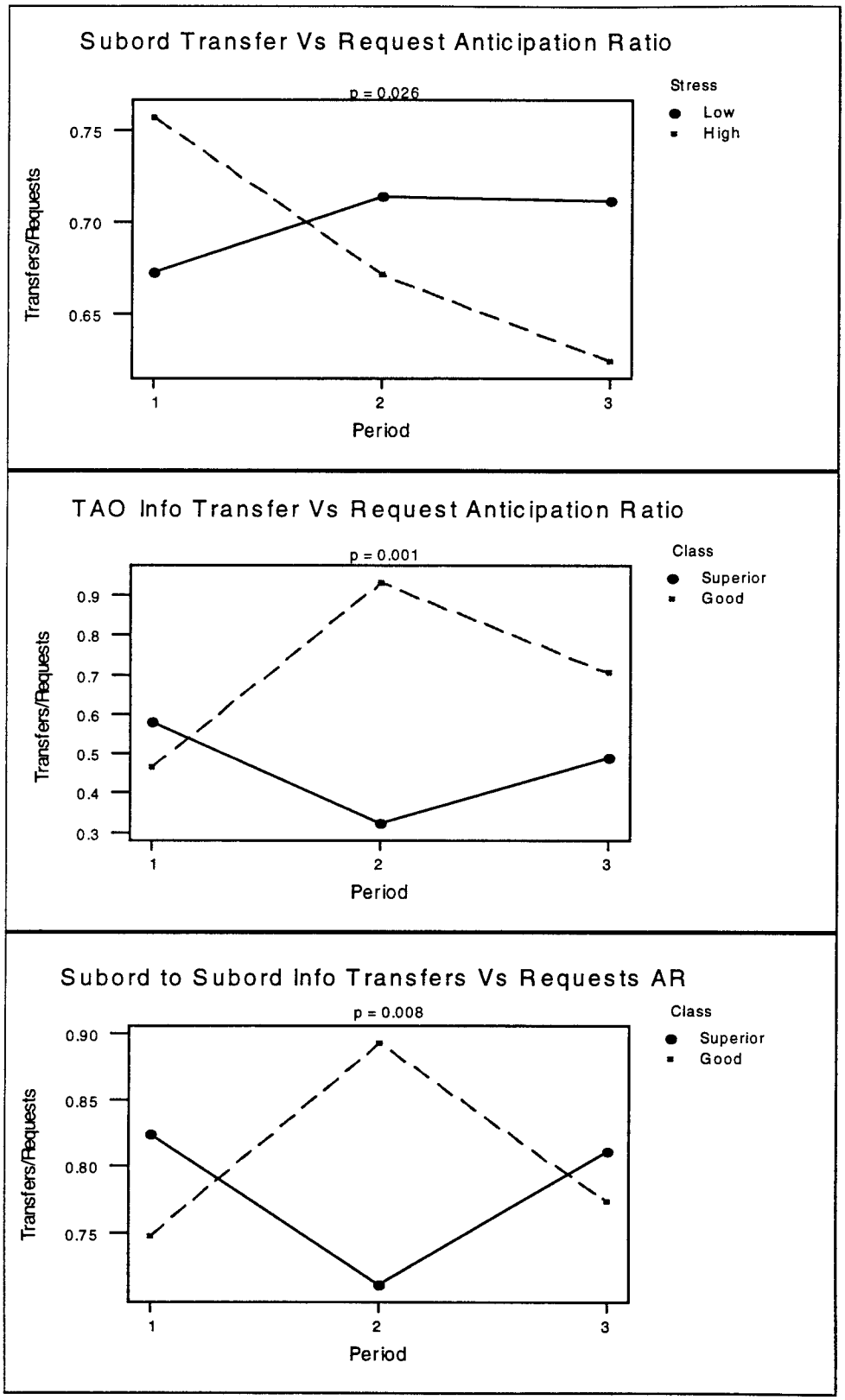

Total Action & Task Rate
p = 0.057
Class
Superior
Good
Mean A&T Per Minute
1.5
1.0
0.5
Low
High
Stress
Total Problem Solving & Planning rate
p = 0.010
Class
Superior
Good
Mean PS&P Per Minute
0.25
0.15
0.05
1
2
3
Period
Subordinate Action & Task Rate
p = 0.018
Class
Superior
Good
Mean A&T Per Minute
1.15
1.05
0.95
0.85
0.75
0.65
0.55
0.45
0.35
0.25
Low
High
Stress

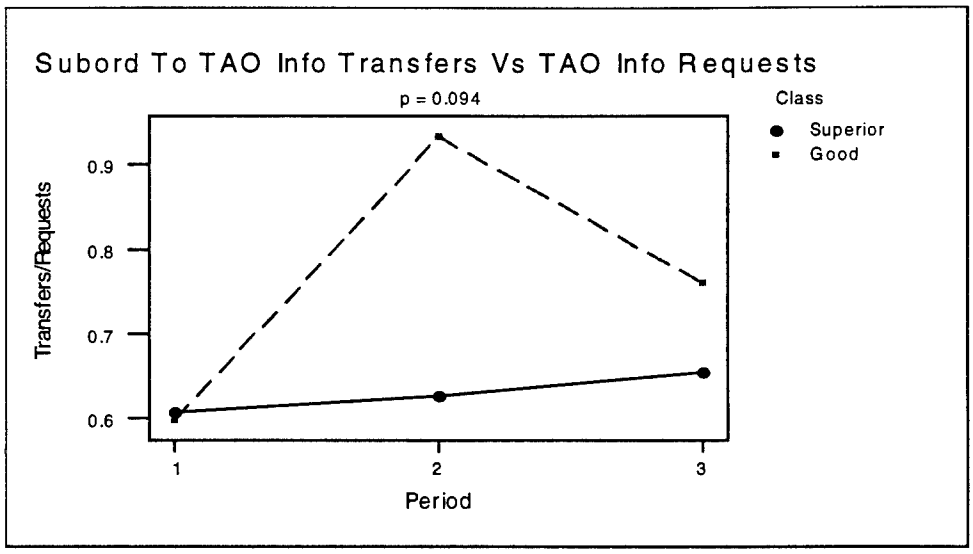

Subordordinate A&T Request Rate From TAO
p = 0.022
Class
Superior
Good
Mean Requests Per Mnute
0.14
0.09
0.04
Low
High
Stress
Subordinate Information Request
Rates From Subordinates
P = 0.012
Class
Superior
Good
Mean Requests Per Mnute
0.5
0.4
0.3
0.2
1
2
3
Period
Subord A&T Transfer Rate to Subord
p = 0.096
Class
Superior
Good
Mean Transfers Per Mnute
0.10
0.05
0.00
1
2
3
period


Transfer Vs Request Anticipation Ratio
p = 0.050
Class
Superior
Good
Transfers/Requests
0.70
0.65
0.60
1
2
3
Period


Transfer Vs Request Anticipation Ratio
p = 0.036
Stress
Low
High
Transfers/Requests
0.70
0.65
0.60
1
2
3
Period

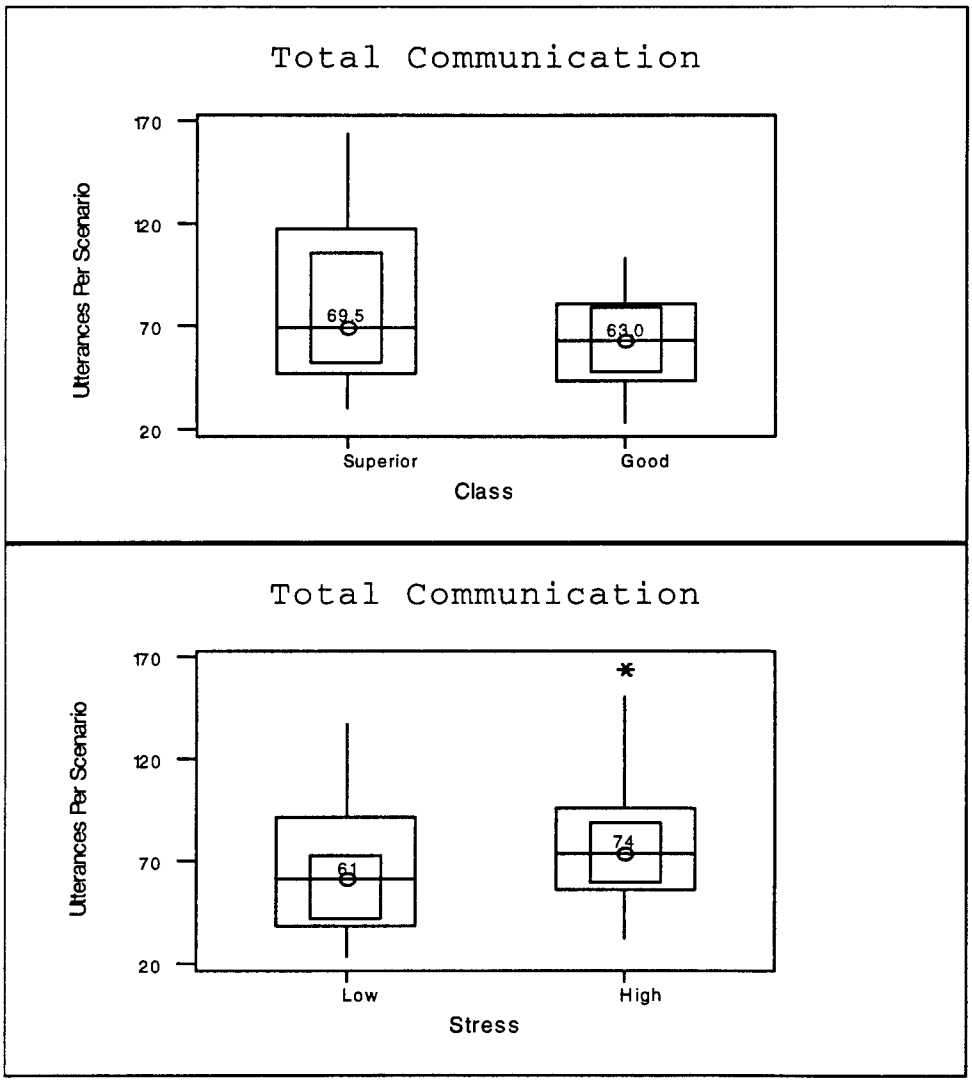

TAO Transfer Vs Request Anticipation Ratio
p = 0.025
Class
Superior
Good
Transfers/Requests
0.6
0.5
0.4
1
2
3
Period

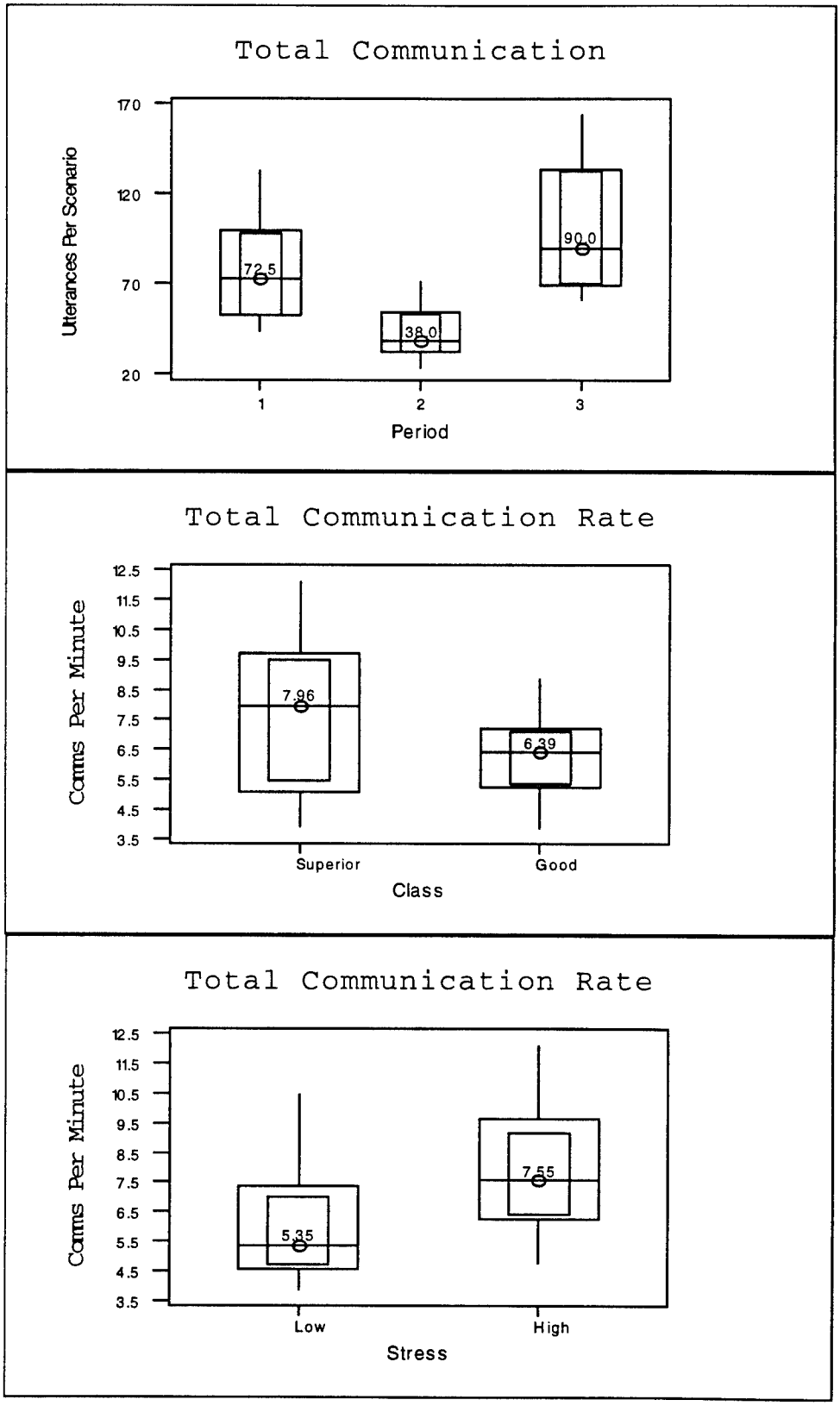

Subord Transfer Vs Request Anticipation Ratio
p = 0.026
Stress
Low
High
Transfers/Requests
0.75
0.70
0.65
1
2
3
Period
TAO Info Transfer Vs Request Anticipation Ratio
p = 0.001
Class
Superior
Good
Transfers/Requests
0.9
0.8
0.7
0.6
0.5
0.4
0.3
1
2
3
Period
Subord to Subord Info Transfers Vs Requests AR
p = 0.008
Class
Superior
Good
Transfers/Requests
0.90
0.85
0.80
0.75
1
2
3
Period

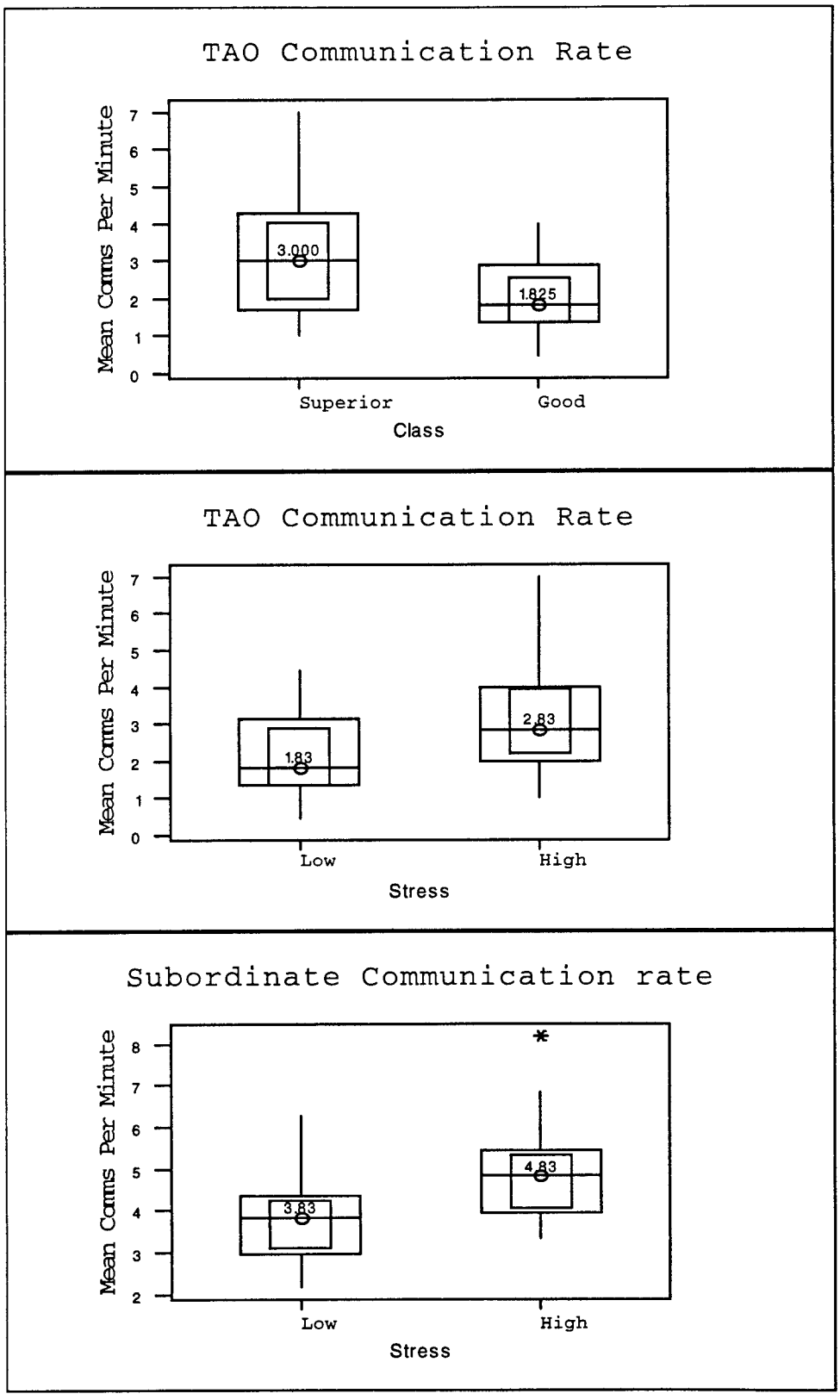

Subord To TAO Info Transfers Vs TAO Info Requests
p = 0.094
Class
Superior
Good
Transfers/Requests
0.9
0.8
0.7
0.6
1
2
3
Period

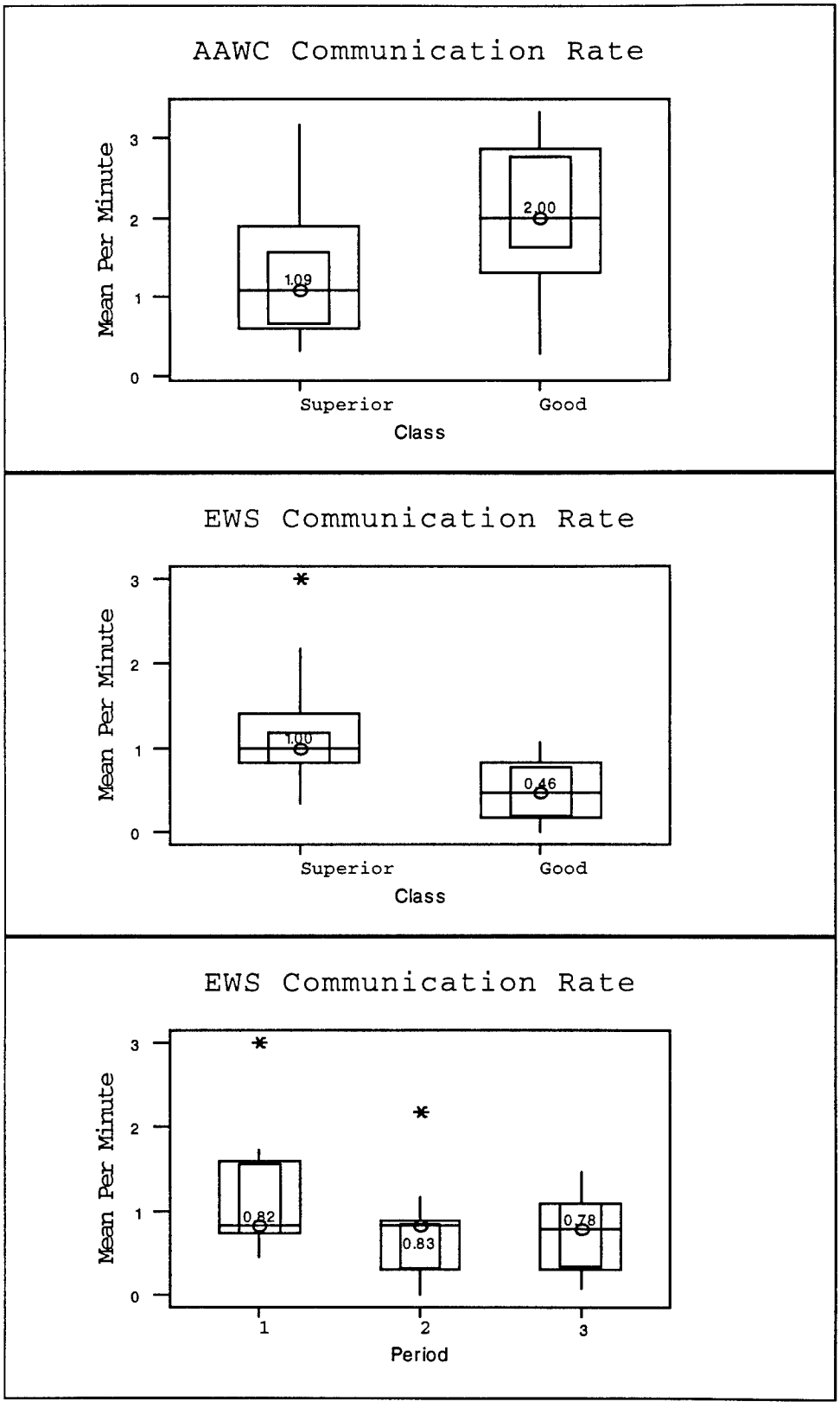
APPENDIX J. BOXPLOTS FOR COMMUNICATION VARIABLES

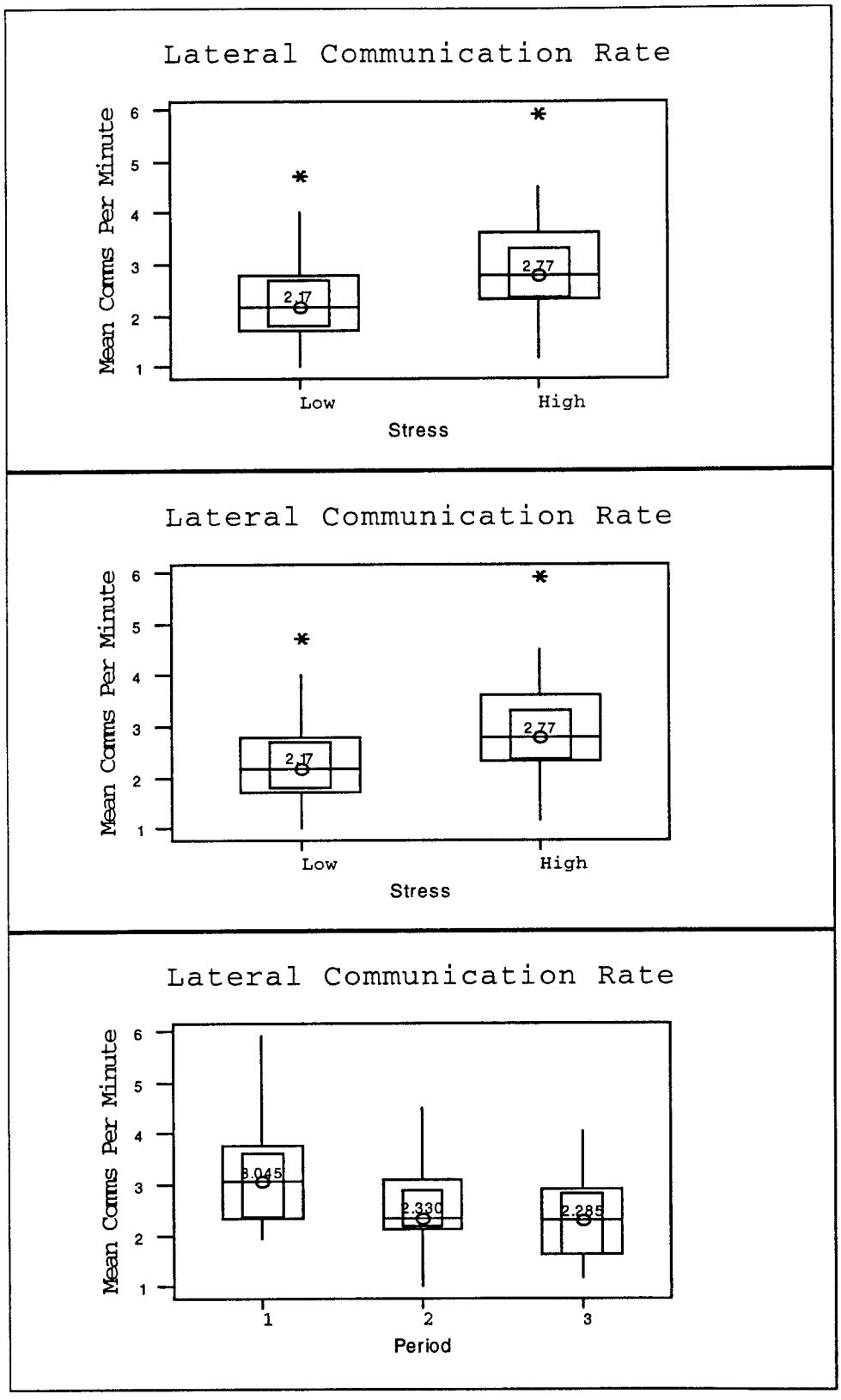
This Appendix displays the boxplots for those communication variables that only had marginal or significant results across the independent variables of Class, Stress, and Period.

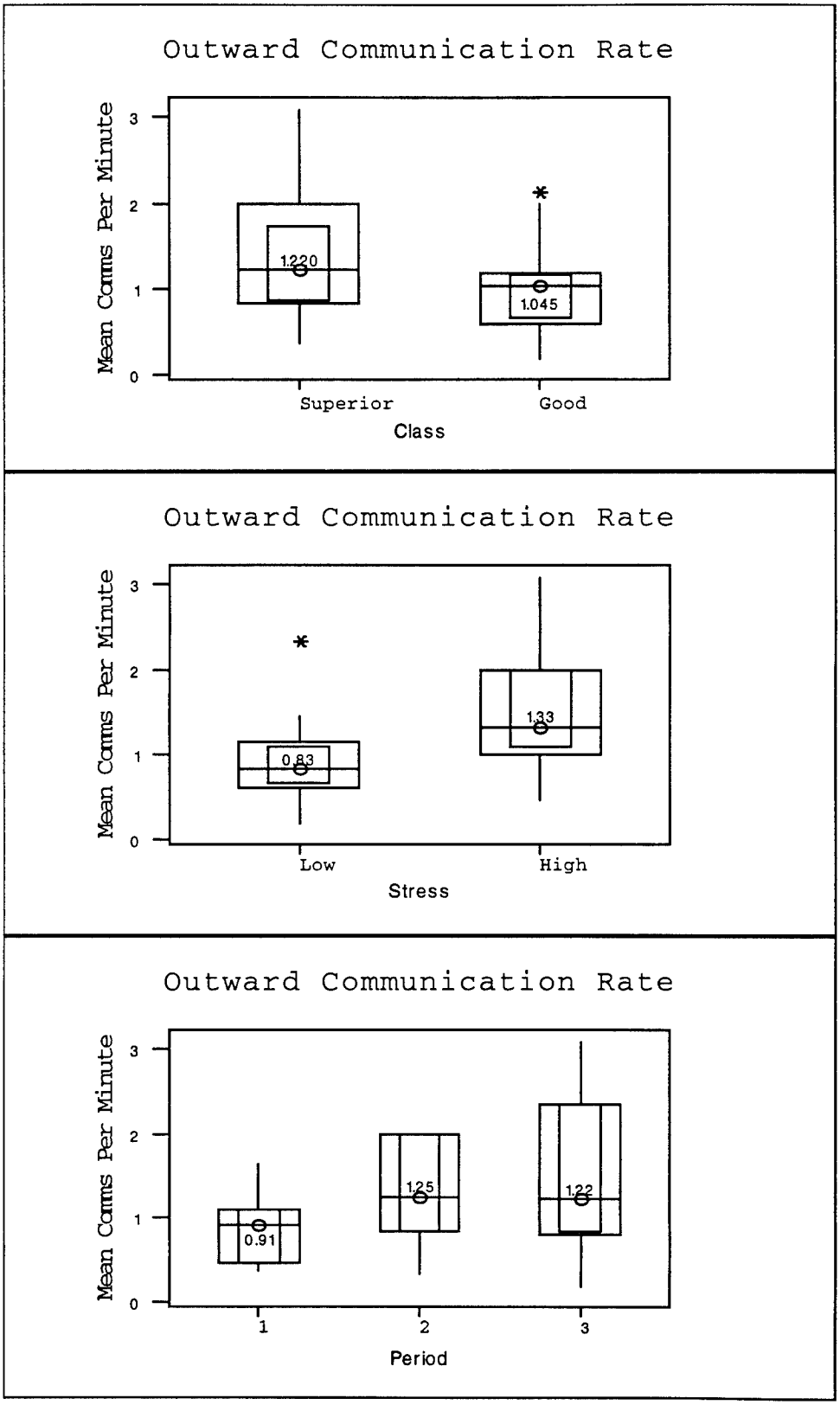


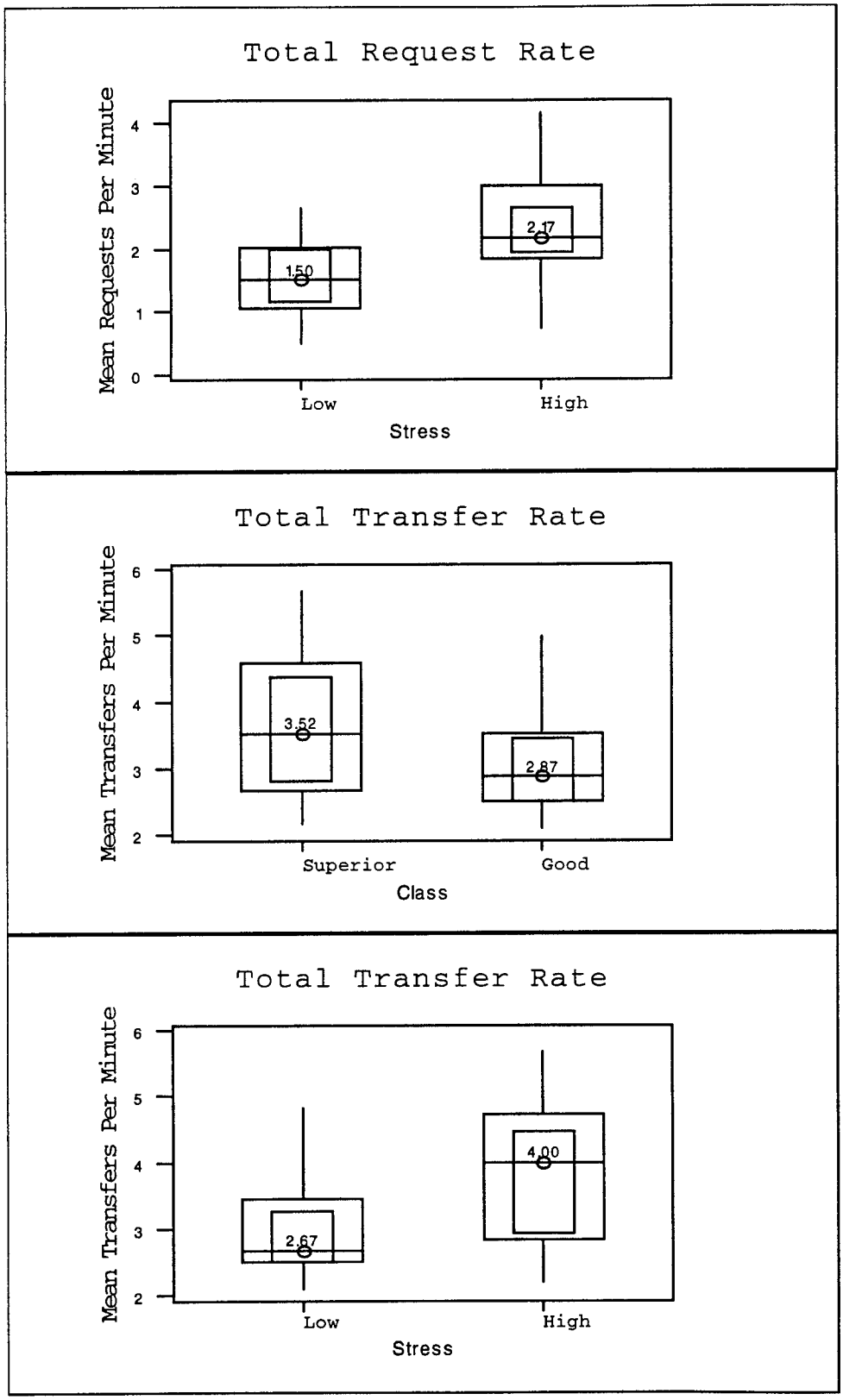

Total Communication
Utterances Per Scenario
170
120
70
20
72.5
38.0
90.0
1
2
3
Period
Total Communication Rate
Comms Per Minute
12.5
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
7.96
6.39
Superior
Good
Class
Total Communication Rate
Comms Per Minute
12.5
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
5.35
7.55
Low
High
Stress

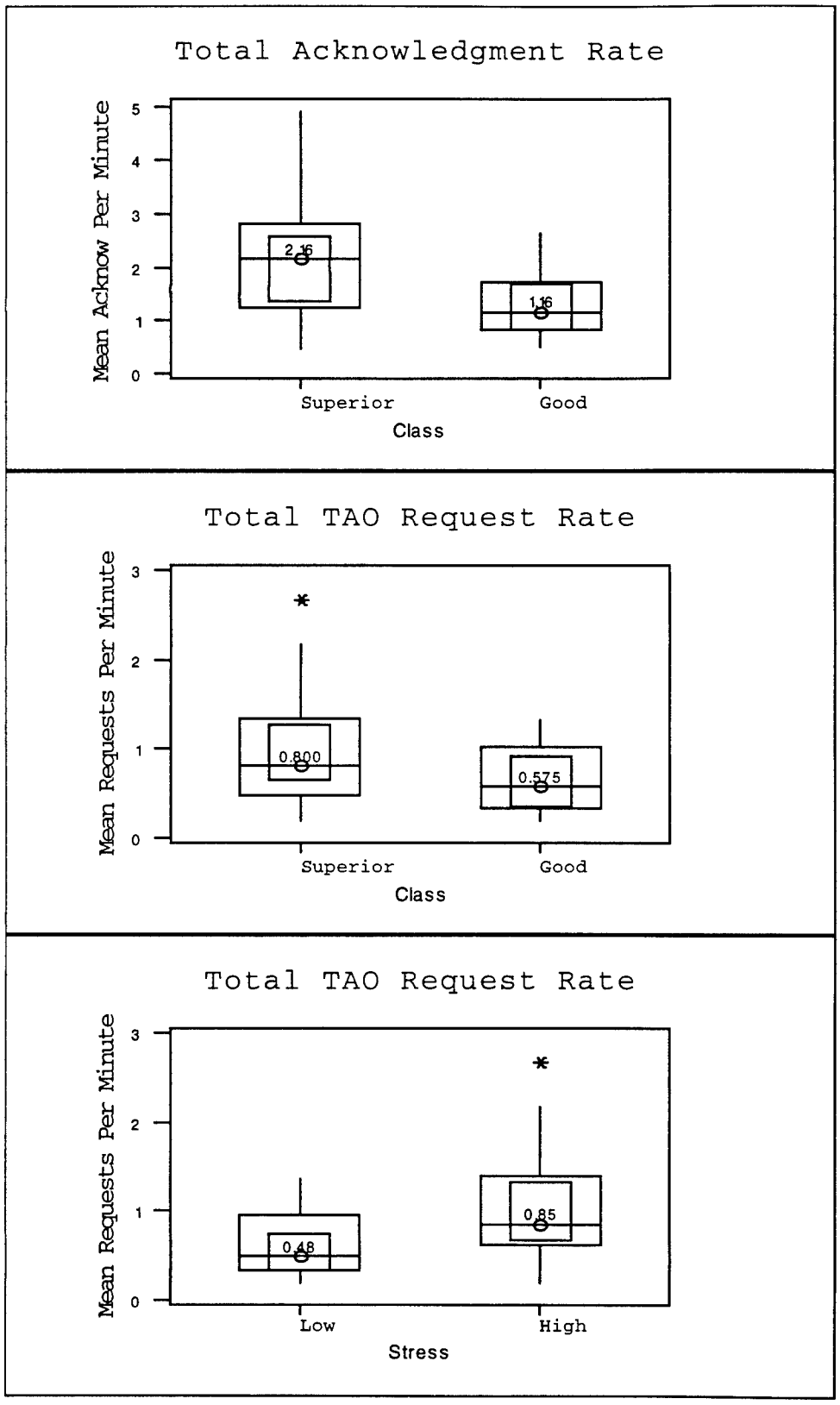

TAO Communication Rate
Mean Comms Per Minute
7
6
5
4
3
2
1
0
3.000
1.825
Superior
Good
Class
TAO Communication Rate
Mean Comms Per Minute
7
6
5
4
3
2
1
0
1.83
2.83
Low
High
Stress
Subordinate Communication rate
Mean Comms Per Minute
8
7
6
5
4
3
2
3.83
4.83
*
Low
High
Stress

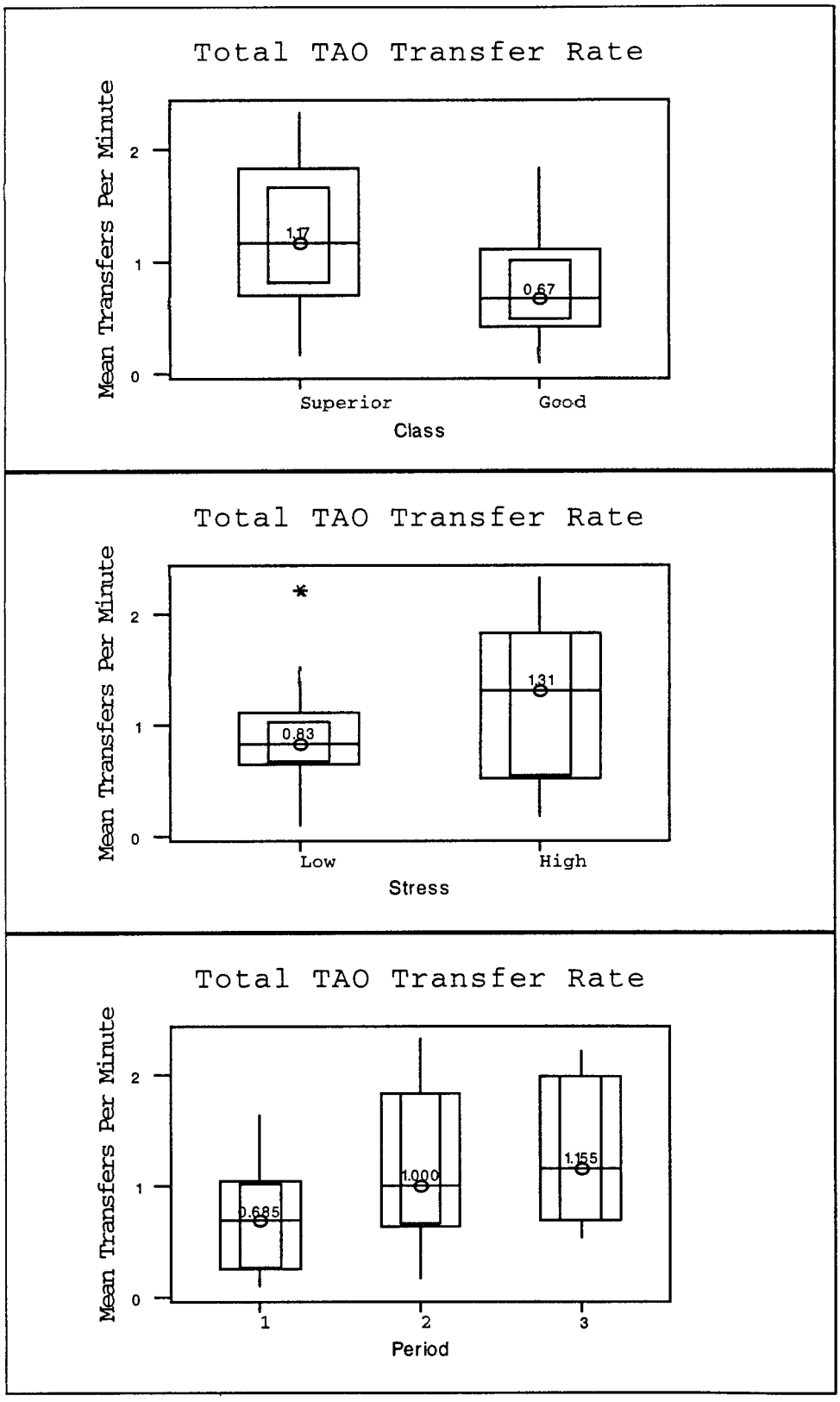

AAWC Communication Rate
Mean Per Minute
3
2
1
0
1.09
2.00
Superior
Good
Class
EWS Communication Rate
Mean Per Minute
3
2
1
0
1.00
0.46
Superior
Good
Class
EWS Communication Rate
Mean Per Minute
3
2
1
0
0.82
0.83
0.78
1
2
3
Period

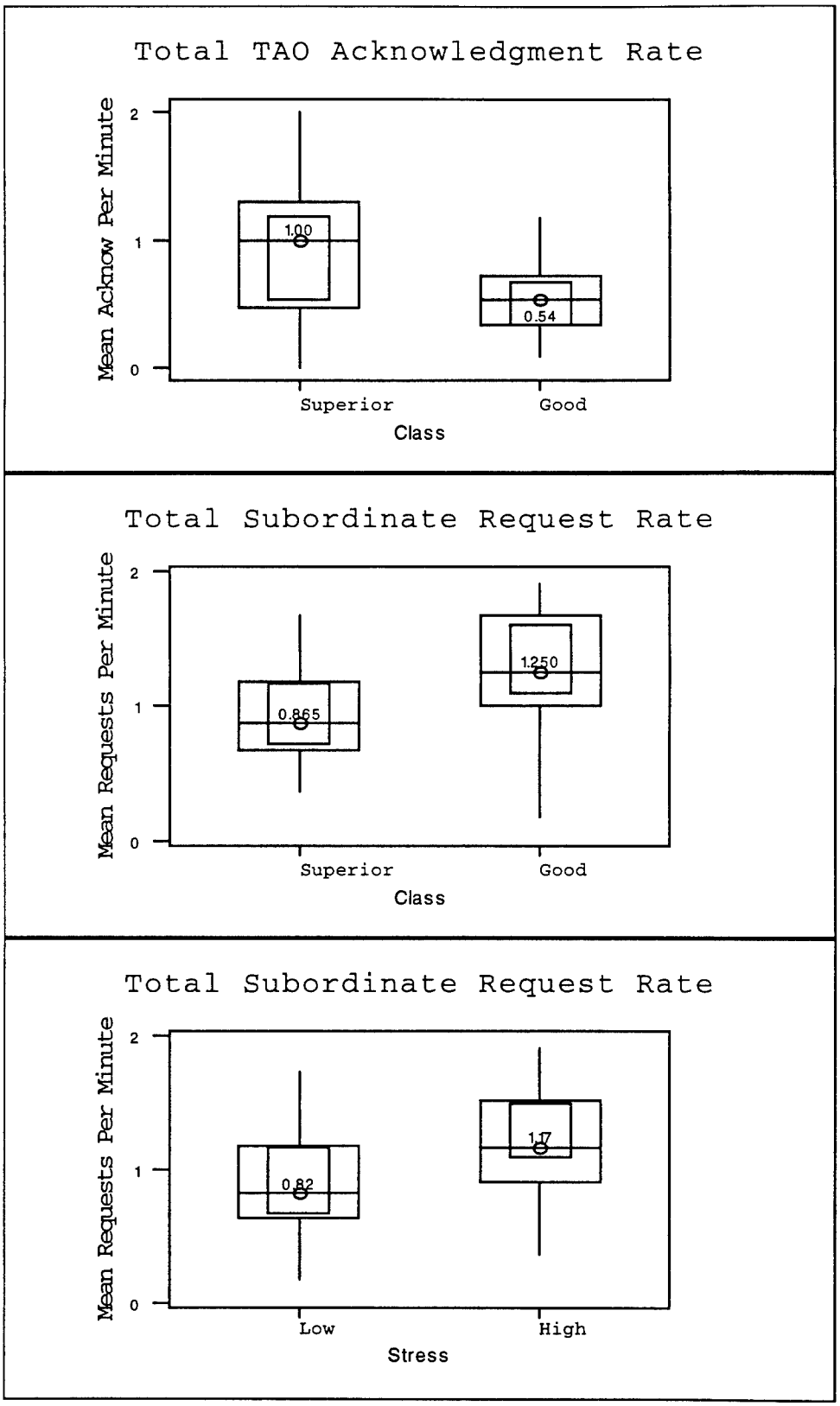

Lateral Communication Rate
Mean Comms Per Minute
6
5
4
3
2
1
2.17
2.77
Low
High
Stress
Lateral Communication Rate
Mean Comms Per Minute
6
5
4
3
2
1
2.17
2.77
Low
High
Stress
Lateral Communication Rate
Mean Comms Per Minute
6
5
4
3
2
1
3.045
2.330
2.285
1
2
3
Period

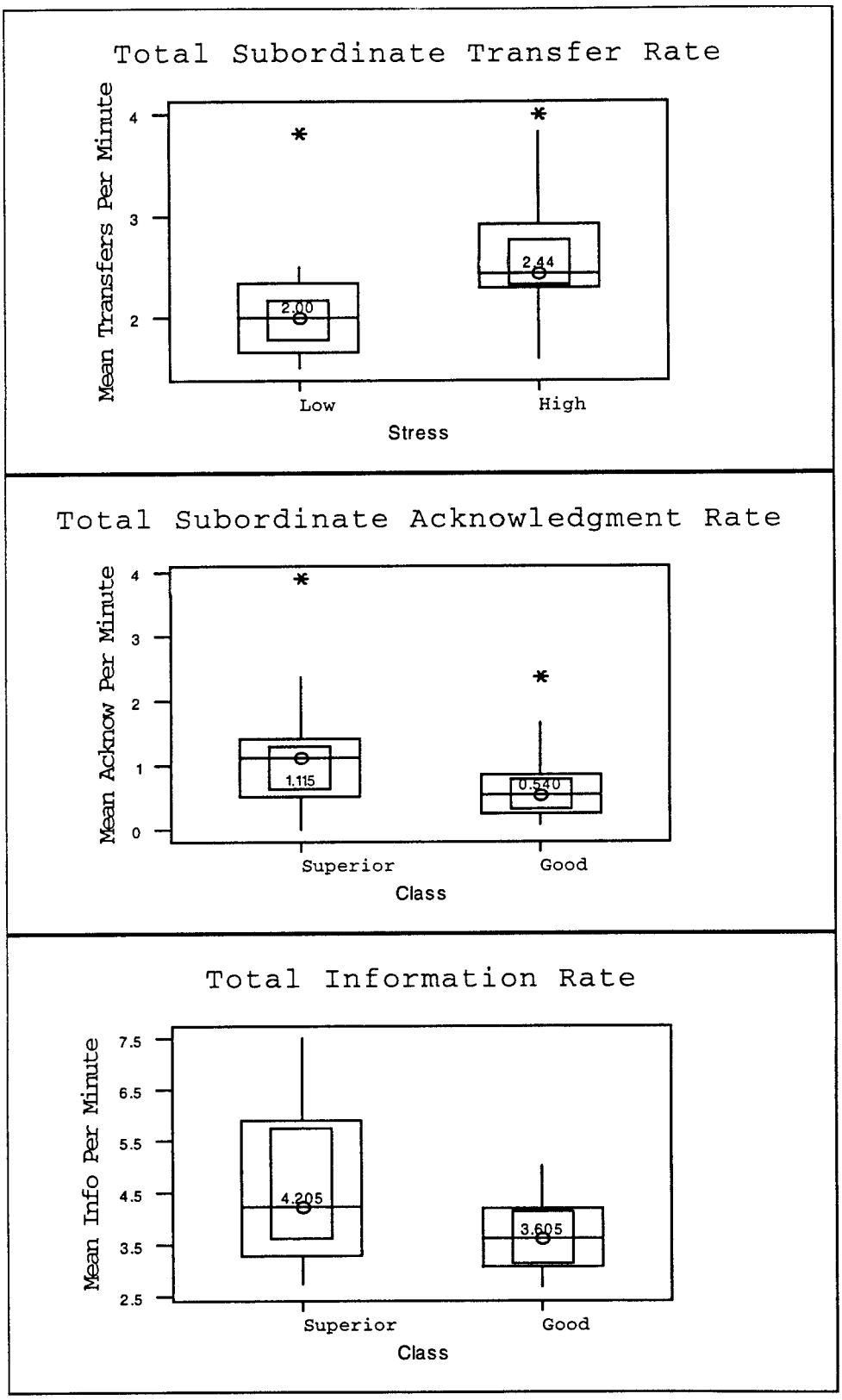

Outward Communication Rate
Mean Comms Per Minute
3
2
1
0
1.220
1.045
Superior
Good
Class
Outward Communication Rate
Mean Comms Per Minute
3
2
1
0
0.83
1.33
Low
High
Stress
Outward Communication Rate
Mean Comms Per Minute
3
2
1
0
0.91
1.25
1.22
1
2
3
Period

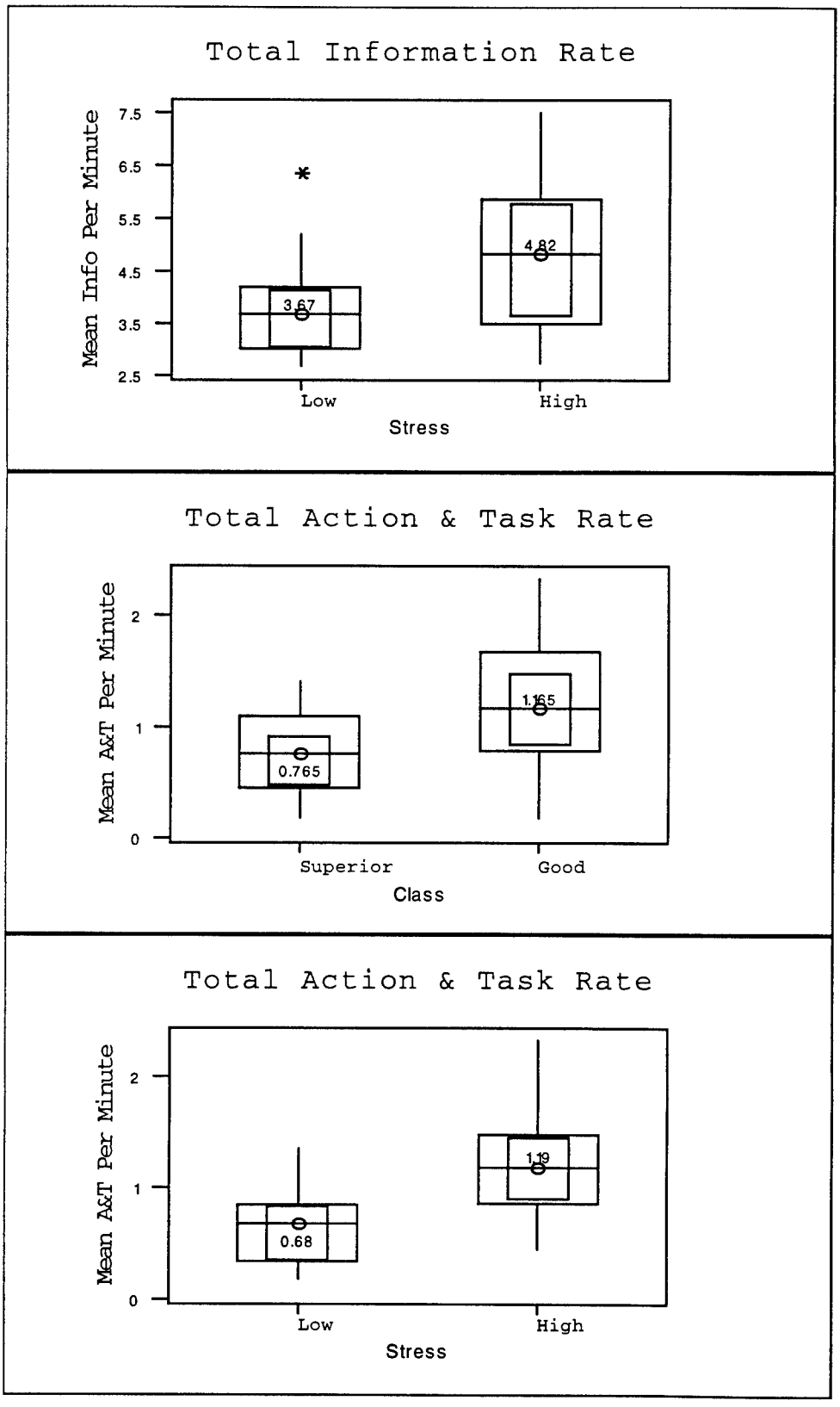

Total Request Rate
Mean Requests Per Minute
0
1
2
3
4
1.50
2.17
Low
High
Stress
Total Transfer Rate
Mean Transfers Per Minute
2
3
4
5
6
3.52
2.87
Superior
Good
Class
Total Transfer Rate
Mean Transfers Per Minute
2
3
4
5
6
2.67
4.00
Low
High
Stress

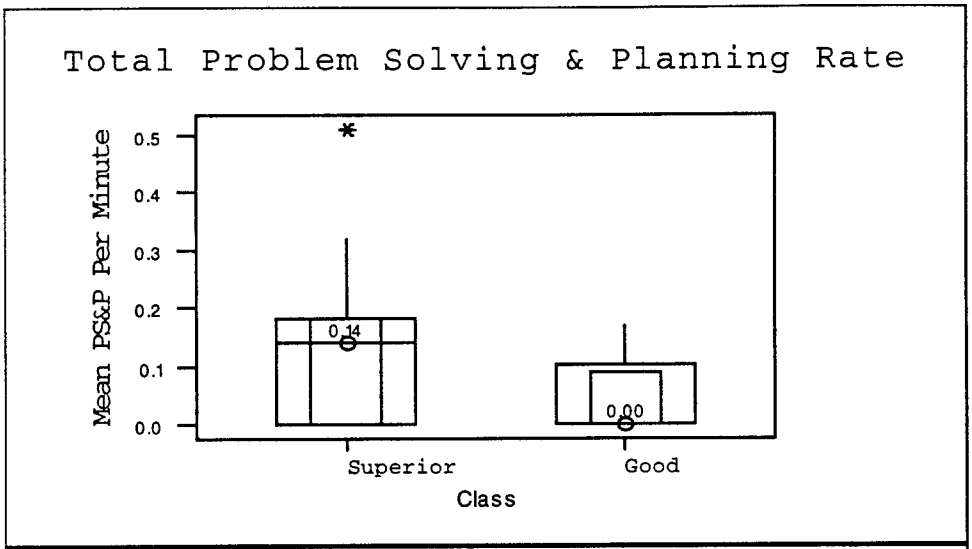

Total Acknowledgment Rate
Mean Acknow Per Minute
5
4
3
2
1
0
2.16
1.16
Superior
Good
Class
Total TAO Request Rate
Mean Requests Per Minute
3
2
1
0
0.800
0.575
Superior
Good
Class
Total TAO Request Rate
Mean Requests Per Minute
3
2
1
0
0.48
0.85
Low
High
Stress

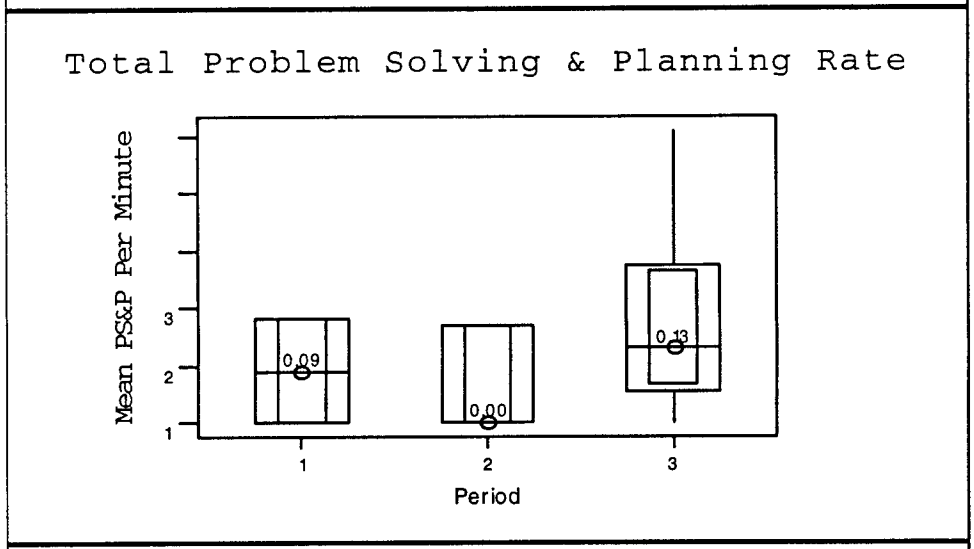

Total TAO Transfer Rate
Mean Transfers Per Minute
2
1
0
1.17
0.67
Superior
Good
Class
Total TAO Transfer Rate
Mean Transfers Per Minute
2
1
0
0.83
1.31
Low
High
Stress
Total TAO Transfer Rate
Mean Transfers Per Minute
2
1
0
0.685
1.000
1.155
1
2
3
Period

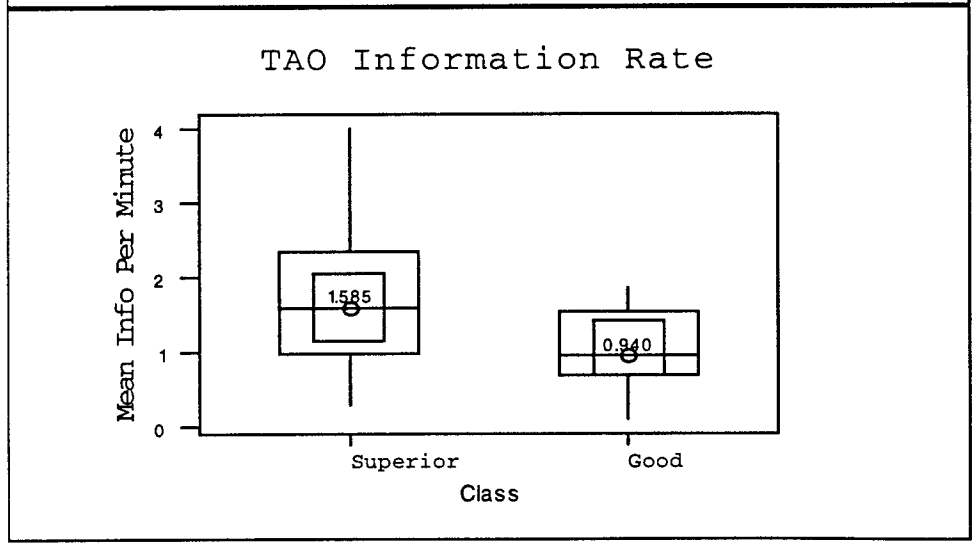

Total TAO Acknowledgment Rate
Mean Acknow Per Minute
2
1
0
1.00
0.54
Superior
Good
Class
Total Subordinate Request Rate
Mean Requests Per Minute
2
1
0
0.865
1.250
Superior
Good
Class
Total Subordinate Request Rate
Mean Requests Per Minute
2
1
0
0.82
1.17
Low
High
Stress

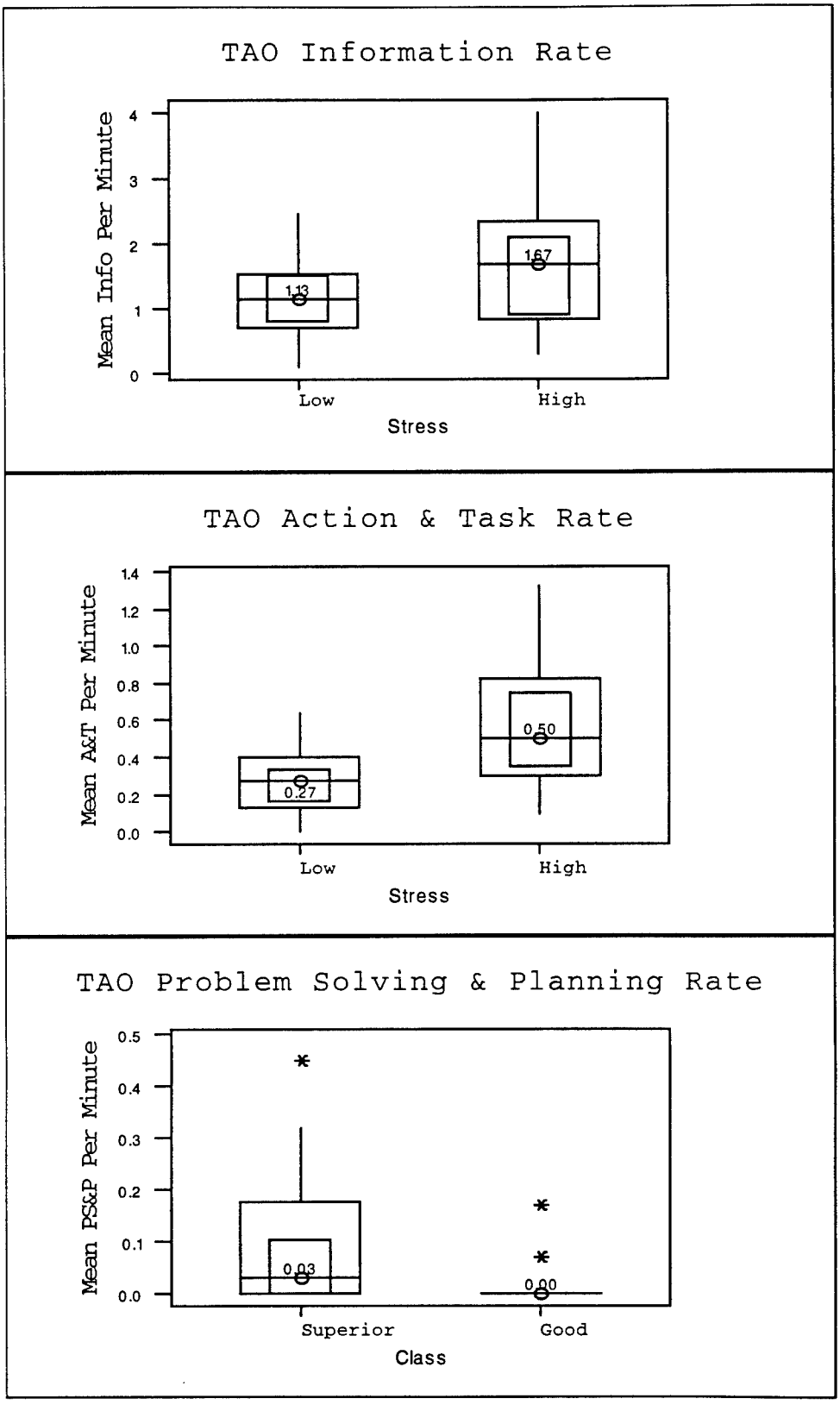

Total Subordinate Transfer Rate
Mean Transfers Per Minute
4
3
2
2.00
2.44
Low
High
Stress
Total Subordinate Acknowledgment Rate
Mean Acknow Per Minute
4
3
2
1
0
1.115
0.540
Superior
Good
Class
Total Information Rate
Mean Info Per Minute
7.5
6.5
5.5
4.5
3.5
2.5
4.205
3.605
Superior
Good
Class

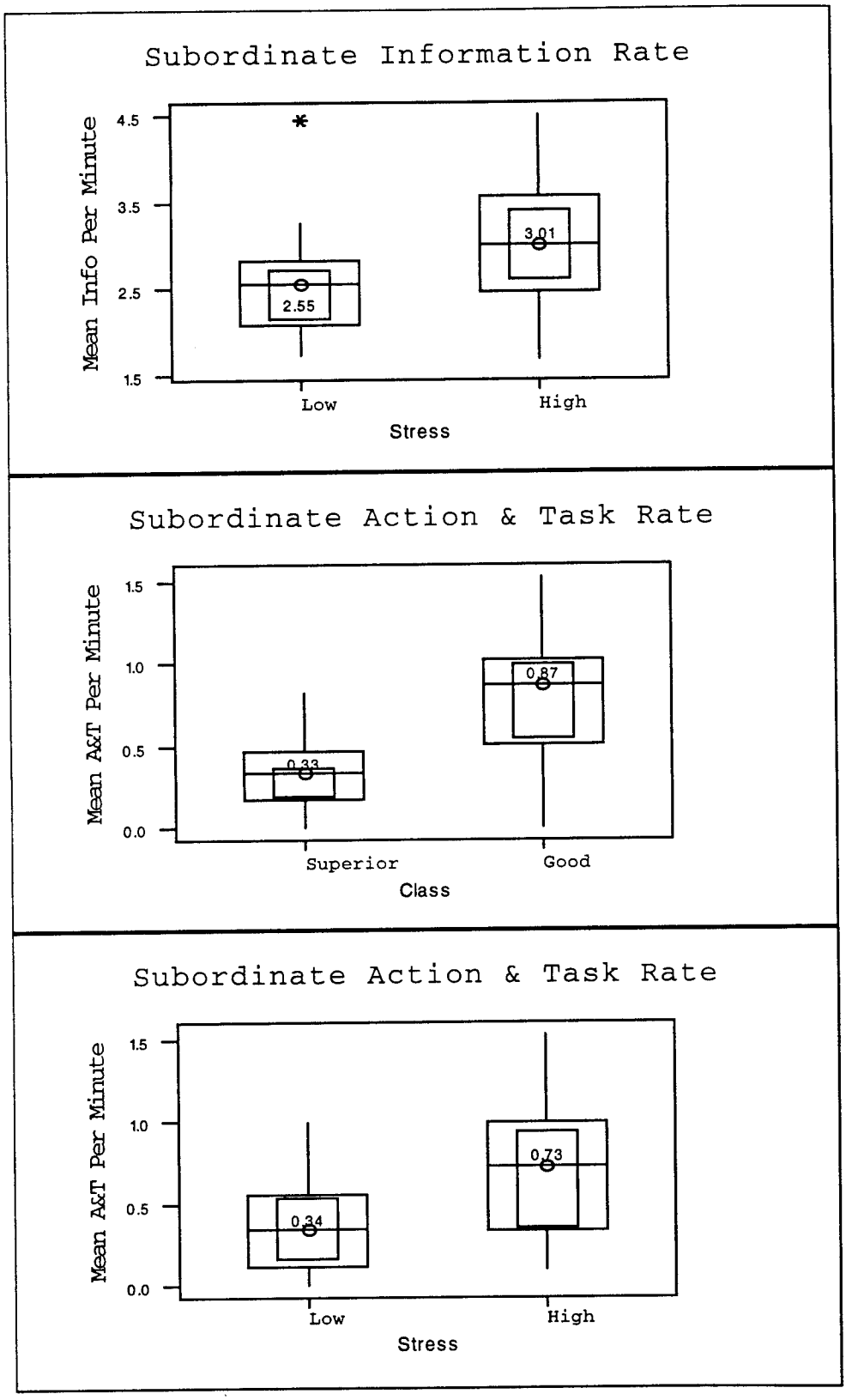

Total Information Rate
Mean Info Per Minute
7.5
6.5
5.5
4.5
3.5
2.5
3.67
4.82
Low
High
Stress
Total Action & Task Rate
Mean A&T Per Minute
2
1
0
0.765
1.165
Superior
Good
Class
Total Action & Task Rate
Mean A&T Per Minute
2
1
0
0.68
1.19
Low
High
Stress

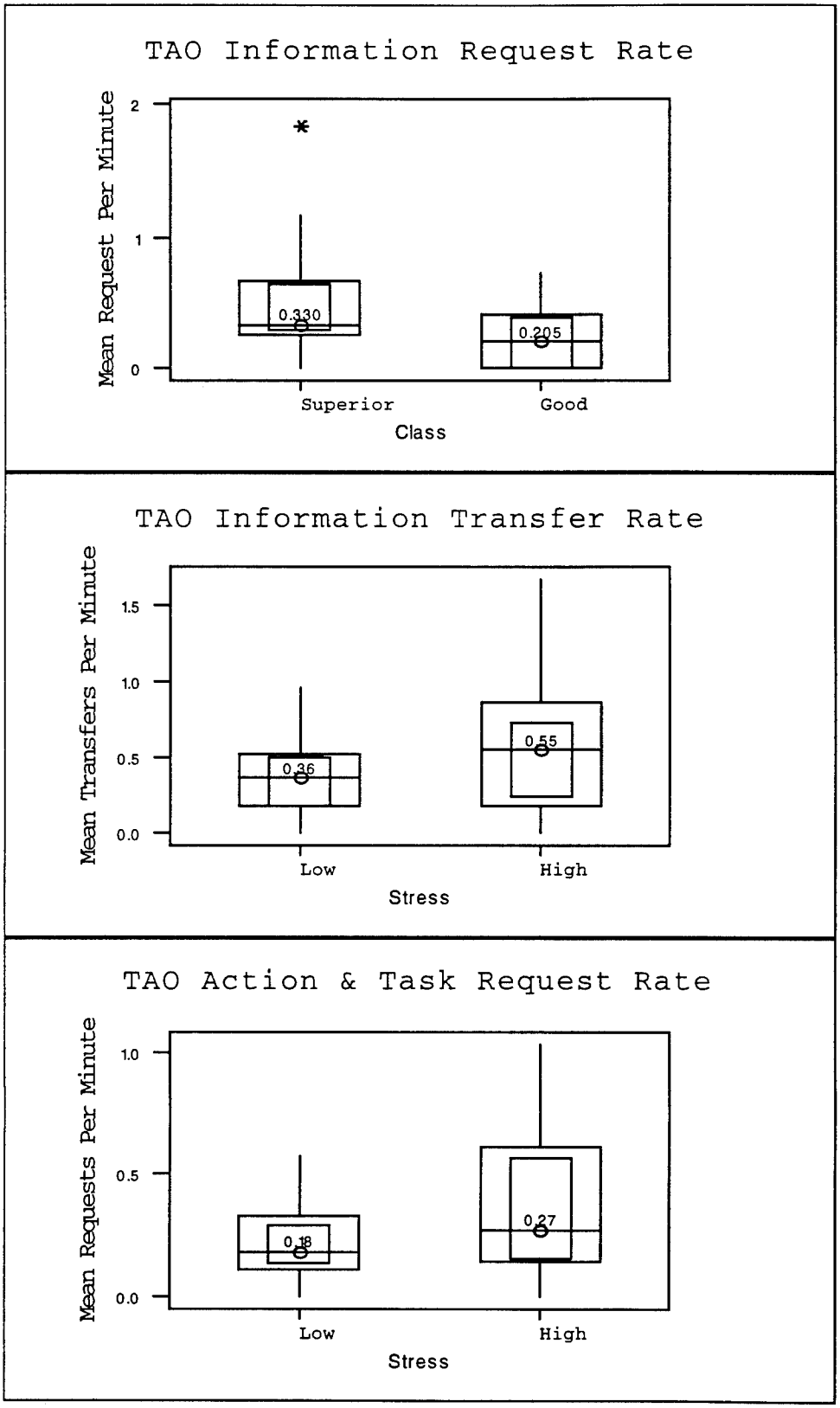

Total Problem Solving & Planning Rate
Mean PS&P Per Minute
0.5
0.4
0.3
0.2
0.1
0.0
0.14
0.00
Superior
Good
Class

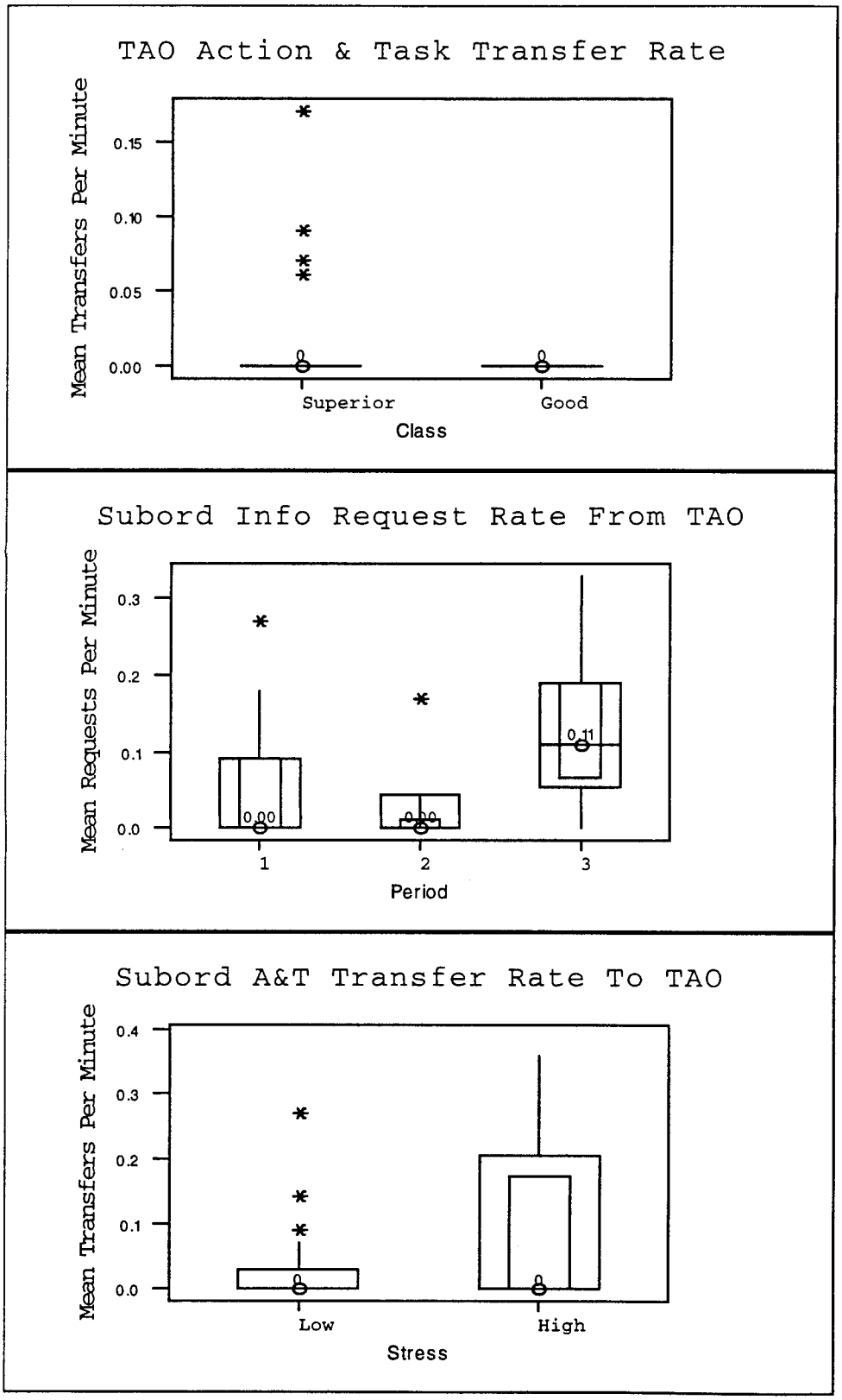

Total Problem Solving & Planning Rate
Mean PS&P Per Minute
3
2
1
0.09
0.00
0.13
1
2
3
Period

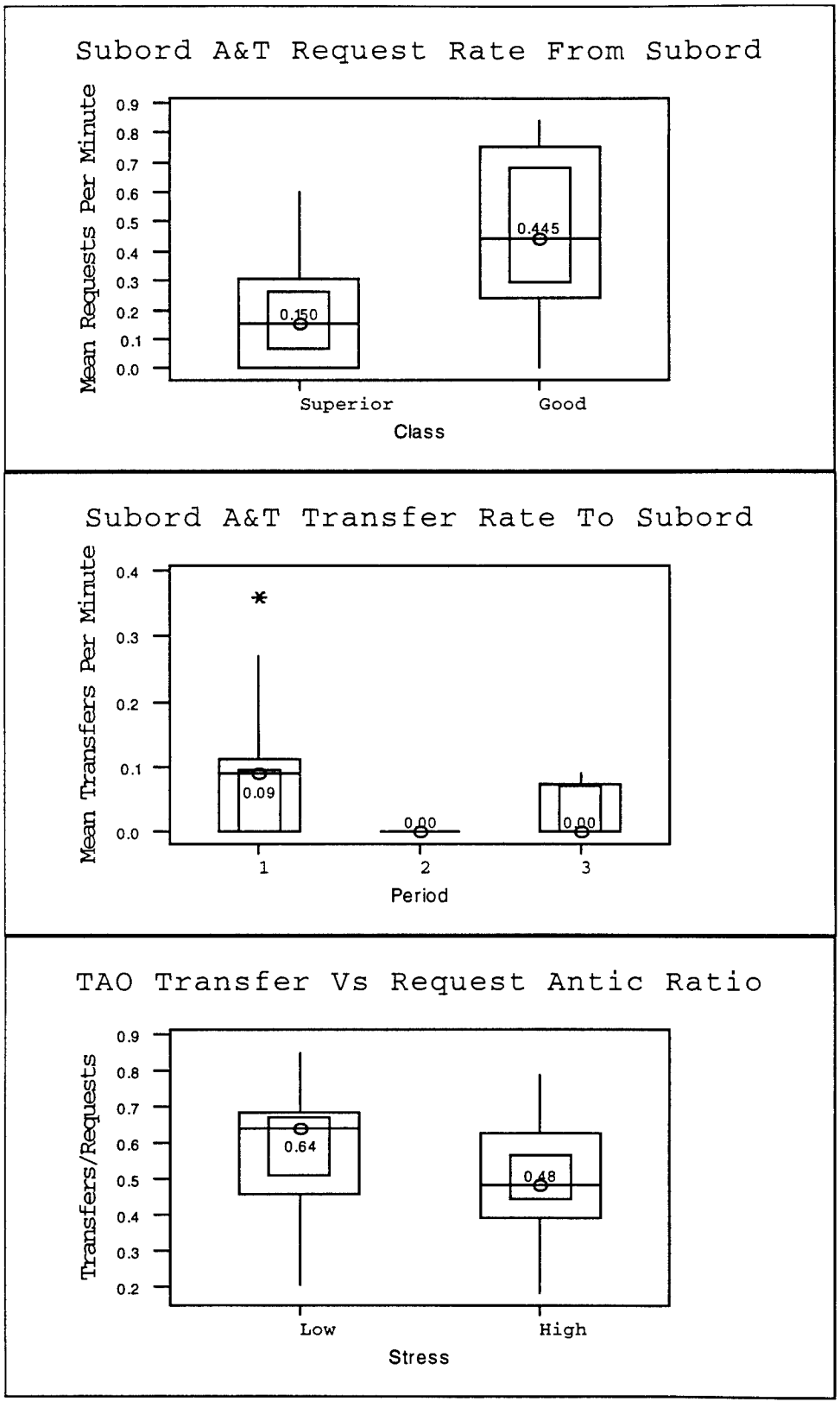

TAO Information Rate
Mean Info Per Minute
4
3
2
1
0
1.585
0.940
Superior
Good
Class

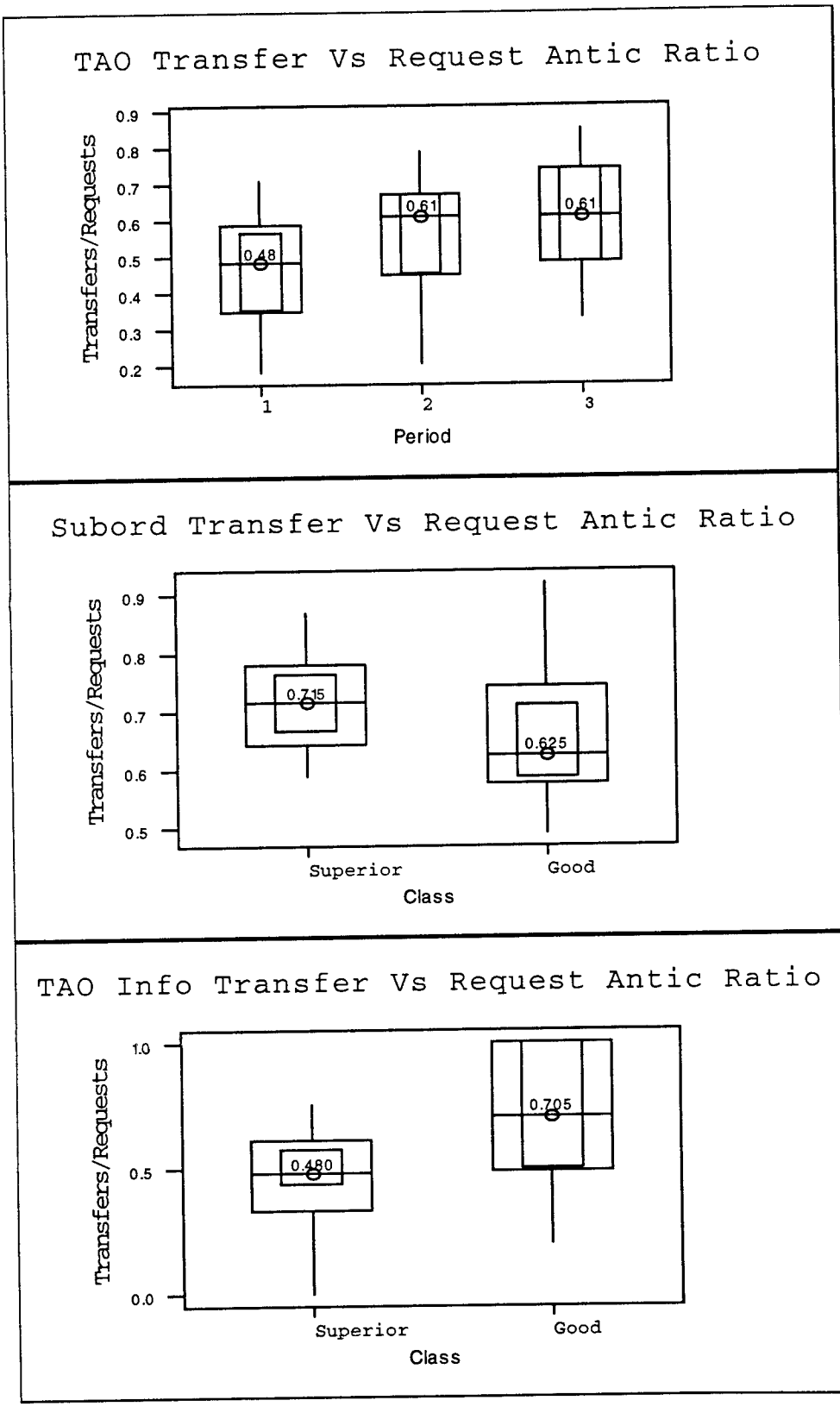

TAO Information Rate
Mean Info Per Minute
4
3
2
1
0
1.13
1.67
Low
High
Stress
TAO Action & Task Rate
Mean A&T Per Minute
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.27
0.50
Low
High
Stress
TAO Problem Solving & Planning Rate
Mean PS&P Per Minute
0.5
0.4
0.3
0.2
0.1
0.0
0.03
0.00
Superior
Good
Class

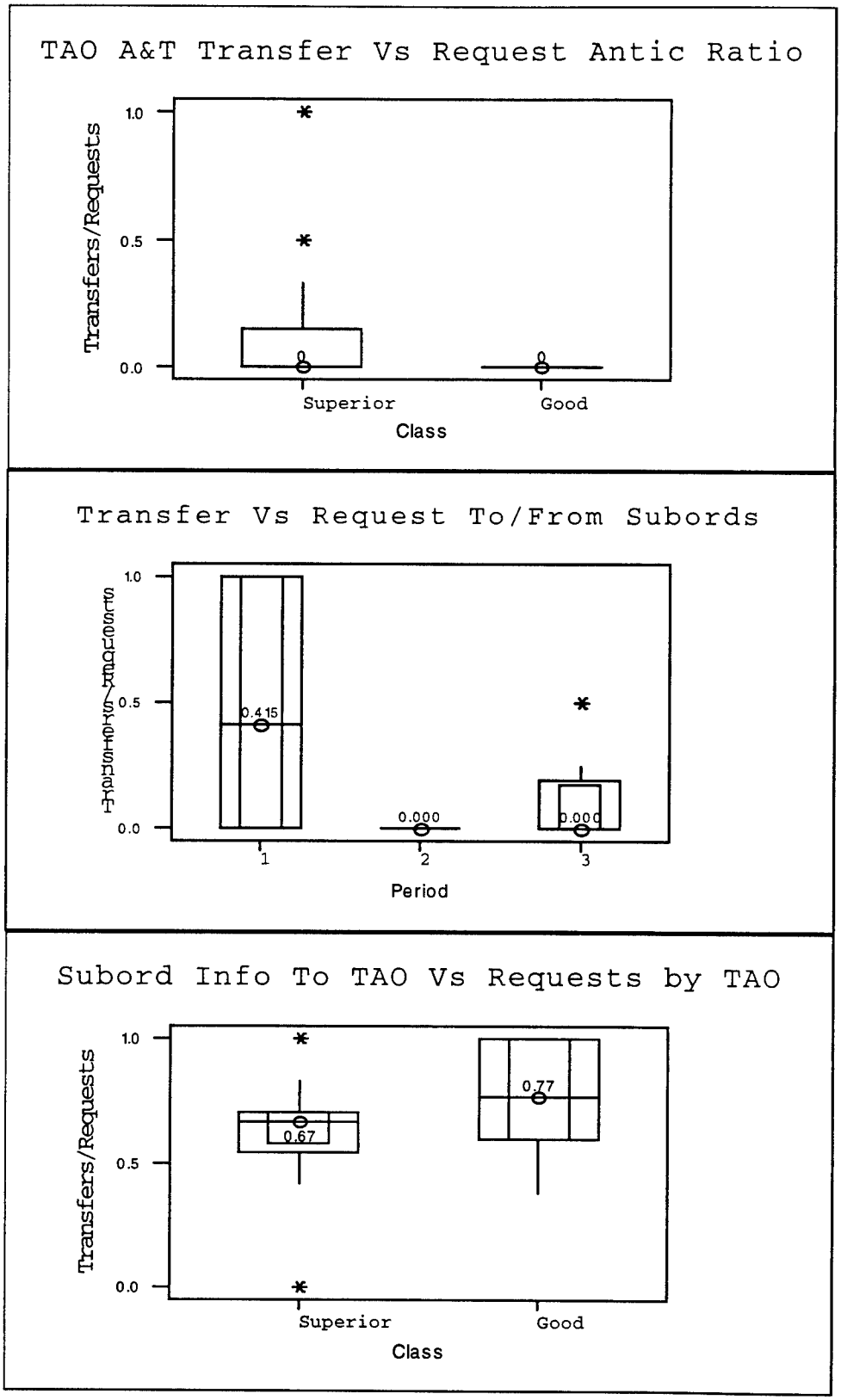

Subordinate Information Rate
Mean Info Per Minute
4.5
3.5
2.5
1.5
3.01
2.55
Low
High
Stress
Subordinate Action & Task Rate
Mean A&T Per Minute
1.5
1.0
0.5
0.0
0.87
0.33
Superior
Good
Class
Subordinate Action & Task Rate
Mean A&T Per Minute
1.5
1.0
0.5
0.0
0.73
0.34
Low
High
Stress

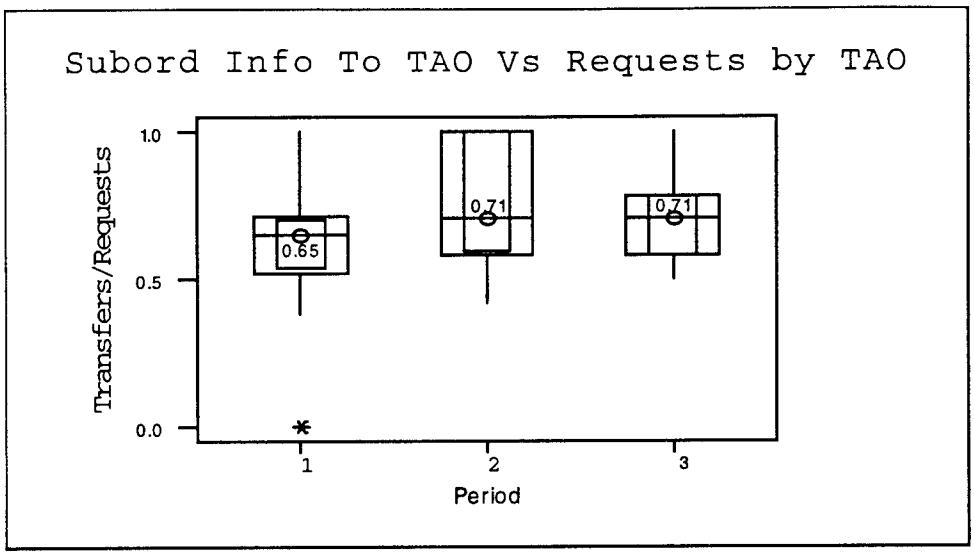

TAO Information Request Rate
Mean Request Per Minute
2
1
0
*
0.330
0.205
Superior
Good
Class
TAO Information Transfer Rate
Mean Transfers Per Minute
1.5
1.0
0.5
0.0
0.36
0.55
Low
High
Stress
TAO Action & Task Request Rate
Mean Requests Per Minute
1.0
0.5
0.0
0.18
0.27
Low
High
Stress


TAO Action & Task Transfer Rate
Mean Transfers Per Minute
0.15
0.10
0.05
0.00
Superior
Good
Class
Subord Info Request Rate From TAO
Mean Requests Per Minute
0.3
0.2
0.1
0.0
0.00
0.11
1
2
3
Period
Subord A&T Transfer Rate To TAO
Mean Transfers Per Minute
0.4
0.3
0.2
0.1
0.0
Low
High
Stress

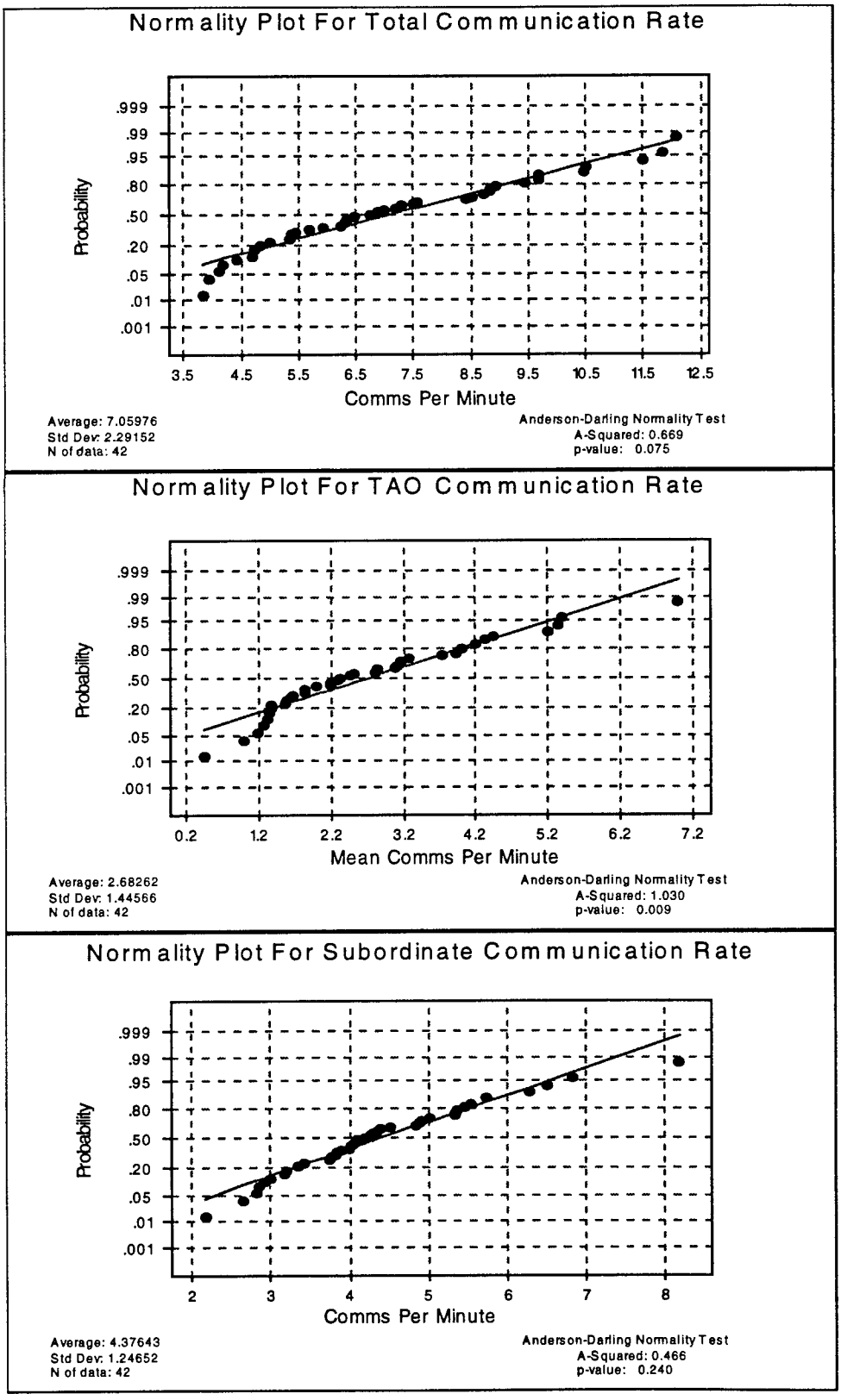

Subord A&T Request Rate From Subord
Mean Requests Per Minute
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.445
0.150
Superior
Good
Class
Subord A&T Transfer Rate To Subord
Mean Transfers Per Minute
0.4
0.3
0.2
0.1
0.0
*
0.09
0.00
0.00
1
2
3
Period
TAO Transfer Vs Request Antic Ratio
Transfers/Requests
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.64
0.48
Low
High
Stress

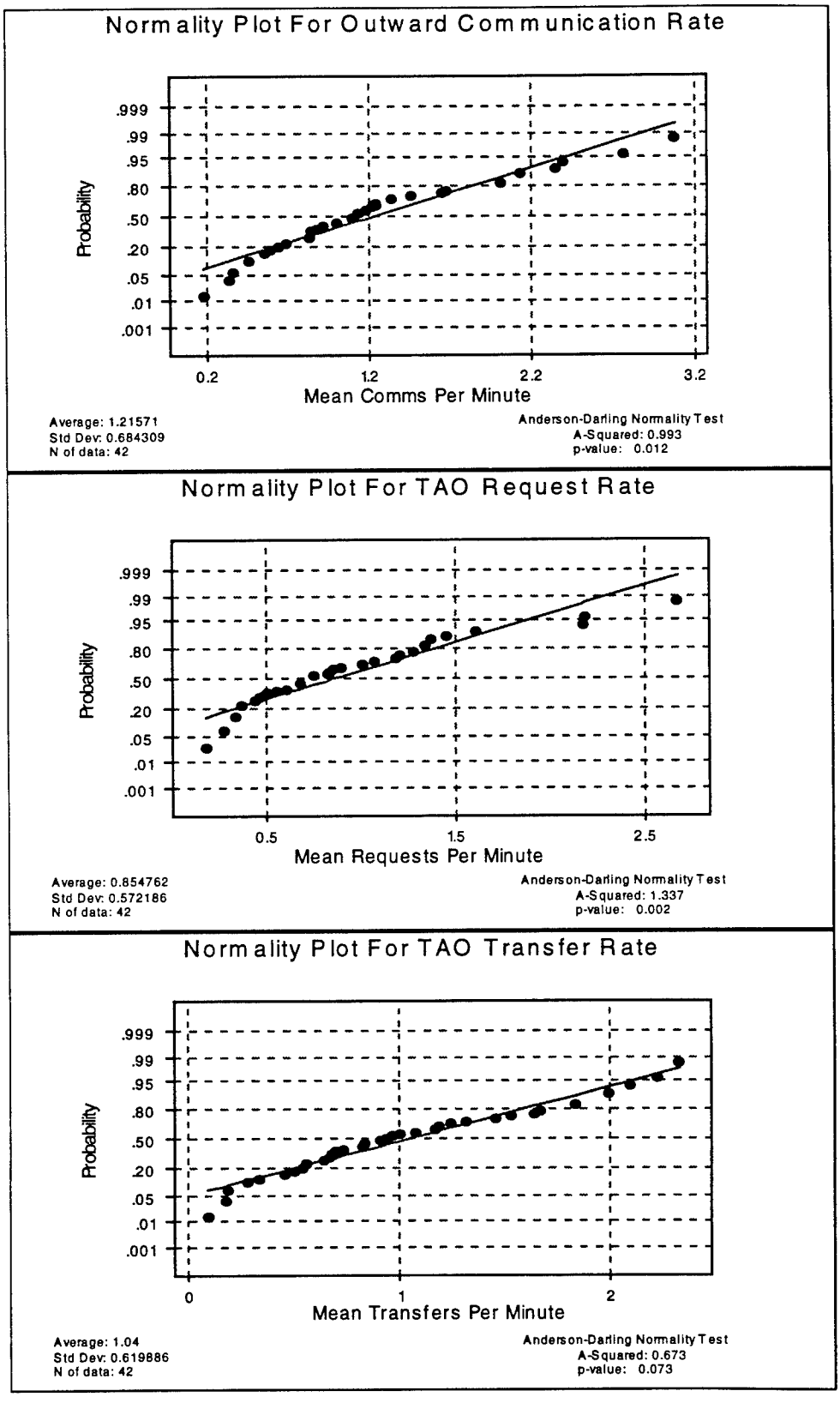

TAO Transfer Vs Request Antic Ratio
Transfers/Requests
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.48
0.61
0.61
1
2
3
Period
Subord Transfer Vs Request Antic Ratio
Transfers/Requests
0.9
0.8
0.7
0.6
0.5
0.715
0.625
Superior
Good
Class
TAO Info Transfer Vs Request Antic Ratio
Transfers/Requests
1.0
0.5
0.0
0.480
0.705
Superior
Good
Class

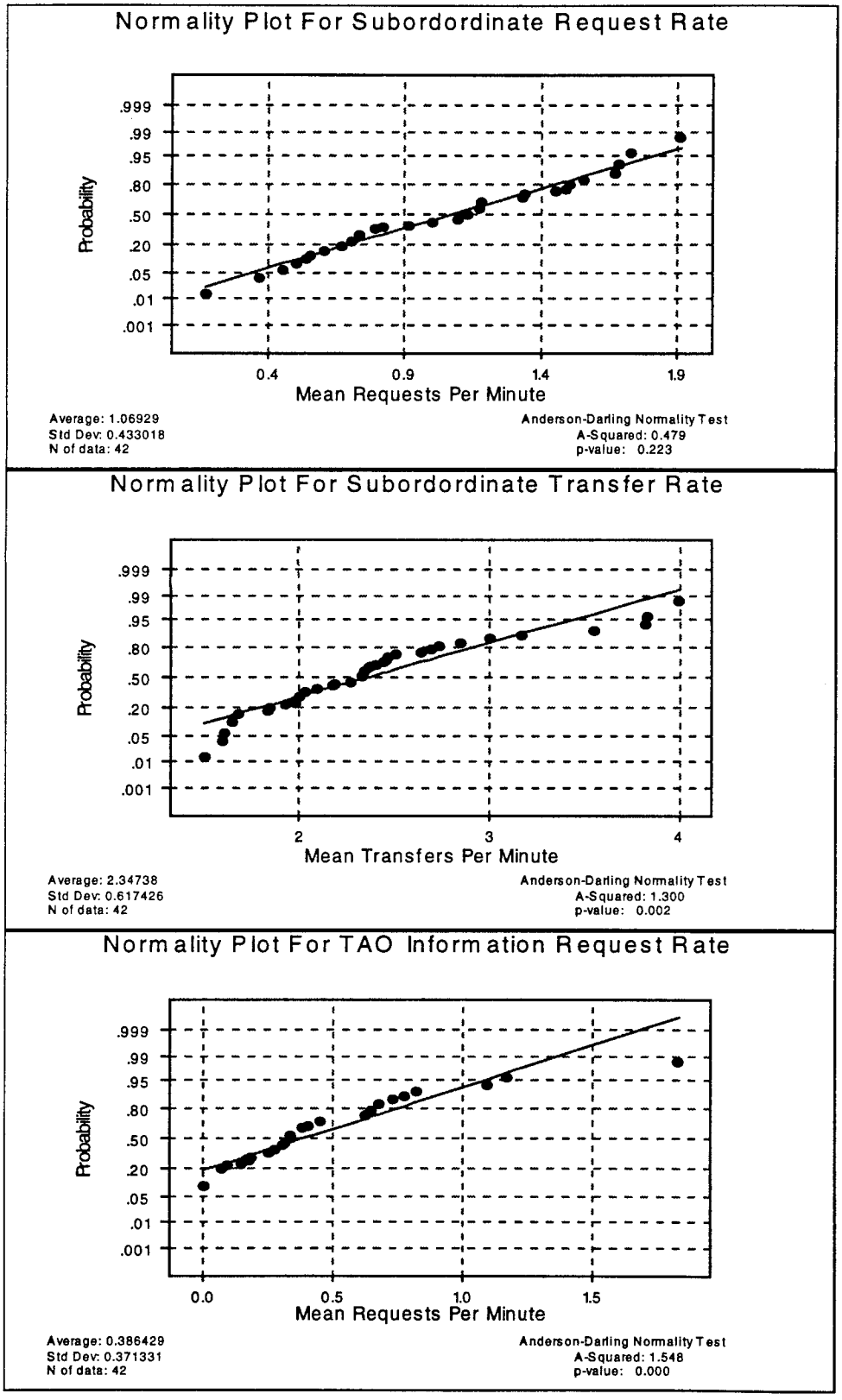

TAO A&T Transfer Vs Request Antic Ratio
Transfers/Requests
1.0
0.5
0.0
Superior
Good
Class
Transfer Vs Request To/From Subords
1.0
0.5
0.0
0.415
0.000
0.000
1
2
3
Period
Subord Info To TAO Vs Requests by TAO
Transfers/Requests
1.0
0.5
0.0
0.67
0.77
Superior
Good
Class

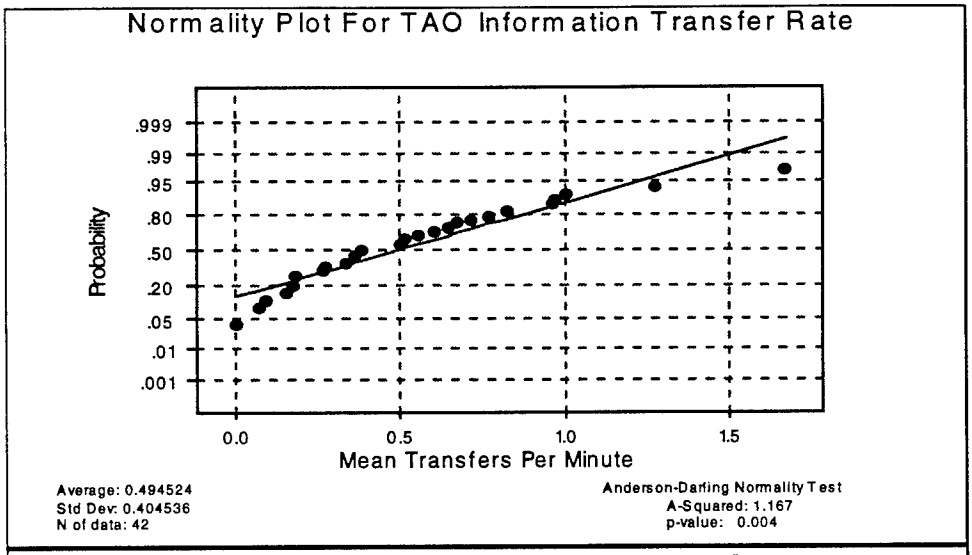

Subord Info To TAO Vs Requests by TAO
Transfers/Requests
1.0
0.5
0.0
0.65
0.71
0.71
1
2
3
Period

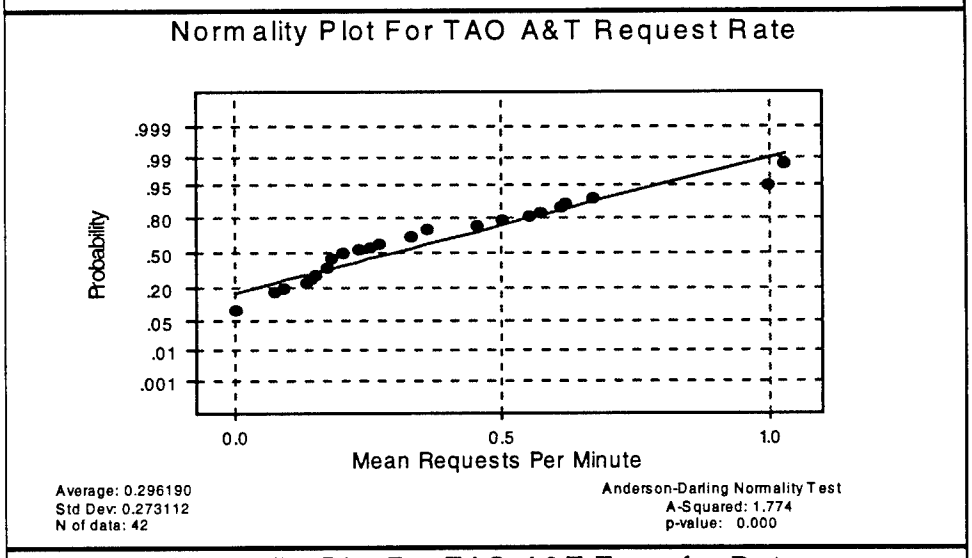
APPENDIX K. NORMALITY PLOTS FOR COMMUNICATION VARIABLES

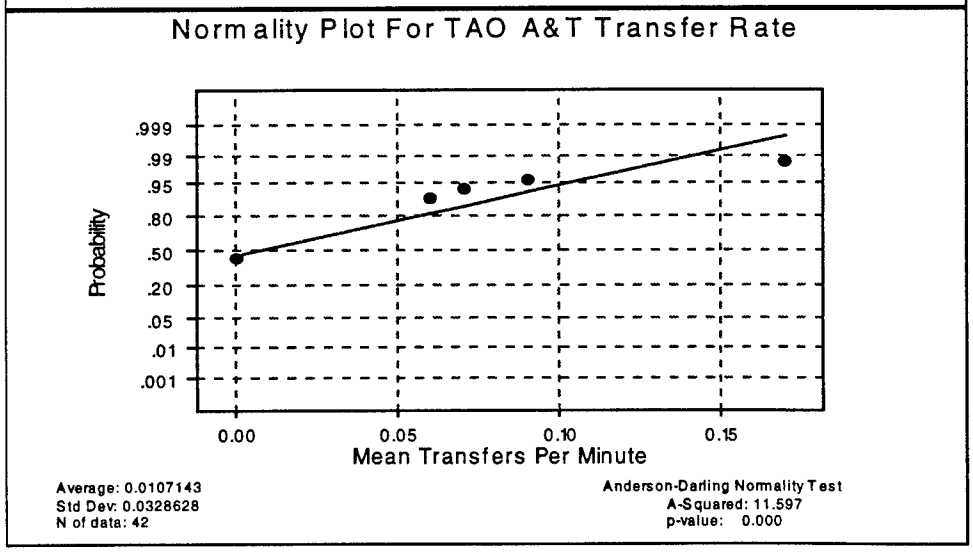


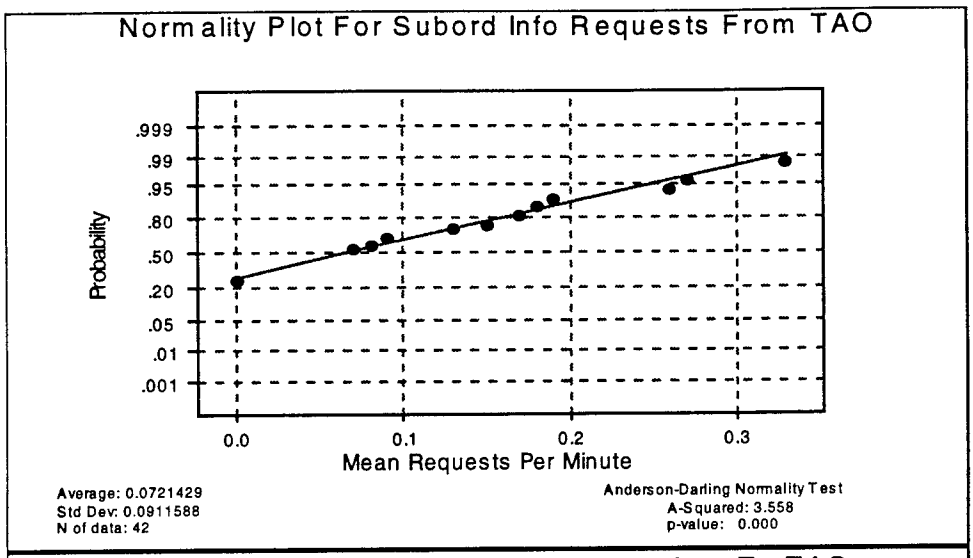

Normality Plot For Outward Communication Rate
Probability
.999
.99
.95
.80
.50
.20
.05
.01
.001
0.2
1.2
2.2
3.2
Mean Comms Per Minute
Average: 1.21571
Std Dev: 0.684309
N of data: 42
Anderson-Darling Normality Test
A-Squared: 0.993
p-value: 0.012
Normality Plot For TAO Request Rate
Probability
.999
.99
.95
.80
.50
.20
.05
.01
.001
0.5
1.5
2.5
Mean Requests Per Minute
Average: 0.854762
Std Dev: 0.572186
N of data: 42
Anderson-Darling Normality Test
A-Squared: 1.337
p-value: 0.002
Normality Plot For TAO Transfer Rate
Probability
.999
.99
.95
.80
.50
.20
.05
.01
.001
0
1
2
Mean Transfers Per Minute
Average: 1.04
Std Dev: 0.619886
N of data: 42
Anderson-Darling Normality Test
A-Squared: 0.673
p-value: 0.073

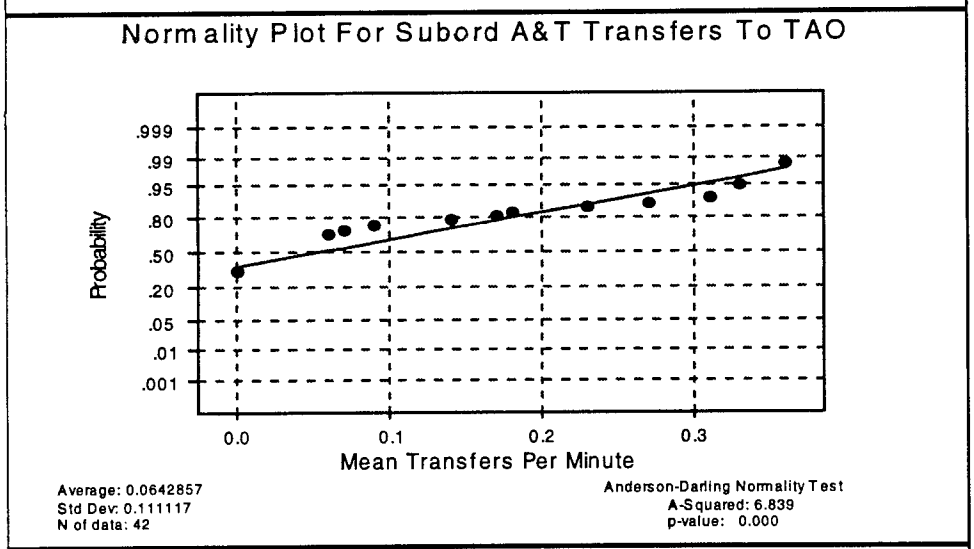

Normality Plot For Subordordinate Request Rate
Probability
.999
.99
.95
.80
.50
.20
.05
.01
.001
0.4
0.9
1.4
1.9
Mean Requests Per Minute
Average: 1.06929
Std Dev: 0.433018
N of data: 42
Anderson-Darling Normality Test
A-Squared: 0.479
p-value: 0.223
Normality Plot For Subordordinate Transfer Rate
Probability
.999
.99
.95
.80
.50
.20
.05
.01
.001
2
3
4
Mean Transfers Per Minute
Average: 2.34738
Std Dev: 0.617426
N of data: 42
Anderson-Darling Normality Test
A-Squared: 1.300
p-value: 0.002
Normality Plot For TAO Information Request Rate
Probability
.999
.99
.95
.80
.50
.20
.05
.01
.001
0.0
0.5
1.0
1.5
Mean Requests Per Minute
Average: 0.386429
Std Dev: 0.371331
N of data: 42
Anderson-Darling Normality Test
A-Squared: 1.548
p-value: 0.000

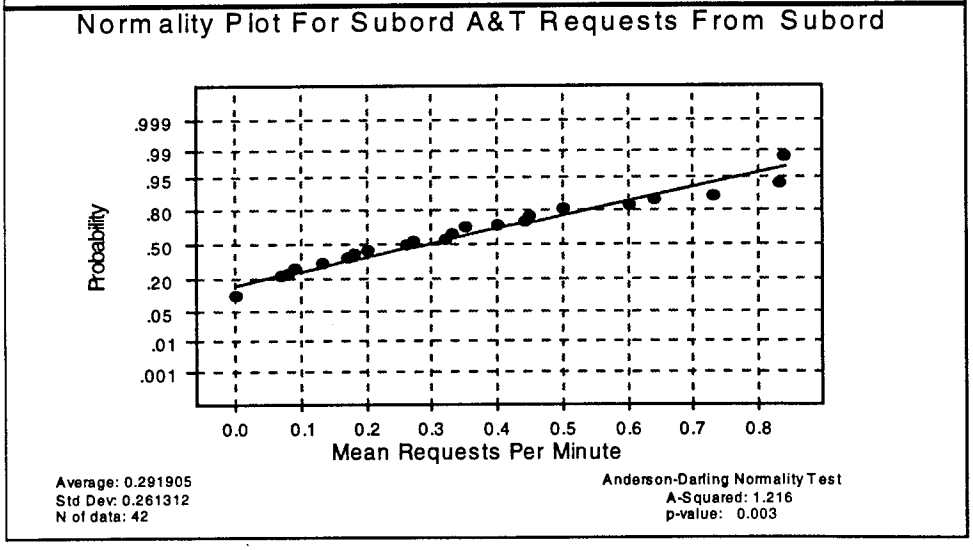

Normality Plot For TAO Information Transfer Rate
Probability
.999
.99
.95
.80
.50
.20
.05
.01
.001
0.0
0.5
1.0
1.5
Mean Transfers Per Minute
Average: 0.494524
Std Dev: 0.404536
N of data: 42
Anderson-Darling Normality Test
A-Squared: 1.167
p-value: 0.004

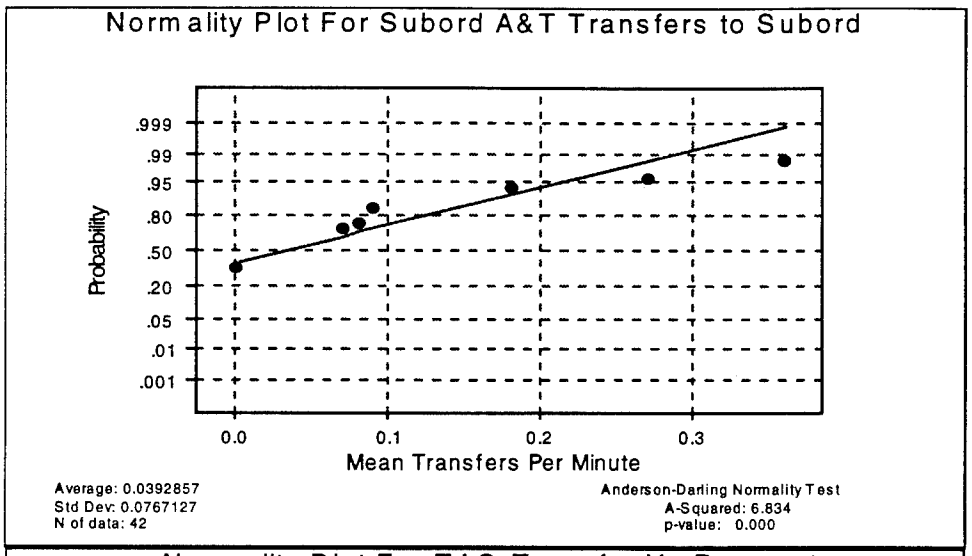

Normality Plot For TAO A&T Request Rate
Probability
.999
.99
.95
.80
.50
.20
.05
.01
.001
0.0
0.5
1.0
Mean Requests Per Minute
Average: 0.296190
Std Dev: 0.273112
N of data: 42
Anderson-Darling Normality Test
A-Squared: 1.774
p-value: 0.000

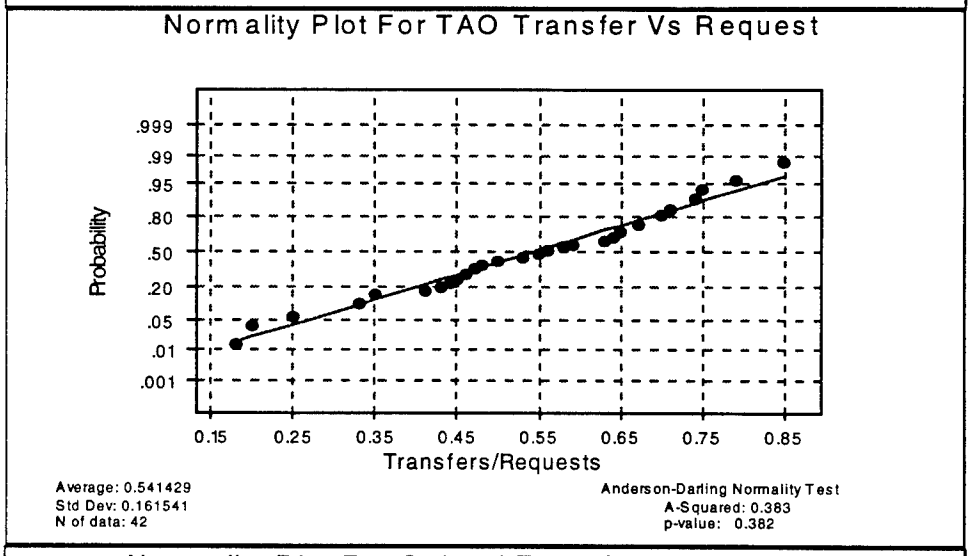

Normality Plot For TAO A&T Transfer Rate
Probability
.999
.99
.95
.80
.50
.20
.05
.01
.001
0.00
0.05
0.10
0.15
Mean Transfers Per Minute
Average: 0.0107143
Std Dev: 0.0328628
N of data: 42
Anderson-Darling Normality Test
A-Squared: 11.597
p-value: 0.000

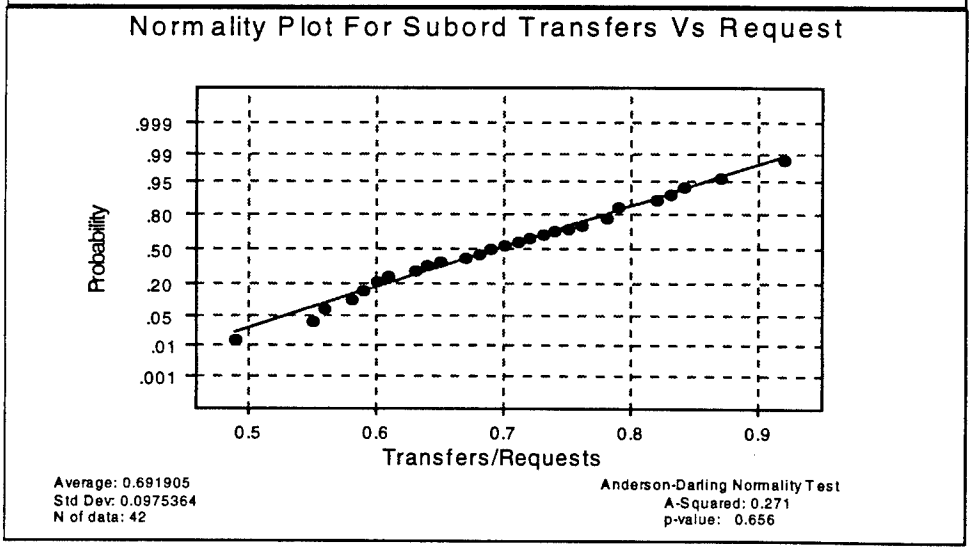

Normality Plot For Subord Info Requests From TAO
Probability
.999
.99
.95
.80
.50
.20
.05
.01
.001
0.0
0.1
0.2
0.3
Mean Requests Per Minute
Average: 0.0721429
Std Dev: 0.0911588
N of data: 42
Anderson-Darling Normality Test
A-Squared: 3.558
p-value: 0.000

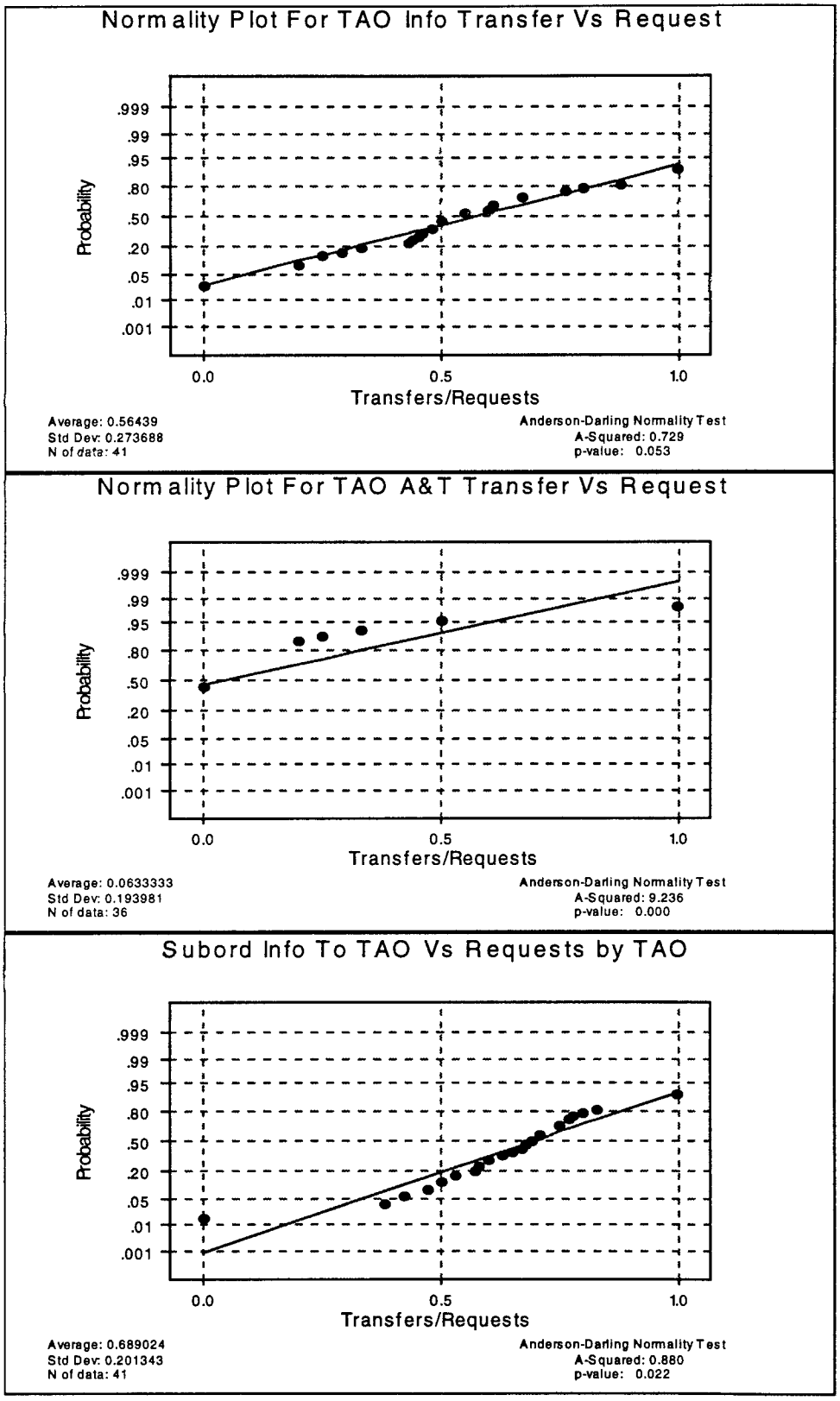

Normality Plot For Subord A&T Transfers To TAO
Probability
.999
.99
.95
.80
.50
.20
.05
.01
.001
0.0
0.1
0.2
0.3
Mean Transfers Per Minute
Average: 0.0642857
Std Dev: 0.111117
N of data: 42
Anderson-Darling Normality Test
A-Squared: 6.839
p-value: 0.000


Normality Plot For Subord A&T Requests From Subord
Probability
.999
.99
.95
.80
.50
.20
.05
.01
.001
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Mean Requests Per Minute
Average: 0.291905
Std Dev: 0.261312
N of data: 42
Anderson-Darling Normality Test
A-Squared: 1.216
p-value: 0.003


Normality Plot For Subord A&T Transfers to Subord
Probability
.999
.99
.95
.80
.50
.20
.05
.01
.001
0.0
0.1
0.2
0.3
Mean Transfers Per Minute
Average: 0.0392857
Std Dev: 0.0767127
N of data: 42
Anderson-Darling Normality Test
A-Squared: 6.834
p-value: 0.000


Normality Plot For TAO Transfer Vs Request
Probability
.999
.99
.95
.80
.50
.20
.05
.01
.001
0.15
0.25
0.35
0.45
0.55
0.65
0.75
0.85
Transfers/Requests
Average: 0.541429
Std Dev: 0.161541
N of data: 42
Anderson-Darling Normality Test
A-Squared: 0.383
p-value: 0.382


Normality Plot For Subord Transfers Vs Request
Probability
.999
.99
.95
.80
.50
.20
.05
.01
.001
0.5
0.6
0.7
0.8
0.9
Transfers/Requests
Average: 0.691905
Std Dev: 0.0975364
N of data: 42
Anderson-Darling Normality Test
A-Squared: 0.271
p-value: 0.656


Normality Plot For TAO Info Transfer Vs Request
Probability
.999
.99
.95
.80
.50
.20
.05
.01
.001
0.0
0.5
1.0
Transfers/Requests
Average: 0.56439
Std Dev: 0.273688
N of data: 41
Anderson-Darling Normality Test
A-Squared: 0.729
p-value: 0.053
Normality Plot For TAO A&T Transfer Vs Request
Probability
.999
.99
.95
.80
.50
.20
.05
.01
.001
0.0
0.5
1.0
Transfers/Requests
Average: 0.0633333
Std Dev: 0.193981
N of data: 36
Anderson-Darling Normality Test
A-Squared: 9.236
p-value: 0.000
Subord Info To TAO Vs Requests by TAO
Probability
.999
.99
.95
.80
.50
.20
.05
.01
.001
0.0
0.5
1.0
Transfers/Requests
Average: 0.689024
Std Dev: 0.201343
N of data: 41
Anderson-Darling Normality Test
A-Squared: 0.880
p-value: 0.022

LIST OF REFERENCES

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