TEAM PERFORMANCE IN AIRLINE SIMULATIONS

by

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A Thesis Submitted for Partial Fulfillments

Of the Requirements for the Degree of

Master of Arts in Industrial/Organizational Psychology

Middle Tennessee State University

2013

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ACKNOWLEDGEMENTS

I would like to thank my family, members of my thesis committee Dr. Moffett and Dr. Hein, and the FOCUS Lab staff for all the support they have granted me throughout this lengthy but rewarding process. It's important to note, that I would not have been able to do this without the help of Dr. Littlepage who was very enthusiastic about my project in its entirety, read and commented on an extensive number of drafts of the manuscript, provided me with limitless amount of material to support my literature review, and who motivated me to finish this thesis in a timely fashion with his conscientious efforts and undying love for conducting research.

Also I would like to express my appreciation to my colleagues Baylea Jackson, Sanna Korpela, Sarah Stallings, Jason Barber, Stacey-Ann Baker, Brannan Mitchel-Slentz, and Stephanie Eide, who collaborated while conducting a Job Analyses for most of the positions in the FOCUS Lab. These Job Analyses were central to creating individual performance measures that were utilized at the core of my thesis. Last, but not least, I would like to thank my colleague Amber Fritsch who has supported my work over the past school-year, and most of all, has been a great source of friendship.

ABSTRACT

Within the Flight Operations Center-Unified Simulation (FOCUS) Lab, an airline simulation capstone course for the aerospace disciplines at Southeastern State University, the positions of pilot, weather and forecasting, crew scheduling, maintenance control, ramp tower coordinator, flight operations data, and flight operations coordinator work interdependently to achieve goals and objectives, such as safety, overall efficiency, and high job performance.

This study investigated the relationships between action and transition processes that the teams engage in at the FOCUS Lab based upon a similar model explained by Marks, Mathieu, & Zaccaro (2001). These authors suggest that transition phase processes are positively related to team action processes. Action phase processes are those activities leading directly to goals and mission accomplishment (i.e., flight simulations). Transition phase processes include mission analysis, goal specification, and strategy formulation; these processes typically take places before and/or following the mission-action period and may involve some type of briefing where the team has a chance to reflect on their past mission (i.e. After-Action Reviews). Lastly, this study investigated the relationship of individual performance measures, which were created as a part of this study, to other action and transition performance measures.

It was found transition phase processes rated by the observers of the FOCUS Lab related more closely to improvement in teamwork (r = .656, .626, .371) while action phase process that were rated by the students related more strongly to improvements in team performance measures (r = .621). Overall, this study showed that teams that perform better during their action phase seem to also perform better during their

transition process compared to teams who exhibit low level of action phase performance. Finally, individual performance measures were validated throughout this study by showing that they are related to things such as team/teamwork/transition performance.

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CHAPTER ONE: INTRODUCTION

Overview of Work Teams

Teams are dynamic, complex systems that involve a set of two or more individuals who interact through specific roles and work toward an interdependent goal/mission/objective (Salas, Bowers, & Cannon-Bowers, 1995; Hackman, 1978). According to these authors, there are many definitions of a team, but there is no one definition of a team that is universally used. It is important to note that not only individual, but teamwork competencies are necessary for team members to perform at an optimal level and function as an interdependent unit (Salas, Rosen, Burke, & Goodwin, 2009). The essence of both individual contribution (taskwork), as well as the collective contributions (teamwork), is central for each team to be effective in a complex environment (Krokos, Backer, Alonso, & Day, 2009).

Team performance is an evaluation of the team against specified criteria. These criteria include the notion that the team may or may not meet its relative objective standards (i.e., productivity). Ideally, measures of team performance are aligned with the goals/mission/objectives of the team, in order for individuals to know what is expected of them. According to Krokos et al., (2009), the overall team performance often can be comprised into one overall score.

Particularly since the 1970s, there has been growing interest in researching team performance (Goodwin, Burke, Wildman, & Salas, 2009). According to these authors, this can be explained by the changing trend of the workforce in the 21st century working

environment: globalization, new technological advancements, and a more complex nature of work.

Teamwork in Dynamic Teams

According to Salas et al., (2009) and Marks, Mathieu, and Zacaro (2001), teamwork is how individual task activities are translated, and synergistically combined/magnified with other team members in order to pursue shared team goals/mission/objectives. It is basically how the team members are working with each other. Teamwork behaviors are at the core of the teamwork process and are central in order to evaluate the overall team performance (Salas et al., 2009).

One of the essential underpinnings of teamwork that is pointed out by Salas and colleagues (2009) is the notion of shared mental models. A shared mental model is a shared mental representation of the knowledge and/or common process that is necessary to carry out tasks that a team executes (Stout, Cannon-Bowers, & Salas, 1996). Accurate shared mental models, which are formed by the team members, result in shared tacit knowledge that is typically necessary in quality decision-making, thus leading to higher overall effectiveness/performance (Edwards, Day, Arthur, & Bell, 2006).

It is important to make a distinction between actions, transition, and interpersonal processes that were identified by some of the leading researchers as predictors of team performance (Marks, Mathieu, & Zaccaro, 2001). Action is what goes on when the team is engaged in performing. Teams in action communicate, coordinate, and dynamically achieve collective results (Dorsey, Russell, Keil, Campbell, Buskirk, & Schuck, 2009). One can typically observe and monitor a team's action – the team's progress toward completion of the mission. According to the authors, the other two categories (i.e.,

transition processes and interpersonal processes) that go on behind the scenes of team action are just as, if not more, critical to team performance (Marks, Mathieu, & Zaccaro, 2001).

Action Phase Processes

According to Marks, Mathieu, & Zaccaro (2001), action phase processes are activities leading directly to goals and mission accomplishment. The authors claim that there are four types of processes that are most common in teams during action phases. These four processes are: monitoring process toward goals, systems monitoring, team monitoring and backup responses, and coordination activities. Monitoring progress toward goals can be defined as a team member's ability to keep track of the team's advancement while determining what needs to be accomplished in order to achieve the team's objective. Systems monitoring mostly pertains to awareness of resources as well as environmental conditions while a team is in an action phase. Team monitoring and backup responses mostly relate to assisting other team members when needed (i.e., feedback, relevant support). Lastly, coordination activities refer to the team's action phase processes that involve managing and timely orchestration of interdependent actions/tasks.

Interpersonal Processes

Interpersonal processes include conflict management, motivation and confidence building, and affect management (Marks, Mathieu, & Zaccaro, 2001). Conflict management is the ability to cope with external demands and frustrations that would harm a team's cohesion as well as the ability to handle internal conflicts such as different work-style preferences, goal orientation, opinions, and etc. Motivation and confidence

building represent a team's task-based cohesion and belief that they can perform at a high level. Key factors that contribute to affect management are: showing respect for other team members and seeking agreement.

Transition Phase Processes

Transition phase processes include mission analysis, goal specification, strategy formulation, and any other activities that are aimed at evaluating events that took place during the last action phase (Marks, Mathieu, & Zaccaro, 2001). Mission analysis refers to the team's ability to identify the main tasks and challenges that the team faces. Goal specification is identification of what needs to be done for the next mission to elevate team performance. Strategy formulation is another dimension that is included in the transition phase processes. It mainly pertains to determining the course of action for the next mission, while making appropriate adjustments to more readily deal with environmental constraints.

A transition phase process typically takes place before and/or after the mission-action period, and may involve some type of briefing or debriefing (Marks, Mathieu, & Zaccaro, 2001). Marks, DeChurch, Mathieu, Panzer, & Alonso (2005) explain that contributions of the transition process have been underutilized, and often its analysis is ignored, even though it has a significant impact on the overall team performance/effectiveness. These authors have tried to objectively measure team performance on the transition process, finding that it was significantly related to team performance.

After-Action Reviews or debriefings have been used in the military for decades to improve team learning and performance (Tannenbaum & Cerasoli, 2012). These

debriefings give an opportunity for the team or individuals to reflect on their recent experience by asking team members a series of specific/structured questions. This allows them to discover the meaning of what actually happened during their past action process and construct lessons learned for future performance. These researchers suggest that AARs can improve team/individual effectiveness over others, who do not use them, by approximately 25%.

Strategic Core Roles

It has been found by Humphrey, Morgeson, & Mannor (2009) that interaction and performance of several members in specific team roles impact the team performance the most. These team members have greater exposure to the task, and are more central to the workflow of the team. These authors refer to those positions as strategic core roles, since their performance is most critical to the overall team's effectiveness. According to these authors, core roles matter, and one should pay more attention to selecting, as well as training, for those positions.

Measuring Team/Teamwork Performance

Dorsey and colleagues (2009) claim that there are two main issues when it comes to measuring team performance: who is being assessed (team or individual), and how the data are quantified. Performance can either be measured by an outside observer, quantified by a mechanism (i.e., a computer that is used to measure the profits), or be accessed via self-reported data. The focus of our study will pertain to measuring performance and teamwork by observers, as well as self-reports.

The measures filled out by the observers are BARS – behavioral anchored rating scales, and BOS – behavioral observation scales (Smith & Kendall, 1963). Both BARS and BOS are central when it comes to measuring quality, rather than quantity. For instance, they usually are employed when assessing the quality of a team's decisions and/or problem-solving strategies, the quality of the team's information utilization from various positions, and features of the communication patterns. Judgments of the raters in BARS have often been equated to a numeric value, and each one of those values has a carefully constructed behavior that has been identified to be important in judging a specific performance objective (Smith & Kendall, 1963). This performance objective of teamwork would be derived from the specific criteria that are expected from the team. BOSs contain a list of desired behaviors required for the successful performance of a specific job, which are then assessed based on the frequency with which they occur (e.g., from never to always).

Smith-Jentsch, Johnston, & Payne (1998) have delineated a distinct multi-level measure of team performance that incorporates the use of BARS, checklists/BOS, and the computerized measure of team effectiveness. It focuses both on the team processes (teamwork) by employing BARS and measures a team's overall effectiveness by capturing it with a computerized data measure. This multi-level model also includes the performance of each individual on the team by employing checklists and BOS that measure individual tasks, skills, latency, and accuracy. These authors state that measuring individual performance is essential to determining training needs, as well as the corrective feedback that is needed to address each individual, consequently leading to

a better overall effectiveness of the team. We will use a similar approach to measuring performance in this study.

Flight Operations Centers

Flight operations centers involve teams of individuals who collaboratively work together to oversee the flight-related activities of an airline. These rooms are not usually exposed to the general public, and they are pivotal to any airline's functioning. Other things such as staffing, accounting, and etc. that are needed to "run" the airline also take place in these facilities. Besides individual task work, there are many teamwork processes that happen at flight operation centers, thus adding to the complexity of the work that has to be done. These processes usually involve positional task work as well as coordination among various aviation specialties. It is here that the converging disciplines in the aviation industry must work collaboratively to ensure high levels of safety and efficiency while orchestrating aircraft in an airline. Decisions that are being made at these centers include: determining the appropriate amount of fuel, determining weight and balance for an aircraft, keeping up with the plane's maintenance issues, scheduling duty times for crew members, examining the impact of weather conditions, making necessary in-flight changes, and evaluating other potentially influential factors that may have an effect on the operation of aircraft.

The Current Research

This research was conducted at the Flight Operations Center Unified Simulation (FOCUS) Lab at a southeastern state university. In the FOCUS Lab, aerospace students from various disciplines (flight dispatch, technology, maintenance/management, professional pilot, and airport administration), participate in high fidelity flight

simulations that represent the environment for the aerospace professionals in today's flight operations centers. These simulations are part of a class that was developed in recent years as part of the aerospace curriculum, allowing students to gain a more holistic view of airlines, and encouraging them to consider the wellbeing of their team members as well as the organization.

The mission of the FOCUS Lab is to better prepare aerospace students to enter the workforce by knowing how to readily reach high levels of safety, efficiency, teamwork, and individual task performance. There, faculty and graduate students from psychology and the aerospace departments are involved in collaborative research.

At the FOCUS lab, there are nine individual roles that are essential in order to run a mock airline. These roles were created to represent main functions of an airline's dispatching team at the flight operations center and other critical positions. Positions that pertain to the airline's dispatching team include: the Flight Operations Coordinator, Maintenance, Weather, Flight Planning, Flight Scheduling, and Crew Scheduling. The other three positions are the Ramp Tower Coordinator, pilot team (pilot and first officer), and pseudo pilot.

The main purpose of this study is to evaluate a causal model similar to the one proposed by Marks, Mathieu, & Zaccaro (2001). The authors of this model have found that transition process is significantly related to team as well as teamwork performance. In this study, we will also try to investigate the relationships between action, and transition/teamwork processes as they relates to performance in the FOCUS Lab. Another important aspect of this study is to validate teamwork and transition performance measures that were created for the Lab. This involves presenting evidence of internal

consistency and convergent validity of constructs that are thought to be related to teamwork and transition performance.

Since individual taskwork is central for each team to be effective in a complex environment (Krokos, Backer, Alonso, & Day, 2009), we hypothesize that individual performance measures are positively related to team performance.

Hypothesis 1: The average score for individual performance will be positively related to the team's performance across all flight simulations.

As mentioned earlier, performance of some team members in specific roles may impact team performance the most (Humphrey, Morgeson, & Mannor, 2009). Some positions in the FOCUS Lab experience more problems, have greater exposure to the task, and are more central to the workflow of the team. Therefore, we hypothesize that certain key positions have a greater influence on team performance in comparison to other positions.

Hypothesis 2: The relationship with team performance will be stronger for individual performance measures for strategic core roles, than for individual performance measures for other positions.

A major component that contributes to the transition processes at the FOCUS Lab is the After-Action Review (AAR) sessions. In a nutshell, the AARs represent the students' discussion about what they did and how they can improve for future simulations. Since Marks, Mathieu, & Zaccaro (2001) suggest that transition process is positively related to teamwork as well as team performance, we hypothesize that performance on the AARs will relate to team performance.

Hypothesis 3: Transition phase processes will be positively related to teamwork improvements on the next flight simulation.

Hypothesis 4: Transition phase processes will be positively related to team performance improvements on the next flight simulation.

Since the nature of the relationship between the individual performance measures and the transition process has not been established, this study investigated these associations:

Research Question 1: Are transition phase processes positively related to improvements in the average score for individual performance on the next flight simulation?

Lastly, this study examined the nature of the relationship between transition phase processes and other indicators of a team's performance. Thus, it would make sense for a low-performing team to more rigorously engage in mission analysis, goal specification, and strategy formulation. In comparison, a high-performing team that has very little need to further examine their errors may not utilize the AAR time to the fullest. Is AAR performance related to the different indicators of prior team performance? Our research questions follow this logic.

Research Question 2: Are transition phase processes inversely related to the prior level of teamwork from the previous flight simulation?

Research Question 3: Are transition phase processes inversely related to prior level of team performance from the previous flight simulation?

Research Question 4: Are transition phase processes inversely related to prior level of the average score for individual performance from the previous flight simulation?

CHAPTER TWO: METHODS

Participants

As mentioned earlier, participants in this study were the aerospace students who were taking the simulation laboratory class as a part of their capstone course in the aerospace curriculum. They were split into teams in accordance with their positional knowledge that corresponds to their aerospace disciplines. That is, each team was composed to represent a mix of aerospace specialists capable of running a small airline. The total sample of participants is 60 students who were divided into six teams with approximately 10 participants on each (sample size varies across measures because of missing data).

Procedure

Aerospace students were onboarded (i.e., given a job orientation) and assigned to work on a simulated airline, called *Universal E-Lines*. Their participation was necessary in order to fulfill the course requirements. They were asked to role-play employees of an airline to increase the fidelity of the flight simulations, and therefore treat the lab part of their class as if it was their actual job. During onboarding, the students were first introduced to all the main objectives expected of them, and were assigned jobs within the simulation that corresponded as closely as possible to their aerospace disciplines. The major expectations were laid out: acting in a professional/ethical manner, engaging in high levels of teamwork and creative problem solving in order to achieve high levels of job performance (efficiency, revenue for the flight simulation), but most importantly, the students were challenged to do everything possible to adhere to the safe flight regulation

rules established by the Federal Aviation Administration. The benefits of participating in lab simulations were explained in terms of professional development that the students were expected to gain. This study received Institutional Review Board approval (*Appendix A*). Informed consent (*Appendix B*) was provided to students to ask them for their allowance to participate in questionnaires that followed flight simulations, as well as a permission to be observed by trained evaluators.

The mock airline where the study took place had 30 aircraft, two hub airports, and 14 spoke airports all over the southeastern United States. At the time of the flight simulation, there were nine positions that were created to represent the main functions of a small regional airline: Flight Operations Coordinator, Crew Scheduling, Maintenance Control, Weather Operations, Flight Scheduling, Flight Planning, Ramp Tower Coordinator, Pseudo Pilot, and Pilot. The Flight Operations Coordinator is responsible for making all final decisions related to all flights, clearing all flight departures and arrivals, as well as ensuring that the airline runs smoothly and efficiently. Crew Scheduling is responsible for keeping track of all duty times of crew members to ensure that they are legally able to fly a given shift. Maintenance crews are responsible for maintaining airworthiness of the airline fleet; without them, problems may occur that can compromise safety and government regulatory compliance. Weather Operations works as a staff meteorologist at the airline who keeps track of all weather-related issues that could impact the safety of any E-lines flights. Flight Operations Scheduling is mainly responsible for flight checking and schedule management. Flight Operations Planning is responsible for fuel, cargo, and passenger management for each flight. Ramp Tower Coordinator operates at one of the hub airports, requests release of flights for departure,

and ensures that flights arrive to an appropriate gate number in a structured manner. The Pseudo Pilot works as a virtual pilot who launches flights, monitors progress, and adjusts flight routes as necessary. The pilot team (pilot and first officer) flies a flight simulator at a nearby airport.

Flight Simulations

Each of six teams participated in three flight simulations. During each simulation, teams were introduced to triggers of varying difficulty levels. These triggers represent typical scenarios/events, which, for the most part, require collaborative teamwork from the dispatching team at an airline. Examples of triggers include a broken aircraft, a hazard that occurred during a flight, and/or any other event that can have an impact on the airline's operations. Since the aerospace faculty has extensive knowledge of obstacles that are faced by an airline, they were thought to be appropriate judges of the trigger's content and construct validity. This simulation software yields performance measures reflecting efficiency of an airline functioning. There are six to ten team members of the FOCUS Lab staff involved in observing each simulation in order to capture each team's teamwork as well as individual performance measures.

After Action Reviews

Each one of the three simulations was followed by an After Action Review. As mentioned earlier, AARs involve evaluation of the previous simulation by the team members. It is suspected that most of the team's transition process (i.e., mission analysis, goal specification, and strategy formulation) takes place during the After-Action Review. To enhance the AAR experience, a member of the psychology department engages in facilitating team discussion, regarding positive and negative outcomes that occurred

during the last simulation. Then the facilitator tries eliciting responses for behaviors that the team believes contributed to those outcomes and, lastly, he/she tries to summarize the key lessons learned that were mentioned by team members.

Measures

Individual Performance Measures

Individual performance measures at the FOCUS Lab were developed by I/O Psychology M.A. graduate students as a part of a class requirement. They were further modified and employed by the Subject Matter Experts (SMEs) to measure individual performance during each simulation. A total of nine individual performance measures were developed specifically for all the positions on the dispatching team of a mock airline (*Appendix C*). They are Flight Operations Coordinator, Weather Operations, Crew Scheduling, Flight Planning, Flight Scheduling, Maintenance Operations, Ramp Tower Coordinator, Pilot, and the Pseudo Pilot. These measures were constructed on the basis of positional job analysis via observations, questionnaires, and interviews of the SMEs. Even though the job analysis approaches differed (work versus worker oriented methods), they provided the basis for the development of behavioral statements that were to discriminate between different levels of positional performance. Then those critical statements were categorized into teamwork and taskwork job dimensions, and then further standardized on a Behavioral Observational Scale.

Following each flight simulation, individual performance measures for each position were filled out by two or three team members of the FOCUS Lab staff. More specifically, the members of the research team were assigned two or three specific positions that they were to observe during each simulation. Then they were asked to rate

each item on an individual performance measure in a way that would best represent student participants' behavior throughout the entire flight simulation. Additionally, the raters who filled out individual performance measures were believed to be SMEs, and have extensive knowledge of every position's role that they assessed.

Transition Performance Measures

The quality of the transition performance was measured by adapting a scale of teamwork transition processes developed by Marks, Mathieu, and Zaccaro (2001). More specifically, the measure evaluated quality of the three main sub-dimensions of the transition processes that occurred during the After-Action Reviews: mission analysis, goal specification, and strategy formulation (*Appendix D*). The measure included eleven items on a Likert scale from one to five, and was distributed to student participants after each AAR and before the next simulation. An identical version of the transition performance measures was handed to a facilitator of the After-Action-Review to see if the two forms of the measure are related to one another (evidence of convergent validity) and/or if they have different relationships with other measures. The question stem of the measure indicated the effectiveness of the last AAR while evaluating items on the survey.

Following are some of the items from the transition performance measure. The item: "To what extent does our team use the After Action Review to identify key challenges that occurred?" represents mission analysis. An item that represents goal setting is: "To what extent does our team use the After Action Review to set goals for the team?" The following item represents strategy formulation: "To what extent does our team use the After Action Review to develop an overall strategy to guide our team activities?" Additionally the transition performance measure included two items that

measure learning that has taken place during the AAR based on student participants. These two questions are: “To what extent does our team use the After Action Review to contribute information during the After Action Review that would help improve team performance?” and “To what extent does our team use the After Action Review to ensure that information learned during the After Action Review will be used to improve team performance?” The construct validity of this transition performance measure was evaluated by examining internal consistency and by examining relations between ratings of members of the same team.

Teamwork Performance Measures

Action Phase Teamwork Performance. A self-reported measure was used to assess teamwork performance during the action phase (*Appendix E*). This measure was adopted on the basis of the action phase teamwork processes measure developed by Marks, Mathieu, and Zaccaro (2001). More specifically, this measure contained four sub-dimensions: monitoring progress toward goals, systems monitoring, team monitoring and backup responses, and coordination activities.

This measure contained twelve items on a Likert scale from one to five and was distributed after each of the three flight simulations. Each of the four sub-dimensions of action phase teamwork performance was captured by three items. A sample item for systems monitoring is, “To what extent does our team actively work to monitor events and conditions outside the team that influence our operations?” A sample item for coordination activities is, “To what extent does our team actively work to smoothly integrate our work efforts?” The Cronbach’s alpha reliability estimates for this measure was assessed and to provide high evidence of construct validity.

Interpersonal Teamwork Performance. A self-reported measure of participant's perception of their team's interpersonal processes was used in this study as one of the measures of teamwork performance (*Appendix F*). This measure was adopted on the basis of the teamwork interpersonal processes measure developed by Marks, Mathieu, and Zaccaro (2001), and is used as a separate measure of teamwork. More specifically, there are 9 items on a Likert scale that can be categorized from one to five and that pertain to 3 sub-dimensions of interpersonal processes: conflict management, motivating and confidence building, and affect management. Sample items for each dimension are: "To what extent does our team actively work to show respect for one another?" (conflict management); "To what extent does our team actively encourage each other to perform our very best?" (motivation); and "To what extent does our team actively share a sense of togetherness and cohesion?" (affect management).

This measure was distributed to student-participants after they completed each one of the three simulations and was intended to capture their experience with the team's interpersonal activities during each simulation. The inter-rater correlations as well as Cronbach's alpha reliability estimates for this measure were assessed.

Teamwork Grading Rubrics. The third measure of teamwork performance that is employed at the FOCUS Lab is the teamwork grading rubrics (*Appendix G*). It was developed as an attempt to capture three dimensions of teamwork. These three dimensions evaluate a team's ability to solve problems collaboratively (problem solving), utilize/share important information (information utilization), and coordinate with other team members (coordination). The grading rubrics were designed on a Behaviorally Anchored Rating Scale (BARS) from one to seven, where specific behaviors, which

teams engage in during flight simulations, correspond to numeric values for a given performance dimension/objective. It was developed by the aerospace/psychology faculty, who had extensive knowledge of Flight Operation Centers as well as team-level performance metrics.

The teamwork grading rubrics were filled out by the FOCUS Lab's research faculty, who have extensive knowledge of the lab's functioning and ideas of appropriate responses expected from each team, in accordance with scenarios and events that take place during the flight simulations. The inter-rater correlations and Cronbach's alpha reliability estimates for this measure were assessed.

Team Performance Measures

Computerized Data. Team Performance at the FOCUS Lab was assessed via a computerized data measure that quantified the simulated revenue that was brought in by the team after each flight simulation. This indicator of team performance is presented to the student-participants during AARs to show how well they did on their last mission.

This measure is mostly influenced by the total amount of flight time delay, and each minute of delay can be translated into a dollar amount. It was indicated by the aviation faculty that flight delays are mostly impacted by collaborative problem solving techniques in response to scenarios/events that take place during the flight simulation. However, there are many other issues (responses to events by specific positions, weather conditions, etc.) that occur during flight simulations that can impact the flight delay time.

Triggers Response Effectiveness. This measure was developed by researchers of the FOCUS Lab and is most similar to the Critical Incident Technique originally created

by Flanagan, (1954). The trigger response effectiveness measure targets a specific situation that was defined to have a critical significance to team outcomes by the staff of the lab. After an issue requiring a team response (trigger) has been identified, lab's faculty discussed on what would be the optimal response to this situation, and compared it to the response exhibited by the team. Following this discussion, that occurs after each flight simulation has ended, trigger response effectiveness measure filled out on the individual basis by all staff that were present during the flight simulation (*Appendix H*). Pertaining to this study, this measure was used to further validate individual performance measures and represents another measure of team performance.

Strategic Core Roles Questionnaire. A brief questionnaire was sent to the Focus Lab staff that concerns identification of strategic core roles at the FOCUS Lab (*Appendix I*). As mentioned earlier, strategic core roles are at those roles that are especially crucial to team success (Humphrey, Morgeson, & Mannor, 2009). For this study, strategic core roles questionnaire was developed to investigate the assumptions in *Hypothesis 2* - - relationship between performance of strategic core roles and team performance.

Level of Analysis

This is only an exploratory study, and I would suggest that results of the correlational findings in this section are interpreted in terms of the magnitude of their *r* values, as opposed to paying attention to their significance. Data in this study were analyzed at the team level. To provide a more holistic interpretation for Hypotheses 1 and 2 as well as all Research Questions 1, 2, 3, and 4 – correlations between various measures were averaged across all three simulations utilizing r to z transformations. To test *Hypothesis 1*, average score for individual performance measures during flight simulation

one, two, and three were computed and then correlated to team's performance during each corresponding flight simulation. Since there are two distinct measures that assess team performance at the FOCUS Lab, two separate analyses were performed to test this hypothesis. First we first determined how the average score of individual performance measures is related to the financial indicators of team performance. Then we calculated correlations between individual performance measures and trigger response effectiveness. For each performance measure, correlations were averaged across all three flight simulations utilizing *r* to *z* transformations. *Table 1* will provide one with the average mean scores for individual performance measures (from 1 to 7) on all three simulation.

It's important to note that while testing *Hypothesis 2*, two separate analyses were performed, one for each of the two distinct measures of team performance criteria. One of those measures is a team performance indicator that was assessed by the financial revenues, and the other measure of team performance that was used to test this hypothesis is the trigger response effectiveness measure. To test *Hypothesis 2*, a correlation between the average score for the four strategic core roles (i.e., Flight Operations Coordinator, Flight Planning, Flight Scheduling, and Maintenance Operations) and each team performance measure (financial indicators and trigger response effectiveness measure) was computed for each simulation and then averaged across all three flight simulations. Then the average score of the individual performance measures for the other five non-core role positions (i.e., Ramp Tower Coordinator, Pilot Team at the CRJ, Pseudo Pilot, Weather Operations, and Crew Scheduling) was computed for each flight simulation. Then the average score for the five strategic non-core roles was correlated with each of the two separate measures of team performance (teams' financial gains, trigger response

effectiveness measure) for each flight simulation and then averaged across all three flight simulations. Furthermore, to see if the correlation for the four strategic core roles is higher than the correlation for the other non-core role positions, the two average correlations for two separate analyses were then compared to one another.

While examining transition performance to test the underlying *hypothesis and research questions* of this study – a separate analysis was performed for both the students as well as facilitators. Also, while analyzing hypothesis that include teamwork performance, all three separate measures of teamwork performance: action phase teamwork performance, interpersonal teamwork performance, and teamwork grading rubrics were analyzed separately. To test *Hypothesis 3*, correlations between measures of the transition performance and improvement in teamwork were computed. Multiple measures of transition performance and teamwork were utilized. Measures of teamwork include: the action phase teamwork scale, the interpersonal teamwork scale, and the teamwork grading rubrics. In each case the transition measures from the first two after action reviews were averaged. These measures of transition performance were then correlated with measures of teamwork improvement (i.e., teamwork improvement from the first to third flight simulations). As it was stated earlier, separate analyses were performed for two measures of transition performance: the student self-ratings and facilitator rating of transition performance.)

To test *Hypothesis 4*, correlation between the average transition performance measures for the first two After-Action Review debriefings and team performance improvement from the previous flight simulations were computed and then correlated to

one another. To test this hypothesis, two measures of team performance were utilized. Separate analysis were conducted to investigate the relationships between transition process and financial team improvements, as well as relationships between transition process and improvements in trigger effectiveness team performance. One may find mean scores for financial revenues as well as the trigger effectiveness measures on all flight simulation on Tables 2 and 3.

To find an answer to *Research Question 1*, correlation between the average transition performance measures for the first two After-Action Review debriefings and the average scores for individual performance measures improvement from the first to third flight simulation were computed. To examine *Research Question 2*, correlations between transition performance measures for students as well as facilitators and prior level of teamwork performance on three separate flight simulations were computed; these correlations were then averaged to find an overall trend across all flight simulations. While examining Research Question 2, three separate measures of teamwork were utilized. These include measures of action phase teamwork, interpersonal teamwork, and teamwork grading rubrics performance.

Since there were two distinct measures of team performance, and two measures of transition process that were filled out by the student participants as well as the facilitators of the After-Action Reviews, four separate analyses were conducted to investigate *Research Question 3*. Specifically, correlations between transition phase performance on the first, second, and third flight simulations that were assessed by students and facilitators were separately correlated to the prior level of team performance that was measured in terms of teams' financial gains. Furthermore, student and then the facilitator

measures of transition process on the first, second, and third flight simulations were correlated to the prior level of team performance that was measured in terms of teams' effectiveness in responding to triggers. For each of the four analyses, correlations were then averaged across all flight simulations to find an overall pattern and reported in the results. To answer *Question 4,* correlations between transition performance measures (students as well as facilitators) and the average score on individual performance measures from the previous flight simulation were computed and then averaged across all simulations.

CHAPTER THREE: RESULTS

Initial Findings

Additional emphasis was placed to further validate new performance measures that were created for the purposes of this study. More specifically these were individual performance measures, teamwork grading rubrics, transition performance measures (completed by students as well as facilitators), and trigger response effectiveness measure. Findings of interclass correlations, Chronbach alpha estimates, and correlations between raters are presented as evidence of construct validity. Since these measures have not been validated and/or used in previous research, their relationship to other performance criteria used at the FOCUS Lab provide substantive findings.

Individual Performance Measures. Since there were up to three raters that assessed performance of individual roles at the FOCUS Lab, inter-rater reliability of the individual performance measures were assessed by providing correlations between raters for each positions. First, average ratings of individual items were computed for each rater separately. This provides an overall measure of individual performance for that position that was assessed by each rater on one simulation. The overall performance ratings of the two (or three in some cases) raters were then correlated flight simulation. The sample size for these correlations was 18 (6 teams and 3 simulations). These findings provided information about inter-rater reliability which was high for some positions (Crew Scheduling r (14) = .733, $p < .01$, Maintenance Operations r = .798, Flight Operations Coordinator r = .640, and Weather Operation r = .624); modest for other positions (Flight Scheduling $r(10)$ = .350, p = 265, Ramp Tower Operations $r(10)$ = .472, p = .121; and Pseudo Pilot $r(16)$ = .433, p = .107), and very low for the flight planning position,

$r(12) = -.117$, $p = .691$. On average inter-rater reliability estimates for the individual performance measure were $r = .492$, which is representative of the fact that for the most part individual performance measures are reliable, and that for most positions there was moderate to strong agreement among raters.

A substantive finding showed that average individual performance of student participants was positively related to teamwork grading rubrics: on average there was a correlation of $r = .731$ across all three flight simulations. Average individual performance measures were also found to be related to teamwork action performance; $r = .587$ was observed across all flight simulations. Additionally, average score for individual performance measures was found to be related to teamwork interpersonal performance measures; $r = .357$ was observed across all flight simulations.

Teamwork Grading Rubrics. Cronbach's alpha for the teamwork grading rubrics was .977 indicating good estimates of internal consistency. Additionally inter-class correlations of average ratings for teamwork grading rubrics was $r = .58$. A substantive finding showed that teamwork grading rubrics were related to other teamwork performance measures. More specifically, it was found that teamwork grading rubrics were positively related to action phase teamwork ($r = .675$) as well as interpersonal teamwork performance measures across all flight simulations ($r = .753$). This provides evidence of convergent validity.

Transition Performance Measures. Cronbach's alpha for the self-rated transition performance measure was .812; indicating that it has good internal consistency. Since measures of the transition performance were taken by student-participants and facilitators of the After-Action Reviews, facilitator and student self-ratings of the transition

performance were correlated with one another to see their interrelations. It was found that transition performance measured by students and facilitators show poor consistency with one another (r = - .038 across three simulations). For the first, second, and third simulations these relationships are $r(4) = -.953$, $p = .012$; $r(4) = .234$, $p = .705$; and $r(4) = .963$, $p = .175$.

Trigger Response Effectiveness. A substantive finding showed a relationship between team trigger response effectiveness and team performance that was assessed via delay costs across all three simulations was $r = .663$ ($r(4) = .321$, $p = .535$; $r(4) = .556$, $p = .252$; $r(4) = -.289$, $p = .638$ for the first, second, and third simulation). This provides evidence of convergent validity for the trigger response effectiveness measure.

Trigger response effectiveness measure was related to teamwork grading rubrics, action phase teamwork, and interpersonal phase teamwork across all flight simulations $r = .940$, $r = .696$, $r = .601$ respectively. For the first, second, and third simulations trigger response effectiveness and teamwork grading rubrics performance measures were related as following $r(4) = .760$, $p = .240$; $r(4) = .990$, $p < .001$; $r(4) = .916$, $p < .05$. For the first, second, and third simulations team performance that was measured in terms of trigger response effectiveness, and teamwork action phase performance measures were related as following $r(4) = .125$, $p = .813$; $r(4) = .867$, $p < .05$; and $r(4) = .811$, $p = .05$. For the first, second, and third simulations team performance that was measured in terms of trigger response effectiveness, and teamwork interpersonal performance measures were related as following $r(4) = -.196$, $p = .710$; $r(4) = .947$, $p < .005$; $r(4) = .447$, $p = .375$.

Other Substantive Findings. Another finding showed that teamwork performance measured in terms of teamwork grading rubrics, action phase teamwork, and interpersonal process measures were weakly related to team performance that was measured by financial performance, $r = .039$, $r = .117$, and $r = .193$ were observed across all flight simulations. For the first, second, and third simulations, financial team performance and teamwork grading rubrics performance measures were related as following $r(4) = -.077$, $p = .923$; $r(4) = .535$, $p = .274$; $r(4) = -.382$, $p = .525$. For the first, second, and third simulations team performance that was measured in terms of financial performance, and teamwork action phase performance measures were related as following $r(4) = .038$, $p = .942$; $r(4) = .618$, $p = .191$; and $r(4) = -.386$, $p = .522$. For the first, second, and third simulations team performance that was measured in terms of financial performance, and teamwork interpersonal performance measures were related as following $r(4) = .216$, $p = .681$, $r(4) = .624$, $p = .185$; and $r(4) = -.351$, $p = .563$.

Hypotheses and Research Questions

Because there are a limited number of people who possess skills to run FOCUS Lab, we could only recruit a limited number of participants for this study. Due to this, results of the correlations examined in this study are based on a small number of teams (six teams total), and since all correlations are analyzed at a team level, they provide weak statistical power while answering most hypotheses and research questions (non-significant findings). That is why, this is only an exploratory study, and I would suggest that results of the correlational findings in this section are interpreted in terms of the magnitude of their *r* values, as opposed to paying attention to their significance.

Results of this study showed that individual performance measures are positively related to team performance measured in terms of team's financial gains as well as team performance measured via trigger response effectiveness measures (*Hypothesis 1*). Across all three simulations we obtained an average positive correlation of $r = .671$ between average score of individual performance measures and team's financial gains (*Figure 1*). The relationships between average individual performances for the first, second, and third simulation and team performance are $r(4) = .914$, $p < .05$, $r(4) = .708$, $p = .115$; and $r(4) = .003$, $p = .996$, respectively. Across all three simulations average score for individual performance measures was positively correlated to team's trigger response effectiveness ($r = .650$; *Figure 1*). Relationships between average individual performances for the first, second, and third simulation and team's trigger response effectiveness are $r(4) = .384$, $p = .452$, $r(4) = .739$, $p = .093$, and $r(4) = .751$, $p = .085$ respectively. These findings provide support for *Hypothesis 1*.

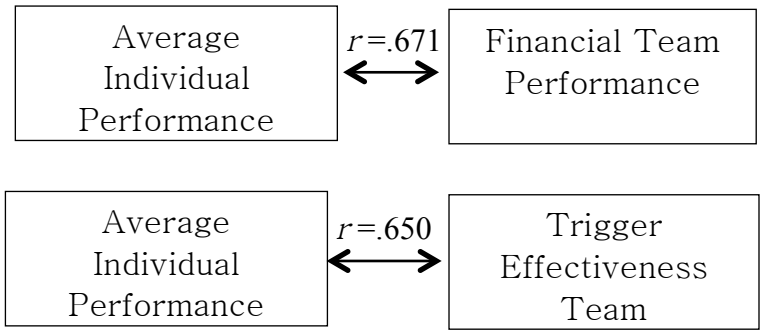

Figure 1. Hypothesis 1

After faculty of the FOCUS Lab completed the Strategic Core Roles Questionnaire, it was identified that FOC, Flight Planning, Flight Scheduling, and Maintenance Operations were the strategic core roles at the FOCUS Lab. Correlations between average individual performance of strategic core roles and team performance

that was measured in term of team's financial performance was $r(4) = .280$, $p = .590$; $r(4) = .755$, $p = .083$; and $r(4) = -.356$, $p = .556$, for the first, second, and third flight simulations. Across three flight simulations average correlation for strategic core roles and team performance that was measured in terms of team's financial performance equaled to $r = .291$. Correlations between average individual performances of non-strategic core roles (i.e., Crew Scheduling, Weather Operations, Ramp Tower Operations, Pseudo Pilots, and the Pilot Team) and financial measure of team performance were $r(4) = .879$, $p < .05$; $r(4) = .192$, $p = .716$; and $r(4) = .319$, $p = .601$, for the first, second, and third flight simulations. Across all flight simulations average correlation for non-strategic core roles and team performance equaled to $r = .632$, which was higher than for strategic core roles by an r value of .341 (*Hypothesis 2*).

On the other hand, while looking at *Hypothesis 2* utilizing a different metric of team performance, correlations between average individual performance measures of strategic core roles and team performance that was assessed via trigger response effectiveness measure showed correlations of $r(4) = .303$, $p = .560$; $r(4) = .681$, $p = .136$; $r(4) = .610$, $p = .199$, for the first, second, and third flight simulations. Across three flight simulations average correlation for strategic core roles and team performance that was assessed via trigger response effectiveness measure was $r = .550$ (*Figure 2*). Correlations between average individual performance measures for non-strategic core roles and trigger response effectiveness was $r = .462$ across all three flight simulations (i.e., $r(4) = .230$, $p = .661$; $r(4) = .385$, $p = .451$; $r(4) = .697$, $p = .124$, for the first, second, and third flight simulations respectively). Analysis of both financial performance and trigger performance do not provide strong support for hypothesis 2 (*Figure 2*). They

suggest that performance is dependent on persons performing a variety of roles rather than primarily the performance of persons staffing a small number of core roles.

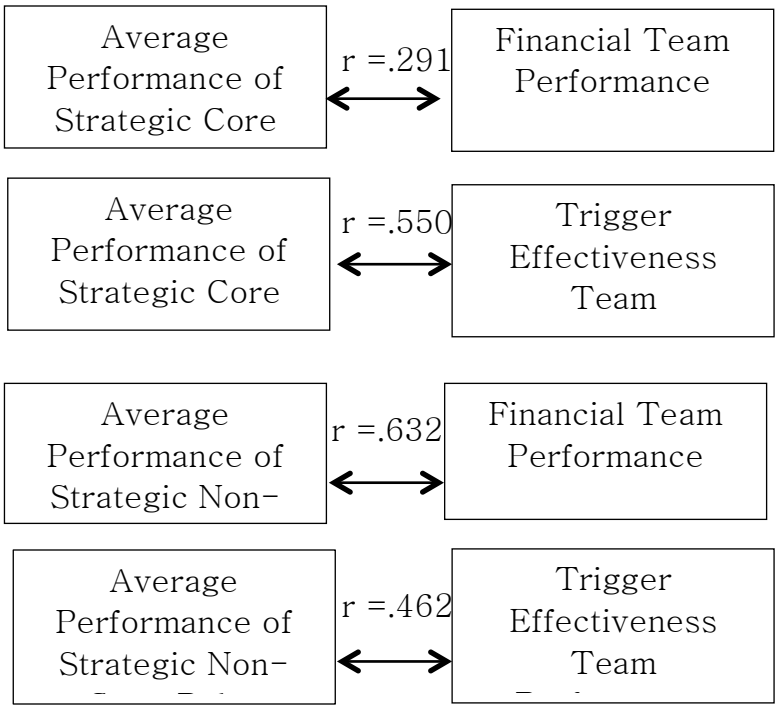

Figure 2. Hypothesis 2

While looking at *Hypothesis 3 (Figure 3)*, it was found that the relationship between transition processes that was assessed by facilitators of the after action review and improvement in teamwork grading rubrics yielded a positive correlation of $r(4) = .626$, $p = .374$. However, while looking at the student's self-reported measure of transition process performance, one may observe a negative relationship with improvement in teamwork grading rubrics that is indicated by a negative correlation of, $r(4) = -.364$, $p = .636$. Transition performance that was rated by the facilitators showed a positive relationship with teamwork action phase improvement, $r(4) = .656$, $p = .157$, but transition performance that was rated by students, showed a negative relationship with teamwork action phase improvement, $r(4) = -.305$, $p = .556$. Similarly, transition

performance that was rated by the facilitators exhibited a positive relations with improvement in teamwork interpersonal processes, $r(4) = .379$, $p = .458$, but transition performance that was rated by students, showed potentially no relationship with teamwork interpersonal performance improvements that can be exhibited by $r(4) = -.141$, $p = .789$. These findings provided mixed support for *Hypothesis 3*. Transition process assessed by facilitators was positively related to teamwork improvements, but self-rated transition performance was not. Overall, the pattern of results does not provide much support for *Hypothesis 3*.

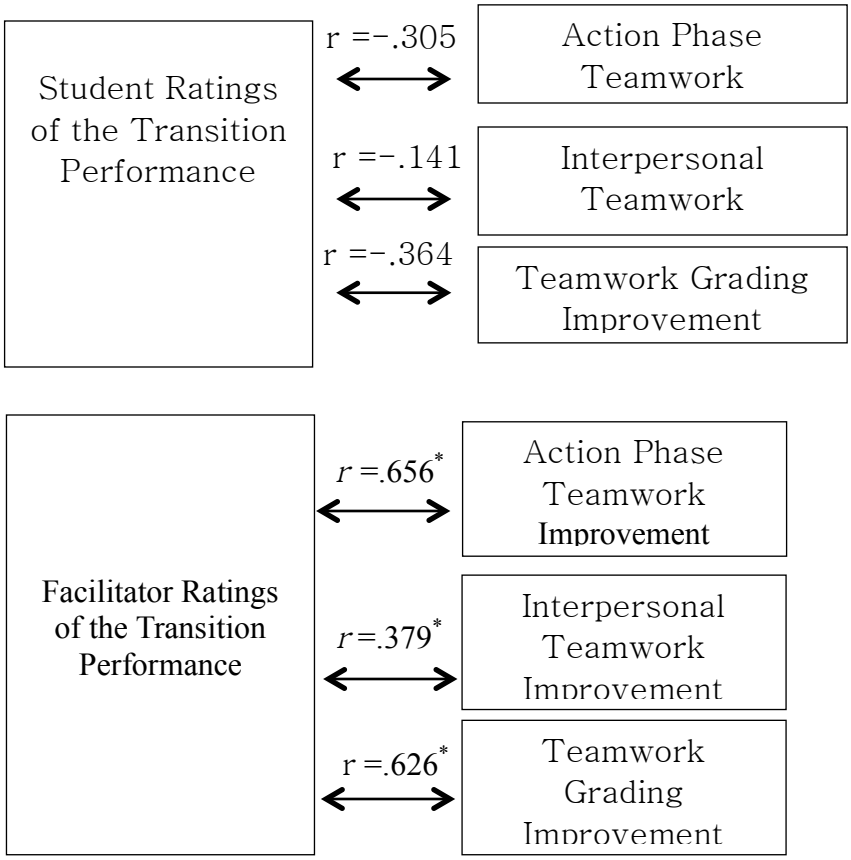

Figure 3. Hypothesis 3

While analyzing *Hypothesis 4,* it was found that transition process that was rated by the facilitators of the After-Action Reviews showed a negative correlation of $r(4) = -.583$, $p = .302$, with team performance improvements that were measured by team's financial gains (*Figure 4*). However, transition process that was rated by student-participants showed a positive correlation with team performance improvements that were measured by financial team indicators, $r(4) = .621$, $p = .263$. On the other hand, it was found that transition process that was rated by the facilitators of the After-Action Reviews showed a weak positive correlation with team performance improvements that were assessed via team's trigger response effectiveness ($r(4) = .178$, $p = .736$). Furthermore, transition process that was rated by student-participants showed a negative correlation with team performance improvements that were assessed via trigger response effectiveness measure, $r(4) = -.475$, $p = .342$ (*Figure 4*).

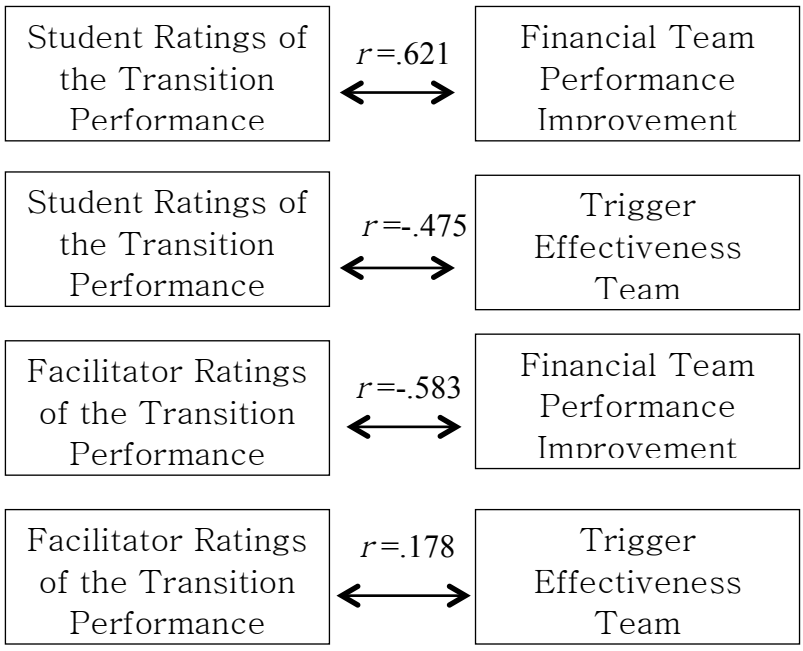

Figure 4. Hypothesis 4

Results of the *Research Question 1* indicate that individual performance measure improvements from the first to third flight simulations were weakly positively related to both facilitator ratings, as well as student's self-reported ratings of the transition phase performance ($r(4) = .164$, $p = .757$, and $r(4) = .206$, $p = .695$, respectively) (*Figure 5*).

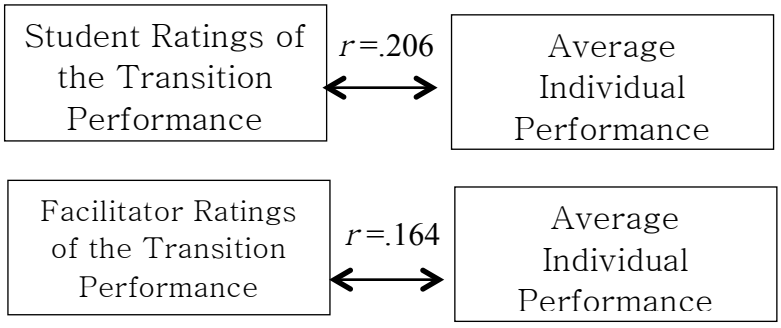

Figure 5. Research Question 1

Research Question 2 concerned with looking at the relationship between prior level of teamwork and transition performance on the following After-Action Review debriefing (*Figure 6*). It was found that previous teamwork that was assessed by the observer's grading rubrics was unrelated to transition process performance that assessed by the After-Action Review facilitator ($r = -.086$) across all flight simulations. However, the student transition performance measure was shown to have a positive relationship with the previous teamwork grading rubrics ($r = .477$) across all flight simulations. Previous teamwork that was assessed via self-ratings of action phase teamwork performance showed a negative relationship with the facilitator's ratings of the transition performance, $r = -.135$ across all flight simulations, however previous action phase teamwork performance was positively related to transition performance of the student ratings ($r = .404$) across all flight simulations. Following this sequence, previous teamwork that was assessed via self-ratings of interpersonal teamwork processes showed

a positive relationship with the facilitator's ratings of the transition performance, r = .287 across all flight simulations, however previous interpersonal teamwork performance was not shown to be related to transition performance of the student ratings (r =- .065) across all flight simulations.

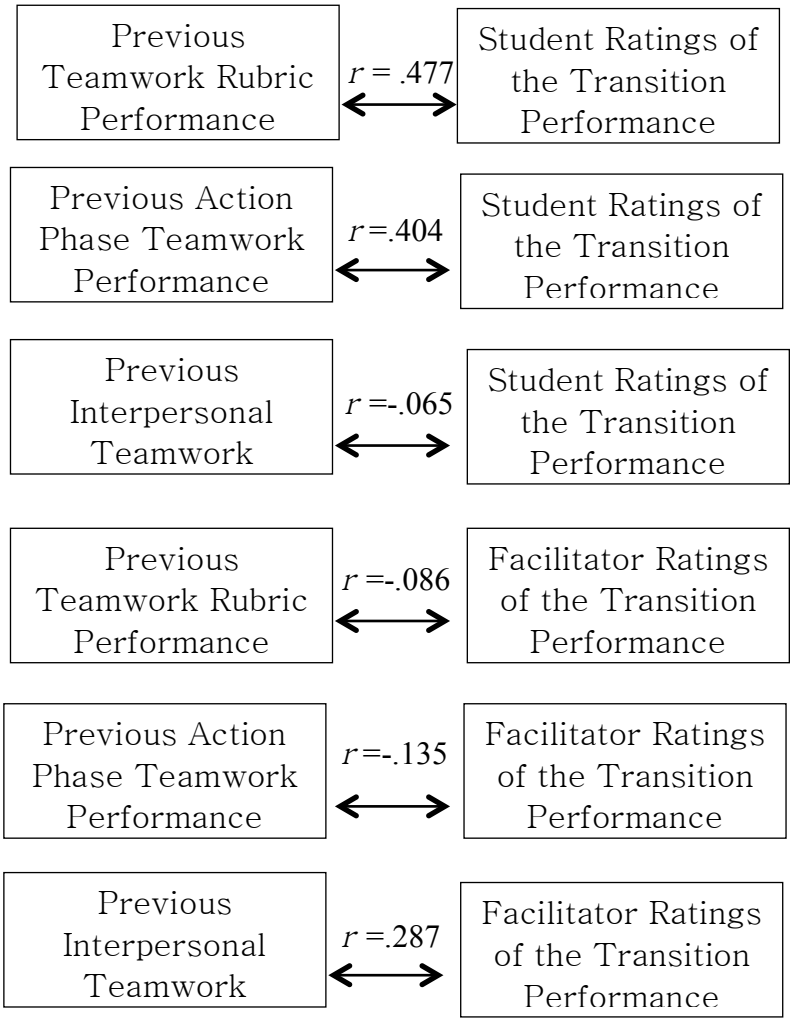

Figure 6. Research Question 2

While looking at the previous level of action phase team performance and how it relates to the transition performance that takes place during following flight simulations (*Research Question 3*), it was found that transition performance measures of the

facilitator and previous levels of teams' financial indicators were positively related (r = .408) across all flight simulations (*Figure 7*). Similarly, transition performance measures that were assessed by the students, were shown to have a positive relationship of r =.458 with prior level of team financial indicators across all flight simulations. Positive correlations were also found for previous level team performance that was assessed via trigger response effectiveness measure with facilitator's ratings of the transition process r = .201, as well as the student ratings of the transition process r = .376 across all flight simulations. This pattern of findings suggests that teams performing well during the simulations also tend to perform well during the After-Action Review.

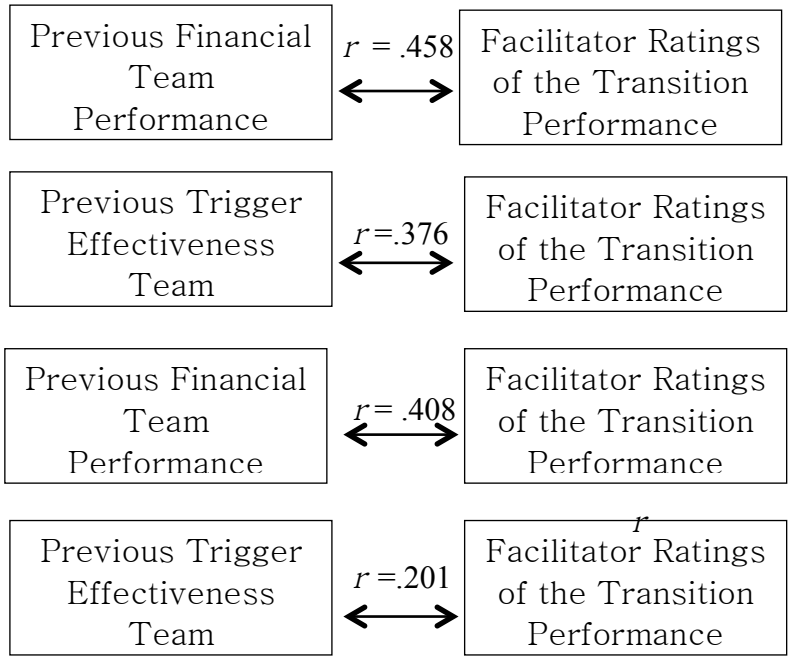

Figure 7. Research Question 3

Research Question 4 was focused on assessing the relationships between transition performance and previous average scores of individual performance measures.

Previous level of individual performance was positively related to the facilitator's measure of transition process performance (r = .672), as well as student self-ratings of transition performance (r = .484) across all flight simulations (*Figure 8*). These findings indicate that teams with members who perform well during the simulation tend to perform well during the After-Action Reviews.

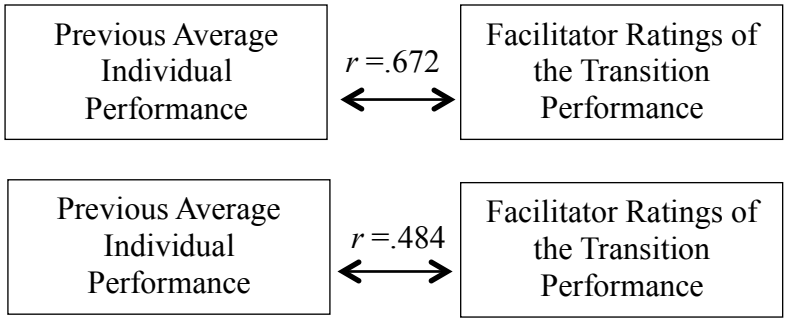

Figure 8. Research Question 4

CHAPTER FOUR: DISCUSSION

Overall, it was found that individual performance measures seem to be a valid measure that is positively related to team performance. Strategic core roles were not related to team performance more highly compared to non-strategic core roles. As it was not expected, average score for individual performance measures for the non-strategic cores roles were more highly correlated to team performance (financial indicators) than the average score of individual measures for the strategic core-roles (r = .291 compared to r = .632).

Action phase teamwork improvements, as well as improvements estimated in teamwork grading rubrics from the first to third flight simulations were positively related to facilitators' measures of transition performance. However, both measures of teamwork improvement were negatively related to student ratings of transition performance. Also, both the facilitators as well as student ratings of the transition performance showed a mixed conflicting pattern in terms of predicting improvements in team performance that was measured by the financial revenues generated by the team as well as trigger response effectiveness. These findings suggest that the level of teamwork exhibited during previous simulations is positively related to student ratings of performance in the After-Action Reviews, but is not related to facilitator ratings of After-Action Review performance.

It is important to interpret the findings of this study with caution. One should only try seeking an overall understanding of a correlations pattern, instead of making concrete statistical judgments in answering the hypotheses/research questions. The associational

nature of this study as well as the lack of statistical power are major limitations of this study. As it was stated earlier in the results section, majority of the correlations provided in this study are non-significant. Caution should also be taken while generalizing the findings of this study to other settings/populations. Because random assignment of participants did not occur and due to the associational nature of the relationships, this study does not provide direct evidence of causal explanations between independent and dependent variables. Also, when FOCUS Lab staff members were completing individual/teamwork performance measures, they were well aware of how well the group performed (team performance) during that particular simulation. This notion may have led to an external bias while rating those measures and could have served as a potential extraneous variable that represents an internal validity threat. Last, students' exposure to the lab itself might have caused performance improvements on following flight simulations (e.g., job experience).

Another major limitation of this study is the self-reported nature of some of the measures that student-participants are asked to complete multiple times. Participants' exposure to activities at the FOCUS Lab may have caused a bias that can be reflected in their perception of improvements in performance. This is true for both the FOCUS Lab staff as well as students.

Besides all the limitations mentioned, in general results provide an interesting pattern. If a team performed well during the simulation, they are more likely to exhibit higher levels of transition performance during After-Action Reviews.

Team performance improvement that was measured in terms of financial revenues generated by teams related to transition performance for student raters opposed to facilitator ratings of the After-Action Review (facilitator ratings were negatively related to team's financial data). This relationship may indicate that students and facilitators may have focused on different issues. It appears that student ratings of the transition performance reflect more closely on performance outcomes of their previous simulations (team financial data are available to each team member after the flight simulation is over) opposed to their potential to improve on next simulations. Facilitator ratings, on the other hand, may more closely reflect process issues identified in the After-Action Review that potentially can be improved in order to achieve higher levels of performance outcomes. After-Action Review tends to emphasize teamwork component. Correlations for the facilitator ratings of the After-Action-Review and improvement in action phase teamwork, interpersonal teamwork, and grading rubrics teamwork are r = .656, r = .379, and r = .626 across all three flight simulations. This pattern of correlations is consistent with the interpretation that students focus on financial performance while facilitators focus on teamwork processes.

Correlations between average score for all individual performance measures and financial gains seem to vary in size on their separate flight simulations. The first simulation had the highest correlation to team performance (r =.914). A big drop was observed in correlations between individual performance and team performance on the third simulation (r = .003), which may show that individual team members have more or less mastered their individual roles, and there is not much variance among how team members perform.

Correlations between average score for all individual performance measures and trigger response effectiveness measures also seem to vary in size on their separate flights simulations. For the first simulation a value of $r = .384$ was observed; which then followed by $r = .739$, and $r = .751$ showing that the relationship between individual performance measures and trigger performance increased. Across simulations individual performance becomes less closely associated with financial performance and more closely associated with trigger performance.

While forming the research questions of this study, it was initially anticipated that teams that perform poorly during the flight simulations, would be more likely to exhibit higher levels of transition performance. However, this isn't what happened; the poor performing groups didn't seem to work harder in the AA reviews to improve performance. Rather, the groups with highest levels of individual performance, and team performance showed higher levels of transition performance. Although there were not specific performance goals, the general logic of goal setting and feedback is that failure to meet standards motivates efforts to improve performance (O'Leary-Kelly, Martocchio, & Frink, 1994). This would suggest that poorer performing teams would place more emphasis on transition performance in after-action reviews. This does not seem to be the case; teams that performed better during the simulations showed higher levels of transition phase performance. This pattern of findings may suggest that the better groups continue to work to get better. A variety of factors may account for this pattern: ability difference between teams, differing group norms (e.g., high performance norms or minimal effort norms), and differences in mean member personality (e.g., conscientiousness, internal or external ambition of performance).

Findings of this study are suggestive of the fact that individual performance measures are generally valid. Contrary to predictions, performance was not more closely related to roles that had been identified as core roles than to other roles. In fact, based on the financial measure of team performance, performance of non-core roles (Crew Scheduling, Weather Operations, Ramp Tower Operations, Pseudo Pilot, and the Pilot team) seem to be more highly related to team performance than performance of core roles (Flight Operations Coordinator, Flight Scheduling, Flight Planning, and Maintenance Operations). The correlation with financial performance is .341 higher than for non-core roles. On the other hand, while looking at the relationships of strategic versus non-strategic roles utilizing trigger effectiveness team performance metric, one may see there is a trivial difference between their r values; $r = .088$. These findings do not show that performance is more highly dependent on the performance of persons in core roles. Rather, they might be suggestive that effective team performance at the FOCUS Lab seems to involve the group as a whole, not merely the core positions. Perhaps this is because of the high degree of interdependence (teamwork); however each position has a critical function and access to information not held by other positions. It may be useful to think of the task as a conjunctive task—where anyone's mistake has serious consequences. On a conjunctive task, performance depends on the weakest member (Tziner & Eden, 1985).

The two measures of team performance (financial performance and trigger response effectiveness) were highly correlated ($r = .633$ across all fight simulations). Nevertheless, comparison of the relationship between teamwork and the two team performance metrics illustrates striking differences. Financial performance was not

closely related to any of the measures of teamwork. Across all simulations, correlations between financial performance and teamwork grading rubrics, action phase performance, and interpersonal teamwork performance were r = .039, r = .117, and r = .193 respectively. On the other hand, effectiveness of responses to triggers was highly correlated with teamwork measures: r = .94, r = .70, and r = .60 for teamwork grading rubrics, action phase performance, and interpersonal teamwork performance respectively.

A negative relationship was found between student reported transition phase process and teamwork, while a positive relationship was found for facilitators. It was also found that self-reported measures of transition process performance, and facilitators measure were shown to be unrelated to each other across all flight simulations (r = -.038); relationship for the first, second, and third simulation are as following: r =-.953, r = -.234, and r = .963. Team members may perceive the After-Action Review differently than facilitators. Even though students and the facilitator see things quite differently at first, this discrepancy decreases across flight simulations. This inverse relationship may also be because the main objectives of facilitators and students differ, such that students are more focused on improving monetary values which are representative of team performance, while facilitators are more focused on improving group interactions which is representative in teamwork performance measures. Students tended to associate their transition processes to team performance, rather than teamwork performance. Facilitators on the other hand tended to relate transition processes to teamwork performance, but not team performance. Overall, this may suggest that team members may perceive the After Action Review differently from facilitators.

Teamwork patterns discussed in this study are essential in today's dynamic environment, especially in highly interdependent work-teams that exist in today's aerospace, fire-fighting, medical, and military units, and many other industries and/or domains. Findings of this research can contribute to other studies that examine effectiveness of team debriefings (i.e., transition performance) and showed its positive relationship with team/individual performance effectiveness (Tannenbaum & Cerasoli, 2012). Finally, there is some concern about the construct validity of some measures. For example, while the two team performance metrics (financial performance and trigger performance) are highly correlated, they show different patterns of correlations with various teamwork measures. This suggests that one or both of these measures does not adequately capture team performance. Another area of measurement concern is transition phase performance. Ratings by participants and by facilitators were unrelated and showed differing patterns of relationships with measures of teamwork and team performance. These measurement issues suggest the need for additional research.

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Table 1

Mean Scores for Individual Performance Measures (1 to 7)

Table Number	SIMULATION 1	SIMULATION 2	SIMULATION 3
Team 1	4.24	4.71	4.97
Team 2	4.67	5.20	5.27
Team 3	4.29	4.56	4.78
Team 4	4.69	5.39	5.91
Team 5	5.02	5.39	5.66
Team 6	5.01	5.02	5.63

Table 2.

Financial Revenues ($)

Team Number	SIMULATION 1	SIMULATION 2	SIMULATION 3
Team 1	359,169.56	390,437.15	
Team 2	374,442.95	403,312.21	408,847.96
Team 3	368,820.78	397,146.13	411,308.30
Team 4	372,498.06	407,790.63	412,080.96
Team 5	394,108.33	410,087.28	404,492.56
Team 6	405,750.18	386,994.71	414,930.68

Table 3.

Mean Scores for the trigger effectiveness measure (1 to 5)

Team Number	SIMULATION 1	SIMULATION 2	SIMULATION 3
Team 1	1.75	3.59	4.07
Team 2	5.16	2.70	3.14
Team 3	4.12	2.14	3.26
Team 4	2.50	4.75	5.15
Team 5	5.07	4.90	5.21
Team 6	3.05	3.16	4.00

Appendices

Appendix A. IRB Approval

MIDDLE TENNESSEE STATE UNIVERSITY

February 18, 2013

Artyom Ivakh, Glenn Littlepage
Department of Psychology
ai2g@mtmail.mtsu.edu, glenn.littlepage@mtsu.edu

Protocol Title: "Team Performance in Aerospace Simulations"

Protocol Number: 13-215

Dear Investigator(s),

The exemption is pursuant to 45 CFR 46.101(b) (4). This is because the research being conducted involves the collection or study of existing data, documents or records that is being recorded by the investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

You will need to submit an end-of-project report to the Compliance Office upon completion of your research. Complete research means that you have finished collecting data and you are ready to submit your thesis and/or publish your findings. Should you not finish your research within the three (3) year period, you must submit a Progress Report and request a continuation prior to the expiration date. Please allow time for review and requested revisions. Your study expires on February 18, 2016.

Any change to the protocol must be submitted to the IRB before implementing this change. According to MTSU Policy, a researcher is defined as anyone who works with data or has contact with participants. Anyone meeting this definition needs to be listed on the protocol and needs to provide a certificate of training to the Office of Compliance. **If you add researchers to an approved project, please forward an updated list of researchers and their certificates of training to the Office of Compliance before they begin to work on the project.** Once your research is completed, please send us a copy of the final report questionnaire to the Office of Compliance. This form can be located at www.mtsu.edu/irb on the forms page.

Also, all research materials must be retained by the PI or faculty advisor (if the PI is a student) for at least three (3) years after study completion. Should you have any questions or need additional information, please do not hesitate to contact me.

Sincerely,

Andrew W. Jones

Compliance Office
615-494-8918
Compliance@mtsu.edu

Appendix B. *Informed Consent*

Consent for participation in the Flight Operations Center project

I understand that the MTSU Aerospace Department is interested in my opinions, thoughts, actions, and experiences pertaining to my overall experience while working in the Flight Operations Center.

I understand that working in the MTSU Flight Operations Center is voluntary. I understand that I can decide not to participate without any penalty. I understand that if I decide not to participate it will not affect any class grade or my standing for future classes in any way. I understand that if I do participate, the information that I give and observations made of me will remain confidential. By signing this consent form I am agreeing to have my experiences, advice, and input anonymously used by MTSU researchers to further safety and effective training methods.

_____

Signature of Participant

Appendix C: Individual Performance Measures

Individual Performance Measure - Flight Operations Coordinator (FOC)

Team _____ Date _____ Rater_____

On a scale of 1 to 7, *where 1 is never and 7 is always*, please rate each task in way that would best represent individual's behavior throughout the entire flight simulation.

Never Sometimes Always

1 2 3 4 5 6 7

1. _____ Performs dispatch duties in a timely manner.
2. _____ Makes effective decisions to resolve unusual events.
3. _____ Multitasks and makes assertive decisions under time-stress situations.
4. _____ Most often anticipates flight delays and cancellations.
5. _____ Employs proactive strategies to remedy the situation/event that takes place during the simulation.
6. _____ Remains cognizant of all ongoing issues that take place during the simulation.
7. _____ Operates in accordance with FAA Regulations.
8. _____ **Information Flow**: Shares relevant information as needed with other team members.
9. _____ **Information Utilization:** When appropriate, actively solicits information from key team members in order to arrive at best quality decisions.
10. _____ **Coordination:** Coordination with other team members is effective. (Proper phraseology/efficient communication channels are always used.)

Individual Performance Measure - Weather Operations (WX)

Team _____ Date _____ Rater _____

On a scale of 1 to 7, *where 1 is never and 7 is always*, please rate each task in way that would best represent individual's behavior throughout the entire flight simulation.

Never Sometimes Always

1 2 3 4 5 6 7

1. _____ Anticipates weather factors that might impact flight schedule/flight issues.
2. _____ Determines accurate recommendations to the alternate arrival airports when the current flying routs are closed.
3. _____ Effectively approves departure, en route, and arrival condition for flights that takeoff and land.
4. _____ Looks at different weather information sources to get an integrated picture (e.g., weather conditions aloft).
5. _____ Works well under time-stress situations and prioritizes work in accordance to weather conditions that take place during the simulation.
6. _____ Operates in accordance with FAA Regulations.
7. _____ **Information Flow**: Shares relevant information as needed with other team members.
8. _____ **Information Utilization:** When appropriate, actively solicits information from key team members in order to arrive at best quality decisions.
9. _____ **Coordination:** Coordination with other team members is effective. (Proper phraseology/efficient communication channels are always used.)

Individual Performance Measure - Crew Scheduling (CS)

Team _____ Date _____ Rater _____

On a scale of 1 to 7, *where 1 is never and 7 is always*, please rate each task in way that would best represent individual's behavior throughout the entire flight simulation.

Never Sometimes Always

1 2 3 4 5 6 7

1. _____ Effectively keeps track of crews' duty times.
2. _____ Incorporates all the flight delays/cancellations into crew's duty times.
3. _____ Incorporates calls to an optimal reserve crew in a timely fashion.
4. _____ Is able to multitask and work well under time-stress situations, prioritizing his/her work in accordance to the event/scenarios that take place during the simulation.
5. _____ Ensures that crews are not scheduled for flights that will result in busted times (e.g., dead heading reserve crews when appropriate, rotating crews).
6. _____ Operates in accordance with FAA required duty times regulations.
7. _____ **Information Flow**: Shares relevant information as needed with other team members.
8. _____ **Information Utilization:** When appropriate, actively solicits information from key team members in order to arrive at best quality decisions.
9. _____ **Coordination:** Coordination with other team members is effective. (Proper phraseology/efficient communication channels are always used.)

Individual Performance Measure - Flight Ops Data 2 (Flight Planning)

Team _____ Date _____ Rater _____

On a scale of 1 to 7, *where 1 never and 7 is always*, please rate each task in way that would best represent individual's behavior throughout the entire flight simulation.

Never			*Sometimes*			*Always*
1	*2*	*3*	*4*	*5*	*6*	*7*

1. _____ Enters the appropriate information into the Spreadsheet.
2. _____ Determines weight and balance information in a timely fashion.
3. _____ Accurately determines fuel, weight and balance information.
4. _____ Effectively bumps passengers and cargo as needed.
5. _____ Quickly and efficiently reroutes bumped passenger & cargo.
6. _____ Operates in accordance with FAA Regulations.
7. _____ **Information Flow**: Shares relevant information as needed with other team members.
8. _____ **Information Utilization:** When appropriate, actively solicits information from key team members in order to arrive at best quality decisions.
9. _____ **Coordination:** Coordination with other team members is effective. (Proper phraseology/efficient communication channels are always used.)

Individual Performance Measure - Flight Ops Data 1 (Flight Scheduling)

Team _____ Date _____ Rater _____

On a scale of 1 to 7, *where 1 is never and 7 is always*, please rate each task in way that would best represent individual's behavior throughout the entire flight simulation.

Never		*Sometimes*				*Always*
1	*2*	*3*	*4*	*5*	*6*	*7*

1. _____ Accurately timestamps all of the released flights immediately after the flights are released by the FOC.
2. _____ Accurately timestamps all of the arrival flights immediately after the radar indicated flight is in approach.
3. _____ Immediately identifies on schedule display all flights under a special condition.
4. _____ Maintains an uncluttered radar screen for most of the simulation.
5. _____ Operates in accordance with FAA Regulations.
6. _____ **Information Flow**: Shares relevant information as needed with other team members.
7. _____ **Information Utilization:** When appropriate, actively solicits information from key team members in order to arrive at best quality decisions.
8. _____ **Coordination:** Coordination with other team members is effective. (Proper phraseology/efficient communication channels are always used.)

Individual Performance Measure - Maintenance (MX)

Team _____ Date _____ Rater _____

On a scale of 1 to 7, *where 1 is never and 7 is always*, please rate each task in way that would best represent individual's behavior throughout the entire flight simulation.

Never Sometimes Always

1 2 3 4 5 6 7

1. _____ Resolves all the maintenance issues in the most effective way.
2. _____ Accurately estimates delay time for repairs.
3. _____ Effectively documents repairs made to an aircraft while using the RMS and the MEL.
4. _____ Effectively handles all the scheduled repairs while dealing with unexpected issues.
5. _____ Prioritizes work as needed.
6. _____ Operates in accordance with FAA regulations.
7. _____ **Information Flow**: Shares relevant information as needed with other team members.
8. _____ **Information Utilization:** When appropriate, actively solicits information from key team members in order to arrive at best quality decisions.
9. _____ **Coordination:** Coordination with other team members is effective. (Proper phraseology/efficient communication channels are always used.)

Individual Performance Measure - Ramp Tower Coordinator (Ramp)

Team _____ Date _____ Rater _____

On a scale of 1 to 7, *where 1 is never and 7 is always*, please rate each task in way that would best represent individual's behavior throughout the entire flight simulation.

Never Sometimes Always

1 2 3 4 5 6 7

1. _____ Effectively manages arrival planes.
2. _____ Keeps track of the status of planes awaiting departure.
3. _____ When necessary, redirects airplanes effectively.
4. _____ Is aware of issues preventing release of an aircraft.
5. _____ Maintains efficiency even in hectic periods.
6. _____ Operates in accordance with FAA Regulations.
7. _____ **Information Flow**: Shares relevant information as needed with other team members.
8. _____ **Information Utilization:** When appropriate, actively solicits information from key team members in order to arrive at best quality decisions.
9. _____ **Coordination:** Coordination with other team members is effective. (Proper phraseology/efficient communication channels are always used.)

Individual Performance Measure - Pseudo Pilot

Team _____ Date _____ Rater _____

On a scale of 1 to 7, *where 1 is never and 7 is always*, please rate each task in way that would best represent individual's behavior throughout the entire flight simulation.

Never Sometimes Always

1 2 3 4 5 6 7

1. _____ Accurately determines vectors and alternate flight routes in a timely manner.
2. _____ Maintains awareness of flights near departure.
3. _____ Maintains awareness of flights that are close to landing.
4. _____ Maintains awareness of flights that are under a special condition.
5. _____ Organizes information on the screen effectively.
6. _____ Moves all the planes up to the best forward speed.
7. _____ Operates in accordance with FAA Regulations.
8. _____ **Information Flow**: Shares relevant information as needed with other team members.
9. _____ **Information Utilization:** When appropriate, actively solicits information from key team members in order to arrive at best quality decisions.
10. _____ **Coordination:** Coordination with other team members is effective. (Proper phraseology/efficient communication channels are always used.)

Individual Performance Measure – Pilot & First Officer at the CRJ

Team _____ Date _____ Rater _____

On a scale of 1 to 7, *where 1 is never and 7 is always*, please rate each task in way that would best represent individual's behavior throughout the entire flight simulation.

Never Sometimes Always

1 2 3 4 5 6 7

1. _____ Completes preflight preparations in a timely and correct manner.

2. _____ Successfully coordinates with Flight Operations for dispatch of the flight

3. _____ Executes the correct procedures during the flight in the IFR environment.

4. _____ Effectively communicates with (simulated) ATC.

5. _____ Correctly identifies and resolves any maintenance problems during the flight.

6. _____ Maintains awareness of weather conditions during the flight.

7. _____ Follows appropriate CRJ procedures per Universal E-Lines operating manual.

8. _____ Operates in accordance with FAA regulations

9. _____ **Information Flow**: Shares relevant information as needed with other team members.

10. _____ **Information Utilization:** When appropriate, actively solicits information from key team members in order to arrive to best quality decisions.

11. _____ **Coordination:** Coordination with other team members is effective. (Proper phraseology/Efficient communication channels are always used.)

Appendix D: *Transition Performance Measure*

Transition Performance Measure

Please use the following scale to describe your team that completed the After-Action Review exercise.

To what extend does our team use the After Action Review to ….

1	2	3	4	5
Not at all	**Very Little**	**To Some Extent**	**To a Great Deal**	**To a Very Great Extent**

1. ____ Identify our main tasks?
2. ____ Identify the key challenges that we expect to face?
3. ____ Determine the resources that we need to be successful?
4. ____ Set goals for the team?
5. ____ Ensure that everyone on our team clearly understands our goals?
6. ____ Link our goals with the strategic direction of the organization?
7. ____ Develop an overall strategy to guide our team activities?
8. ____ Prepare contingency (“if-then”) plans to deal with uncertain situations?
9. ____ Learn when to stick with a given working plan, and when to adapt to a different one?
10. ____ Contribute information during the After Action Review that would help improve team performance?
11. ____ Ensure that information learned during the After Action Review will be used to improve team performance?

Appendix E: *Action Phase Teamwork Performance Measure*

Action Phase Teamwork Performance

Please use the following scale to describe your team that just completed the NASA lab simulation exercise.

To what extent does our team actively work to …..

1	2	3	4	5
Not at all	**Very Little**	**To Some Extent**	**To a Great Deal**	**To a Very Great Extent**

Monitoring Progress Toward Goals

_____1. Regularly monitor how well we are meeting our team goals?

_____2. Use clearly defined metrics to assess our progress?

_____3. Seek timely feedback from stakeholders (e.g., customers, top management, other organizational units) about how well we are meeting our goals?

Resource and Systems Monitoring

_____4. Monitor and manage our resources (e.g., financial, equipment, etc.)?

_____5. Monitor important aspects of our work environment (e.g., inventories, equipment and process operations, information flows)?

_____6. Monitor events and conditions outside the team that influence our operations?

Team Monitoring and Backup

_____7. Develop standards for acceptable team member performance?

_____8. Balance the workload among our team members?

_____9. Assist each other when help is needed?

Coordination

_____10. Communicate well with each other?

_____11. Smoothly integrate our work efforts?

_____12. Coordinate our activities with one another?

Appendix F: *Interpersonal Teamwork Performance Measure*

Interpersonal Teamwork Performance

Please use the following scale to describe your team that just completed the NASA lab simulation exercise.

To what extent does our team actively work to …..

1	2	3	4	5
Not at all	**Very Little**	**To Some Extent**	**To a Great Deal**	**To a Very Great Extent**

Conflict Management

_____1. Deal with personal conflicts in fair and equitable ways?

_____2. Show respect for one another?

_____3. Maintain group harmony?

Motivating and Confidence Building

_____4. Take pride in our accomplishments?

_____5. Develop confidence in our team's ability to perform well?

_____6. Encourage each other to perform our very best?

Affect Management

_____7. Share a sense of togetherness and cohesion?

_____8. Manage stress?

_____9. Keep a good emotional balance in the team?

Appendix G: Teamwork Grading Rubric

Teamwork Grading Rubric

	1 Trainee Level	3 Developing Level	5 Experienced Level	7 Professional Level	Score
Problem Solving Objective or Performance	Problems go unseen until a point where they become critical. Once the problem is recognized corrective actions are slow or non-existent.	Reacts to problems after they occur. Implementing corrective actions is non-assertive.	Resolves problems as they arise quickly and efficiently.	Team members work together to pre-empt problems. The team sees a problem in the making and implements corrective measures in advance.	
Problem Solving Objective or Performance	Decisions go un-made because team members are unaware that a decision is called for.	Decisions are non-assertive and tentatively made. Little or no confidence in decisions is displayed.	Decisions are made in a timely manner.	Decisions are made assertively and with confidence.	
Problem Solving Objective or Performance	Events of the scenario go undetected.	Ramifications of the events in the scenario are not completely understood. Decisions are made without understanding the full consequences of the choices that are made.	Consequences of the events of the scenario are understood, and actions are taken to reduce adverse effects.	Consequences of the events of the scenario are understood, anticipated, and mitigated to the greatest possible extent.	

	1 Trainee Level	3 Developing Level	5 Experienced Level	7 Professional Level	Score
Problem Solving Objective or Performance	The events of the scenario seem to overwhelm some or all team members. Increased workload events come as a surprise - team members never anticipate events to come.	Team members use downtime when the action of the scenario is reduced to "catch their breath." There is no preparation in the lulls for the peek workload times.	Team members do not waste downtime opportunities, but no time-use strategy is in place.	Team members use downtime or lulls in the action to prepare for the busy times. Team members anticipate what is to come. Time-use strategies are used by individuals as well as the group as a whole.	
Coordination Objective or Performance	Decisions are made in isolation without understanding that decisions have an impact on other team members.	Decisions are made, but the impact of these decisions on other team members is not seen until after the fact.	Team members understand that decisions they make will have an impact on others	Every team member understands the degree to which the decisions they make will impact other team members.	
Coordination Objective or Performance	Individual team members attempt to carry out their own responsibilities but do not have time or interest in worrying about anyone else's job.	Decisions are often made that do not consider the well being of the total organization. Individual team members concentrate on doing their job, but don't see their role in the "big picture."	Decisions are made considering most of the factors that affect the total organization – but in a time-stress situation the "easiest" but not the "best" decision is sought.	Decisions are always made with the benefit of the entire organization in mind. Team members clearly see "the big picture."	

	1 Trainee Level	3 Developing Level	5 Experienced Level	7 Professional Level	Score
Information Utilization Objective or Performance	The quality of decisions is compromised because information is not effectively shared among centers. Team members are unaware that others on the team could have vital information.	Decisions are made with limited input from information centers. Information that could have been used to arrive at a high quality decision is frequently missed or goes unsolicited.	Decisions are made after considering information from several team members. Information is actively solicited from team members.	Decisions are made after obtaining and considering information from all team members, and includes economic factors. Information is obtained using an assertive leadership style.	
Information Utilization Objective or Performance	Communication between team members is random or non-existent. Non-standard phraseology is the norm.	Communication between team members is occasionally chaotic. Non-standard phraseology is used most of the time.	Communications between team members is effective. Proper phraseology is frequently used. Miss-communications happen but are detected and corrected.	Communication between team members is efficient. Proper phraseology is always used. The team members communicate as if they understand the challenges of the other team member's positions. Miss-communication is extremely rare.	

	1 Trainee Level	3 Developing Level	5 Experienced Level	7 Professional Level	Score
Information Utilization Objective or Performance	Team members have limited understanding of their own role and even less understanding of the role of other team members. Information flows often exclude team members simply because its unknown what other team members are supposed to know.	Team members have a limited understanding of what other teams members are supposed to do. Information flows often exclude team members that could have valuable information for decision-making.	Every team member understands the role of every other team member. Information flows freely between the team members.	Every member of the team understands every other team member's role and expertise. Full benefit of this knowledge is used when extracting information that is used in decision-making.	
Information Utilization Objective or Performance	The flow of information when it takes place is almost accidental. No information is solicited from others because nobody is aware what information others have access to.	The flow of information is random. Team members that have access to vital information frequently do not speak up and share their information. Likewise decision makers who need information frequently do not ask for information from others.	The flow of information and subsequent decisions follow no specific pattern. Occasionally final decisions are made without the benefit from all information.	The flow of information and subsequent decisions follow a pattern. Final decisions are made only after it is clear that all relevant information has been considered.	

Appendix H: Trigger and Response Rating Form

Triggers and Responses

Date_____ Team # _____ Rater_____

Present at Sim: yes no Present at Review Meeting: yes no

Trigger 1 _____

Disruptive Potential of the trigger

1 2 3 4 5 6 7

Minimal Catastrophic

Effectiveness of Response to the trigger

1 2 3 4 5 6 7

Extremely Ineffective Extremely Effective

Trigger 2 _____

Disruptive Potential of the trigger

1 2 3 4 5 6 7

Minimal Catastrophic

Effectiveness of Response to the trigger

1 2 3 4 5 6 7

Extremely Ineffective Extremely Effective

Trigger 3 _____

Disruptive Potential of the trigger

1 2 3 4 5 6 7

Minimal Catastrophic

Effectiveness of Response to the trigger

1 2 3 4 5 6 7

Extremely Ineffective Extremely Effective

Appendix I: *Strategic Core Role Survey*

Step 1*: After reading the definition below, please take a few minutes of your time to think of strategic core roles at the NASA Focus Lab.*

Strategic Core Roles Definition: Depending on team's objective, size, and the workflow involved, interaction and performance of several members (e.g., specific positions) has been found to impact team performance the most. These team members usually have greater exposure to the task, and are more central to the workflow of the team. In team research, those positions are referred to as **strategic core roles** because their performance is most critical to the overall team's effectiveness (Humphrey, Morgeson, & Mannor (2009).

Step 2: *After you're finished with step 1, please read through the list of positions at the NASA FOCUS Lab and decide which of them are the* ***four*** *strategic core roles. Fill in the blank below by ranking them in order of importance to overall team performance/effectiveness, so that the* ***most important position is one, and the least is four****. (Note that other four positions will not be included.)*

List of Positions: Flight Operations Coordinator, Maintenance, Weather, Flight Planning, Flight Scheduling, and Crew Scheduling, Ramp Tower Coordinator, Pilot Team (pilot and first officer), and the Pseudo Pilot.

Strategic Core Role 1: _____

Strategic Core Role 2: _____

Strategic Core Role 3: _____

Strategic Core Role 4: _____

Thank you very much for your help - this information will be central to finishing my thesis!

Artyom