11-21-2000

A test of a tripartite framework of team strategy development

Kevin William Brown
Florida International University

DOI: 10.25148/etd.FI14051859

Follow this and additional works at: <https://digitalcommons.fiu.edu/etd>

Part of the [Psychology Commons](#)

Recommended Citation

Brown, Kevin William, "A test of a tripartite framework of team strategy development" (2000). *FIU Electronic Theses and Dissertations*. 1875.
<https://digitalcommons.fiu.edu/etd/1875>

This work is brought to you for free and open access by the University Graduate School at FIU Digital Commons. It has been accepted for inclusion in FIU Electronic Theses and Dissertations by an authorized administrator of FIU Digital Commons. For more information, please contact dcc@fiu.edu.

FLORIDA INTERNATIONAL UNIVERSITY

Miami, Florida

A TEST OF A TRIPARTITE FRAMEWORK OF TEAM STRATEGY
DEVELOPMENT

A thesis submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE

in

PSYCHOLOGY

by

Kevin William Brown

2001

To: Dean Arthur W. Herriott
College of Arts and Sciences

This thesis, written by Kevin William Brown, and entitled A Test of a Tripartite Framework of Team Strategy Development, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this thesis and recommend that it be approved.

Juan I. Sanchez

William M. Kurtines

Michelle A. Marks, Major Professor

Date of Defense: November 21, 2000

The thesis of Kevin William Brown is approved.

Dean Arthur W. Herriott
College of Arts and Sciences

Interim Dean Samuel S. Shapiro
Division of Graduate Studies

Florida International University, 2001

DEDICATION

I dedicate this thesis to my family, friends, and many wonderful mentors without whom I would not have made it this far. Thank you all.

ACKNOWLEDGMENTS

I wish to thank the members of my committee for their support and guiding wisdom. You have all been so pivotal in my development as a student, researcher, practitioner, and man. Words alone cannot convey my gratitude – “thank you” is simply not enough. But I will strive to make you proud, and I will never forget the journey.

ABSTRACT OF THE THESIS

A TEST OF A TRIPARTITE FRAMEWORK OF TEAM STRATEGY DEVELOPMENT

by

Kevin William Brown

Florida International University, 2001

Miami, Florida

Professor Michelle A. Marks, Major Professor

This study provided further insight into the process (or processes) of team strategy development and its relationship with team performance. Building upon the taxonomies introduced by Marks, Mathieu, & Zaccaro (in press) and Wood and Locke (1990), this thesis attempted to test a tripartite framework of team strategy development.

Specifically, this model posits that strategy development consists of three unique, though interrelated, processes: deliberate planning, contingency planning, and reactive adaptation. It was hypothesized that 1) task complexity would moderate the relationship between the three types of strategy development and team performance, and 2) that the three types of strategy formation occur in specific time periods of team performance.

The results of this study provided mixed findings. Correlational analyses provided discriminant evidence for the uniqueness of the three processes in their relationships with one another and with other variables. Furthermore, support was found for hypothesis 2, providing evidence that the three processes occur primarily in specific

periods of team performance. However, contrary to the existing literature, complexity was not found to be a moderator of the relationship between strategy development and team performance.

TABLE OF CONTENTS

CHAPTER	PAGE
I. INTRODUCTION.....	1
II. METHODS.....	14
III. RESULTS.....	26
IV. DISCUSSION.....	33
LIST OF REFERENCES.....	47
APPENDICES.....	49

LIST OF TABLES

TABLE	PAGE
1. Descriptive Statistics.....	42
2. Intercorrelations Between Key Variables.....	43
3. Correlations Between Covariates and Key Variables.....	44
4. Summary of Hierarchical Regression Analysis for Variables Predicting Team Performance.....	45
5. Summary of Hierarchical Regression Analysis for Variables Predicting Team Performance.....	45
6. Summary of Hierarchical Regression Analysis for Variables Predicting Team Performance.....	46

CHAPTER I

INTRODUCTION

As organizations become increasingly reliant on teams as the basic unit of production and delivery of goods and services, the study of teams has become a focal point for both researchers and businesspeople, alike. There is a drive to better understand the dynamics and utilities of teams in the workplace; as a result, there has amassed a wide body of literature that has explored how teams work, why teams work, and how to make them work better. Many processes thought to contribute to the success or failure of a team have enjoyed considerable attention in recent years. Strategy development is one such process.

Evidence has shown strategy to be an important predictor of team performance (Hackman, Brousseau, & Weiss, 1976; Hackman & Morris, 1975; Jehn & Shah, 1997; Saavedra, Earley, & Van Dyne, 1993; Yetton & Bottger, 1982); those who engage in planning activities typically perform better than those who do not. As such, strategy has proven to be a popular topic in recent years, having grown tremendously both in depth and breadth. However, there remains a need to go further. Despite the abundance of research (or perhaps because of it), strategy has come to encompass an immensely eclectic body of literature; that is, the literature has become conceptually broad with any number of terms (e.g., strategization, strategy development, planning, strategic planning, tactical planning) connoting a common process or set of processes. Thus, there is a need to more fully develop and delineate the process or processes of strategy development and reconcile the existing inconsistencies within the literature.

Though most of the literature conceptualizes strategy development as a single process, some researchers have proposed that it is more likely a set of distinct but related processes (e.g., Jehn & Shah, 1997; Marks, Mathieu, & Zaccaro, In press; Wood & Locke, 1990). Based on a review of the literature, Marks et al. (In press) have proposed that three distinct types of strategy development exist. However, this has yet to be tested empirically. The purpose of this thesis is to review and further delineate these types of strategy development (i.e., deliberate planning, contingency planning, and reactive adaptation) and be the first to empirically test this tripartite framework.

Definition

Within the team literature, strategy is most commonly defined as a “description of a time-and-function-linked series of actions that, if executed, will (it is supposed) lead to a specific goal/outcome/consequence” (McGrath, 1984, p. 128). It is a plan that directs the efforts of individuals within a group and integrates their actions to produce a “coherent whole” (Weldon & Weingart, 1993). However, there does exist a conceptual inconsistency within the literature. It is not uncommon for strategy to be treated as a process in itself, when in fact it is a product; that is, many studies have neglected to distinguish between actual strategies and the process or processes through which they are developed.

For most, planning is defined singularly; since the literature does not generally distinguish among types of strategy, nor does it usually attempt to distinguish among the processes from which it emerges. For example, McGrath (1984) defines planning as a specific type of task-related communication in which a team develops an action plan for the attainment of a given goal. According to others, groups engage in strategy

development anytime they specify procedures, delegate responsibilities, determine “temporal” order for task duties, or determine the task requirements for successful performance (Jen & Shah, 1997; Weldon, Jehn, & Pradhan, 1991). These definitions make no distinctions among different types of strategy development and put few limitations on the types of processes that may be included; in essence, any behaviors that contribute to or result in strategy may be considered components of strategy development.

However, a handful of studies have proposed that strategy development is not a single process, but rather a set of multiple, related processes. For example, both Marks et al. (In press) and Wood and Locke (1990) have proposed that there are three distinct “types” of strategy development. Despite differences in terminology, the two taxonomies share a common conceptual core and present parallel typologies of strategy development. These processes are thought to interact and often co-occur in order to develop strategies that are most appropriate for the performance environment. Although studies have provided evidence for each of the three types of strategy, this tripartite framework of strategy development has yet to be directly tested. Therefore, it is the purpose of this thesis to be the first to empirically test the tripartite framework of strategy development, which proposes that strategy emerges as the result of three primary processes: deliberate planning, contingency planning, and reactive adaptation.

Deliberate Planning

Deliberate planning refers to the development and transmission of an action plan for task performance and goal accomplishment (Marks et al., In press). Of the three, it is most consistent with the conceptualization of planning most commonly used in the

literature. Essentially, deliberate planning entails the formulation of a course of action that spans a period of time from the start of a task through to its completion. It is goal-oriented and ultimately focused on the general expectations of the performance environment.

Deliberate plans are similar to Wood and Locke's (1990) "stored universal plans." These are broad plans that are primarily motivational in nature in that they direct effort and attention towards the accomplishment of a given task or goal. They guide the basic action and coordination of a team – who does what, when, where, and why. However, they are limited in specificity; it is not focused so much on how a task is executed, but rather when and at what point it is executed. It is this qualification of generality that I choose to avoid at this point. Although it seems logical that deliberate plans may be less specific than those produced by either of the other two types of strategy development, I am reluctant to assert such a statement.

Several studies have provided evidence for the positive relationship between deliberate planning and performance (Saavedra et al., 1993; Hackman et al., 1976; Weldon et al., 1991). Put simply, teams that strategize perform better than those that do not. However, this relationship has been shown to be moderated by task complexity (Hackman et al., 1976; Wood & Locke, 1990). As the task demands increase, the need for coordination and planning among members also increases. Therefore, in order for successful performance, members must organize and coordinate their resources to accommodate.

Contingency Planning

Contingency planning refers to the development of plans or strategy adjustments in response to anticipated changes in the performance environment (Marks et al., In press). Like deliberate planning, contingency planning takes place prior to performance (Marks et al., In press). It differs, however, in its scope; whereas deliberate planning focuses on a team's general expectation of the task and the environment, contingency planning is concerned with specific, though uncertain, demands likely to be encountered during performance.

The product of contingency planning is consistent with Wood and Locke's (1990) "stored task-specific plans." These are strategies that develop in anticipation of specific environmental elements or challenges likely to be encountered during task performance. Furthermore, they are grounded in previous experience; as a team becomes more familiar with the task, it is better able to predict the types of variations and fluctuations it can expect given the performance environment. Although qualities of contingency planning are common throughout the literature, only two studies have looked at it specifically. To start, Pepitone, King, and Murphy (1988; cited in Orasanu & Salas, 1993) provided some evidence in support of the role of contingency planning in team performance.

Specifically, they found that flight teams who engaged in contingency planning made better decisions when confronted with emergencies (Pepitone et al., 1988; cited in Orasanu & Salas, 1993). The importance of contingency planning is in part determined by the nature of the task; it is posed that as the performance environment becomes more complex and dynamic, the need for contingency planning should become more evident (Marks et al., In press). For example, very simple or static task environments may not

present teams with a situation that demands anything more than the basic strategy. Therefore, in such a case, contingency planning, though probably not counterproductive, could be viewed as wasteful in that it will not contribute significantly to a team's performance (Hackman et al., 1976). But the opposite may exist also. In very complex, changing performance environments, deliberate planning may not be sufficient; some level of contingency planning may actually be required for successful performance.

Entin and Serfaty (1999) investigated contingency planning as well. They provided evidence that a group's "team coordination strategy," which entails the development of strategy in anticipation of specific changes in the situation or in the needs of fellow members, does significantly contribute to performance under high stress situations. Among naval officers, they found that teams who engaged in contingency planning exhibited superior performance on a series of Navy simulation exercises.

In sum, despite the paucity of research that distinguishes contingency planning from deliberate planning, the little evidence that does exist provides some conceptual grounding for their distinctiveness. The two differ primarily in form – whereas deliberate planning entails the development of a single plan of action that spans the task from beginning to end, contingency planning refers to the development of multiple strategies in anticipation of expected environmental fluctuations or changes. Therefore, it is expected that contingency planning is a higher-level process that should become more and more critical as task complexity increases. Overall, it is hypothesized that contingency and deliberate planning are distinct processes.

Reactive adaptation

Reactive adaptation refers to the adjustment or alteration of existing plans in response to unanticipated changes in the performance environment (Marks et al., In press). Consistent with Wood and Locke's (1990) "new task specific plans," these plans are primarily cognitive in nature and may emerge either as the adjustment of existing plans or the introduction of altogether new plans. However, they do not necessarily replace existing strategies; they may also develop in addition to active plans. As such, they tend to be very specific and concrete in nature and emerge out of the failure (or prospect of failure) of existing plans to successfully meet the challenges of the dynamic task environment.

This conceptualization diverges from traditional definitions of strategy development on multiple fronts. As with contingency planning, reactive adaptation is specific to the situation; it emerges in response to a specific demand for which neither the primary plan nor a team's contingency strategies are equipped to meet. Specifically, there are two occasions when teams might find it necessary to engage in reactive adaptation. First, inadequacies of the primary and/or contingency plans may force a team to reconsider and reconfigure the decided course of action (Marks et al., In press). Second, when teams encounter abrupt, unexpected changes in the task environment, they may be forced to adjust, amend, or even discard existing strategies for ones more appropriate to the situation (Marks et al., In press). Thus, to the extent that performance conditions are unpredictable (and thus unforeseeable), reactive adaptation becomes key to the performance and effectiveness of given tasks (Argote, 1982).

Also, reactive adaptation differs from traditional conceptualizations of strategy in that it occurs during actual performance in response to the introduction of specific, unanticipated changes or fluctuations in the performance environment as opposed to beforehand. Although the vast majority of the existing literature has focused on a priori planning, it has been suggested that strategy development may emerge during performance itself (Argote, 1982; Jehn & Shah, 1997; Meyer, 1982; Weick, 1993).

Reactive adaptation may also differ from traditional definitions of strategy development by way of the process itself. Whereas the literature most often conceives of strategy development as an amorphous, undefined process, the dynamics involved are necessarily variable among the three types of strategy development; since the three emerge in various conditions at various points in performance, it can be assumed that certain processes are unique to one and not the others. In a study of organizational adaptations to environmental jolts, Meyer (1982) poses that reactive adaptation to these jolts may be divided into three stages: perception, response, and readjustment. The first stage entails a team's perception of an environmental change; in order for a team to react to a given stimulus, it must first perceive that stimulus and interpret it as threatening. Once a team has become aware of a challenge, they may then respond. The response stage involves the development or adjustment of strategies and their implementation to aid in combating the challenge. To the extent that the response stage is successful, the team should then progress to the final stage, the readjustment phase. This phase takes place after the jolts have subsided, when the team descends from an elevated sense of urgency and emergency to a more baseline level of normalcy. Meyer (1982) suggests that teams may choose one of two routes at this point – they may either revert back to

their original plans or implement new or adjusted plans for the completion of the team task.

As with contingency planning, reactive adaptation has received considerably less empirical investigation than has deliberate planning. In fact, only two studies have directly tested the role of reactive adaptation in team performance. Argote (1982) was the first to view “in-process” planning independently of other strategy development. She distinguished between “programmed” coordination, which is consistent with the traditional pre-performance planning process, and nonprogrammed coordination, which involves “on-the-spot sharing of information among organization members” (Argote, 1982; p. 424) to combat increased demands associated with increased uncertainty. Nonprogrammed coordination is consistent with the conceptualization of reactive adaptation as it is used in this study. With a sample consisting of hospital emergency units, she posed that reactive adaptation becomes increasingly more critical as the level of environmental uncertainty rises; as it becomes more difficult for a team to predict the task environment and develop appropriate strategies beforehand, their reliance on nonprogrammed coordination is increased. Consistent with her hypotheses, Argote found evidence that in-process planning enhances performance on tasks high in uncertainty.

Building on Argote’s work, Jehn and Shah (1997) have recently revisited the concept of in-process planning. Among friendship groups, they investigated the impact of explicit in-process planning on the performance of various problem-solving and motor-skill tasks. Contrary to Argote’s study, no significant relationship between in-process planning and performance emerged. Whereas it was hypothesized that in-process planning should enhance performance, no such relationship was found. The authors note

that this might be due to the lack of uncertainty in the task environment. Although the tasks were moderately complex, the levels of uncertainty were not sufficient to yield significant results.

In summary, there is conceptual grounding for the independence of reactive adaptation, deliberate planning, and contingency planning. Although not a formal hypothesis, this thesis will attempt to provide empirical evidence for the uniqueness of the three processes, further investigating specific dimensions on which the three are thought to differ. The following sections will explore differences on two primary dimensions: task type as moderator of the planning/performance relationship and the temporal relationship among the three.

Task Complexity

Numerous studies have suggested that the impact of strategy and strategy development on team performance is moderated by the complexity of the task (Argote 1982; Entin & Serfaty, 1999; Hackman et al., 1976; Jehn & Shah, 1997; Saavedra et al., 1993; Weldon & Weingart, 1993; Weldon et al., 1991; Wood & Locke, 1990). According to Wood and Locke (1990), strategy development is not integral to the performance of simple tasks. They suggest, instead, that it is when task complexity increases that there arises a need for greater coordination and planning among teams. To the extent that the environment is such that a team's implicit strategy is optimal for performance, then strategy will contribute very little to performance (Hackman et al., 1976). That is, for tasks where the optimal plan is either obvious or for which there is only one course of action, engagement in strategy development will be wasteful in that it will not produce a superior mode of task execution. Therefore, strategy development will

only contribute to performance on those tasks for which members' implicit strategies are not optimal for performance.

A further distinction must be made, however. Although all three types of strategy development are thought to be moderated by task complexity, this relationship varies among the three. Deliberate planning, contingency planning, and reactive adaptation are thought to operate at different levels of complexity. It is proposed that the three function hierarchically, building off the previous to accommodate increasingly more complex and demanding environments. This is consistent with much of the literature. According to Wood and Locke (1990), contingency planning and reactive adaptation become critical in particular task environments. Specifically, they propose that contingency planning will emerge in coordinatively complex cognitive tasks which require the conscious employment of a priori alternative strategies to match the demands of the task. Although some studies have provided evidence for the role of contingency strategies in the performance of complex tasks (Entin & Serfaty, 1999; Pepitone et al., 1988), no one has directly tested the hypothesized moderated relationship.

Wood and Locke (1990) also proposed that reactive adaptation should become increasingly critical for tasks with high "dynamic complexity." Dynamic complexity is defined by uncertainty and variability in the performance environment; therefore, reactive adaptation should become more critical as the demands and outcomes of a task become less predictable or certain. Again, no direct test of moderation has been conducted to date. However, the two primary studies that have investigated reactive adaptation have provided some justification for the hypothesis; whereas Argote (1982) found a strong positive effect between reactive adaptation and performance on tasks high in uncertainty,

Jehn and Shah (1997) failed to find such an effect for tasks lacking uncertainty.

Therefore, there is some basis for the hypothesis that reactive adaptation is moderated task uncertainty.

Hypothesis 1: Strategy development will moderate the relationship between environmental complexity and performance, such that in complex situations strategy development will be positively related to performance and in less complex situations strategy development will be unrelated to performance.

Strategic Phases

In discussing deliberate planning, contingency planning, and reactive adaptation, a further distinction should be made as to the sequence and occurrence of each. Not only do the three differ conceptually, they also differ temporally. Several studies have asserted the functional importance of time in team processes and performance (Gersick & Hackman, 1990; Marks et al., In press; McGrath, 1991). Though there is a dearth of empirical studies that have explored the team process/performance relationship, it is thought that teams operate according to a multi-phasic performance cycle. That is, teams function episodically, performing given tasks and engaging in various processes at specific times throughout the performance period (Marks et al., In press).

According to McGrath's (1991) theory of time, interaction, and performance (TIP), teams simultaneously manage multiple bundles of activities over time. More importantly, however, he asserts that particular bundles of activities are "matched" to particular times throughout the performance period (McGrath, 1991). In other words, teams engage in specific activities during particular intervals of time. Marks et al. (In press) has taken McGrath's TIP theory a step further yet. Their recurring phase model

proposes that teams operate according to alternating performance episodes. These include both action phases, which are periods of engagement that contribute directly to goal accomplishment, and transition phases, which are periods focused on evaluation and/or planning activities that will guide the action phase (Marks et al., In press). It is, therefore, the interaction of the activities and processes that occur within these alternating phases that facilitate team performance and goal attainment.

This provides for an important distinction among the three types of strategy development - that is, they likely operate during various phases throughout the performance period. As noted previously, not all strategy development takes place prior to performance. Whereas deliberate and contingency planning occur during transition phases, reactive adaptation occurs during the action phases of actual performance. To illustrate, let's consider the scenario of a B-2 Bomber flight team. In this context, all three types of strategy development and their temporal relationships with one another and the task may be easily identifiable. For instance, deliberate planning would likely consist of an explicit pre-flight strategy session from which a general flight plan would be derived, noting waypoint markers, enemy lines, drop zones, and return route. Usually (though not necessarily) occurring simultaneously, the team would also engage in contingency planning, developing multiple strategies for implementation in the event of specific, foreseeable fluctuations in the performance environment; for example, the team would likely formulate plans to specifically outline a course of action should they or their escort be damaged or destroyed by enemy fire from the ground. However, not all environmental fluctuations are foreseeable or expected. In some cases, a team may be confronted with a situation in flight for which they have made neither plans nor

preparation. As such, a team may be forced to amend existing strategy or to produce altogether new plans in order to accommodate a given situation; i.e., they must engage in reactive adaptation in order to adjust to the emerging environmental demands.

As illustrated by the scenario, the three types of planning do operate temporally independent of one another; whereas deliberate and contingency planning are exclusive to transition phases of team performance, reactive adaptation is limited to action phases.

Hypothesis 2a: Deliberate planning occurs exclusively during transition phases of team performance.

Hypothesis 2b: Contingency planning occurs exclusively during transition phases of team performance.

Hypothesis 2c: Reactive adaptation occurs exclusively during action phases of team performance.

CHAPTER II

METHOD

Participants

A total of 132 undergraduate students enrolled in Psychology courses at a large Southeastern university were recruited for participation. Approximately 34% of participants were male. In keeping with the unique demographic composition of the university, approximately 73% of participants were Hispanic, 11% White, and 9% African American. In exchange for their involvement, participants received either class credit or extra credit toward their course grade. All participants were assigned to 2-member F-14 flight teams (66 in total) according to their availability. This number of teams was chosen using the “G-Power” power-analysis computer program, with $\alpha = .05$,

Power = .8, and ES = .15 ($f^2 = .1764$) for detection of medium effect sizes. This is a conservative estimate of power, as each team yielded three performance data points (thereby tripling N), thus further strengthening the power of the tests conducted.

Participants were assigned to one of two positions within each flight team (pilot and weapons specialist) according to performance scores on one- and two-hand psychomotor tests.

Experimental Design

This study employed a within-subjects design. A laboratory paradigm was used to manipulate the variable of interest, which consisted of three levels of environmental complexity (low, medium, and high). All participants were trained for basic positional proficiency and performed three different experimental missions which were counterbalanced to control for any ordering effects. Prior to each performance mission, teams engaged in a 10-minute videotaped mission planning session. Following the planning session, the mission commander was interviewed and asked to provide a synopsis of the team's strategy and reasoning. The dependent measures consisted of quantitative indices of team performance.

Laboratory Design

A pair of two-person teams engaged in a low-fidelity air war simulation. Each team functioned as a separate combat aircrew, with one designated as the air-to-air flight team and the other designated as the air-to-ground flight team. Although each team possessed identical capabilities, the duties and responsibilities of each team varied slightly. The two teams were linked both electronically and by task requirements but yielded team-level performance data for analysis.

Based on Casner's (1994) work on the task requirements of maintaining an aircraft in flight, a team of USAF instructor pilots and SME judges divided basic mission task responsibilities between the pilot and weapons specialist roles. This division and allocation of task duties between the two positions reflect the basic requirements of flight and navigation, as well as the fostering of a minimal level interdependency necessary for mission performance.

Both individuals in a team had access to their own monitor, each of which displayed identical information. Connected headsets were the team's sole source of communication between its own members as well as the members of any other accompanying team.

Apparatus

This study used a PC-based F-22 flight simulator in which teams are required to navigate, pilot, target, and destroy a series of enemy targets. Although designed for single-player use, the display was split between two monitors so as to provide for two positions – pilot and weapons specialist. Task duties and responsibilities were divided and allocated between the two positions such that each had specific, unique task responsibilities that prevent any one member from successfully completing the task without the input and effort of the other position.

Software: Simulation

This study used a low fidelity PC-based air-combat simulator, F-22 Total Air War (TAW; Digital Image Design Limited, 1998), to create the necessary experimental conditions needed for the research parameters. The aircraft and weapons capabilities are based on the capabilities and limitations of the functional F-22 aircraft as described by

the USAF in the open press. This particular simulation was chosen for this study for a number of reasons. To begin, the simulation provides for a selection of quantified, real-time performance indexes that add to the accuracy and functionality of teams throughout performance. Also, on any given flight, a team may encounter any number of allied, enemy, or neutral crafts, thereby restricting the video gaming strategies that entail the attack and destruction of all entities encountered during performance. Most importantly, TAW provides a task that lends itself well to team and multi-team observation and performance. With the aid of the Air Defense Fighter Graphic User Interface Editor (AGE), version 2.14 (Independent Mercenary Corps.), it is possible to design intricate manipulations of numerous team and multi-team level variables such as interdependence, environmental complexity, and difficulty, among others. Furthermore, by allowing for the scripting of missions, it ensures control over the environmental conditions under which teams will be performing. All programmed missions have undergone extensive trials with research assistants and participant volunteers to ensure their quality and suitability for the study. Any and all flaws or inconsistencies in the programs were immediately corrected and tested.

Programmed missions were specifically designed to be playable by novice teams in a fifteen-minute time period. One training mission and three experimental missions were designed and tested. These three performance missions vary as a function of the study's manipulation – environmental complexity.

Over 100 types of targets and 16 different countries could be scripted into any single mission. Missions were scripted to include a number of friendly ground and air units to discourage any participant's urge to seek and destroy all targets.

Hardware: Computers and Accessories

The F-22 TAW software operated on networked Pentium II 300 MHz computers. As discussed previously, a video-splitter was used to transmit the display of a single CPU to two separate monitors, one for each position (pilot and weapons specialist). Each participant had a 19" SVGA monitor to view the screen display.

The pilot used a mounted Thrustmaster F-22 joystick and F-16 Throttle Quadrant System to control the flight of the aircraft. The joystick was programmed such that the pilot may not only fly the aircraft, but also change cockpit views, fire weapons, and activate air brakes. The throttle allows the pilot to control the speed of the simulated F-22. The weapons specialist used a standard PS2-style keyboard to perform his or her tasks and duties. Color-coded labels were used to identify and highlight relevant keys.

Hardware: Audio

Each participant had a microphone-equipped headset through which they could communicate with his or her fellow team member, as well as with members of the other flight team. Other audio sounds embedded in the simulation, such as combat sounds and audio prompts and status reports, are presented in stereo via the headsets. Participants were not able to eliminate background noise from the headsets. They were instructed to conduct all conversations during the performance missions via the headsets, thus providing for the recording of all audio for future analysis. The weapons specialist retained control over the types of communication, whether within or between teams, by activating a switch on a control box that connects the two teams; when the switch was turned "on," both teams could communicate simultaneously.

Hardware: Data Recording

Both audio and visual displays for each team were recorded on separate VHS VCRs. Also, the Air Combat Maneuvers Instrumentation (ACMI) feature creates a digital recording of each team's flight path and actions for each mission, including events such as the firing of weapons and the number of targets hit or destroyed. Furthermore, ACMI files may be displayed from several different perspectives (e.g., cockpit view, satellite view), therefore making them ideal for scoring collective team performance following each mission.

Procedure

This study entailed the assessment, training, and eventual engagement of two-member teams in a low-fidelity F-22 air war combat simulator. The experiment lasted approximately five hours and consisted of six primary phases. These phases are as follows: (1) premeasures, (2) pre-training assessment, (3) task training, (4) practice mission, (5) pre-mission planning and (6) mission engagement.

Premeasure Session. The first phase, the premeasure session, lasted approximately one hour. In this period, participants completed a battery of measures and two psychomotor tests. The battery of surveys included measures of KSAOs, biographical data, and demographic information. The psychomotor tests, developed by USAF researchers and adapted from the USAF's Basic Attributes Tester, assessed a participant's one- and two-hand visual tracking ability. Participant scores were used to designate pilots and mission commanders among the participants.

Pre-training Assessment. During the second phase, the pre-training assessment, participants were assigned to one of the two positions (pilot or weapons specialist) on one

of the two teams (air-to-air or air-to-ground). The two scoring highest on the psychomotor tests were designated as pilots, the higher having been assigned to the air-to-air team and the lower to the air-to-ground team. The air-to-air pilot was designated as mission leader. The two lowest scorers on the psychomotor tests were designated weapons specialist, the higher of the two assigned to the air-to-air team with the lower assigned to the air-to-ground team. Participants were allocated using this procedure because the position of pilot requires greater gaming knowledge and skill than the weapons position. Furthermore, higher scorers were assigned to the air-to-air teams because it is slightly more difficult in that their targets are moving and capable of dodging missiles; the tasks of the two teams are otherwise equivalent.

Task Training. Once assigned to their respective roles, participants received 30 minutes of basic task training. This training consisted of hands-on instruction, demonstration, and practice on the simulator and was conducted by a trained SME. Training focused on the key tasks and duties of each position to ensure positional task proficiency of all participants (see Appendix A).

This training contained built-in competency checks that allowed instructors to assess a participant's proficiency on a given set of skills and make a determination as to their competency in each area. Providing that the participant demonstrated the requisite skills necessary for task performance, he or she continued on to the experiment. Any apparent deficits were immediately addressed by the trainer and appropriate steps were taken to remedy any deficiencies, including additional training or, in extreme cases, the discontinuation of the experimental session. Following task training, teams watched a twenty-minute video of the task at hand and a short demonstration of the flight missions.

Practice Mission. Upon completion of the task training, teams engaged in a single practice mission. This mission incorporated much of the skill and teamwork requirements necessary for the successful completion of the experimental missions. The session began with a 10-minute planning period during which teams were provided their specific mission objectives, intelligence information, and a map of their assigned flight route. Pictures identifying the various vehicles and aircraft likely to be encountered were posted at each station for reference.

Pre-Mission Planning Session. The fourth phase, pre-mission planning, consisted of an in-basket exercise and 10-minute mission planning session. During this time, teams were given a variety of relevant information (e.g., flight maps, briefings, situation reports; see Appendix B), as well as irrelevant information (e.g., unrelated intelligence reports, media descriptions of F-22). Teams were given ten minutes to develop their mission strategy, prioritize their goals and objectives, and refine their roles and responsibilities. At the end of the ten minutes, the mission commander was interviewed and asked to provide a synopsis of the team's strategy and the reasoning behind it. A planning session preceded each of the three performance missions.

Mission Engagement. Following the planning session, participants engaged in three combat missions (a planning session preceded each). Teams were allowed to take important reference tools (provided in planning) with them to aid in performance of the actual performance missions. Each mission lasted approximately 15 minutes or until both aircraft were destroyed. The three missions differed in complexity (high, medium, and low) and were counterbalanced to control for ordering effects. When a mission was completed, teams were debriefed and provided feedback as to their performance score.

Manipulations

Task Complexity: Teams performed three 15-minute combat missions of varying complexity (i.e., low, medium, high). According to Wood (1986), task complexity is composed of three primary components: component complexity, coordinative complexity, and dynamic complexity. Since the missions differ only minutely in the types of actions and behaviors required to perform, there is little difference in levels of component complexity from one mission to another. However, there is notable variation among missions on both coordinative and dynamic complexity.

Coordinative complexity refers to “the nature of the relationships between task inputs and task products;” this includes the timing, frequency, intensity, and location requirements necessary to perform specific tasks (Wood, 1986). In this respect, the missions vary significantly. Specifically, enemies are positioned and clustered around one another in order to vary the level of intensity among missions. For example, in less complex missions enemies are spread more sparsely throughout the mission with air and ground enemies rarely operating within the same combat area, whereas in more complex missions both air and ground enemies may be clustered together in a fairly small combat area. Also, these enemies may vary in their aggressiveness and skill; in less complex missions enemies will not typically engage the participant until the participant first engages them, whereas in complex missions enemies typically engage the participants from the outset of the mission. To illustrate, all three missions included a total of 13 ground threats and 10 air threats. They were distributed as follows:

For the least complex mission, the air and ground threats were distributed along entirely different flight paths, significantly reducing the probability that a team

would encounter both types of enemies; that is, the air-to-air team typically encountered only air threats, whereas the air-to-ground team typically encountered only ground threats.

For the medium-level complexity mission, the air and ground threats were distributed along flight paths that converged only past the middle of the mission, thus reducing the likelihood that a team would encounter both types of enemies in the first half of the mission. Also, the mission consisted of mountainous terrain that reduced the distance from which a team could detect enemies, thereby forcing teams to engage in combat in closer proximity to enemy targets and, as a result, making them more vulnerable to enemy fire.

For the most complex mission, the air and ground threats were distributed along nearly identical flight paths, significantly enhancing the probability that a team would encounter both types of enemies throughout the entire span of the mission. Like the medium complexity mission, this mission also included mountainous terrain with numerous canyons and valleys that further shrunk the distance from which a team could target an enemy. Furthermore, this mission included more aggressive enemies clustered together in smaller combat areas.

These same manipulations also contributed to the dynamic complexity of the task, which refers to “changes in the states of the world which have an effect on the relationships between task inputs and products” (Wood, 1986). The variations in placement and intensity of enemies introduce an increasingly dynamic task environment, with more numerous and more aggressive enemies presented earlier in the mission, thus

requiring (as is hypothesized) greater adjustments among teams insofar as tactics and strategy to successfully meet the demands of mission performance.

The manipulation check consisted of two questions that asked participants to identify the “least difficult” mission and the “most difficult” mission. To test whether participants accurately identified the least complex and most complex missions, a Chi Square analysis was conducted to test the proportion of accurate responses to each of the two questions. The results of the first test (less complex) were significant, $\chi^2(2, N=132)=23.36, p<.00$, with 57.3% of participants accurately identifying the least complex mission. However, the results of the second test (most complex) were not significant, $\chi^2(2, N=132)=3.05, p=.22$, with 38.6% of participants accurately identifying the “most complex” mission, with an additional 34.6% identifying the “medium complexity” mission as the most difficult. This shows that participants had difficulty making distinctions between the “medium” and “high” complexity missions.

Measures

Performance. Team performance were measured by the tabulation of points based on a team’s fulfillment of three primary objectives. These objectives are as follows:

1. Survival of self and other allied flight teams
2. Destruction of designated targets while preserving friendly and neutral targets
3. Destruction of designated bonus targets

Following each mission, the experimenter recorded a total score as well as a summary of performance on each of the three objectives. The summary score was used in the analysis of hypotheses because it was a better estimate of general team performance on the task as

a whole; noting the low fidelity of the simulation, facet performance provides little insight as to the generalization of the research findings to other dissimilar tasks.

Deliberate Planning. Subject matter experts were used to rate both the quality and quantity of deliberate planning, which was operationalized as any a priori planning behavior that is aimed at the development of a general plan of action. SMEs were trained to identify instances of deliberate planning; examples of deliberate planning would include the development of a general flight plan or the coordination of timing and location guidelines. They rated quality on a five-point scale, ranging from “high skill” to “little or no skill,” and quantity on a dichotomous scale, noting that the process either “occurred” or “did not occur” (see Appendix C).

Contingency Planning. Contingency planning was operationalized as any a priori planning that is aimed at developing multiple courses of action given the introduction of specific, anticipated events into the performance environment. SMEs were trained to identify instances of contingency planning; examples of contingency planning would include the development of back-up plans for any number of scenarios such as running out of weapons or incurring damaged. They rated quality on a five-point scale, ranging from “high skill” to “little or no skill,” and quantity on a dichotomous scale, noting that the process either “occurred” or “did not occur” (see Appendix C).

Reactive Adaptation. Reactive adaptation was operationalized as any in-process planning that is aimed at developing specific courses of action in order to confront specific, unanticipated changes or fluctuations in the performance environment. SMEs were trained to identify instances of reactive adaptation; examples of reactive adaptation include making impromptu adjustments to circumvent engine failure. They rated quality

on a five-point scale, ranging from “high skill” to “little or no skill,” and quantity on a dichotomous scale noting that the process either “occurred” or “did not occur” (see Appendix C).

CHAPTER III

RESULTS

Prior to testing the hypotheses, descriptive statistics were computed and initial correlational analyses were conducted to assess the relationship among key variables and identify possible covariates. Descriptive statistics, an inter-correlation matrix of key study variables, and a correlation matrix of possible covariates are presented in Tables 1 through 3, respectively. This initial examination of the variables yielded many important insights in to the relationships among the several variables included in the study. To begin, deliberate planning during transition phases was significantly correlated with contingency planning during transition phases ($r = .45, p < .01$) and reactive adaptation during action phases ($r = .15, p < .05$). This finding is important for two reasons: first, it shows that teams that strategize well typically do so consistently at both stages of performance. Second, the correlations between deliberate planning and the other two processes are moderate enough to provide discriminant evidence for their uniqueness and distinctiveness as separate processes. Contingency planning during transition phases and reactive adaptation during action phases were not significantly correlated ($r = -.00, p = .95$). However, deliberate planning and contingency planning during action phases were significantly correlated ($r = .18, p = .01$), thereby providing further support for the relationship and distinctiveness of the strategy variables.

Team performance and complexity were significantly and negatively correlated ($r = -.18$, $p = .01$); that is, performance decreased as task complexity increased. However, none of the three types of strategy development was found to be significantly correlated with either team performance or task complexity. This is most likely due to the nature of the task itself. First, it may be that the difficulty of the task is such that the required skill needed to perform even the least complex mission exceeded that which could be adequately trained during the training and practice sessions. Therefore, the knowledge and skill necessary to anticipate the performance environment and develop appropriate plans may not have been realized by most teams. Were a similar study conducted either providing increased training on the task at hand or using a more familiar, less difficult task, it is possible that a significant relationship might be found.

The order in which a mission was delivered (i.e., first, second, or third) was found to be significantly related with contingency planning during transition phases ($r = -.18$, $p = .01$). This suggests that teams typically show greater skill in developing contingency plans on the second or third mission as opposed to the first, regardless of complexity. Of course, it seems logical that as teams become more familiar with the task at hand, they would be better able to anticipate the possible problems or environmental changes they may likely encounter during performance, thereby allowing them to formulate contingency plans with greater skill and improved accuracy.

Since slight differences existed in the tasks of air-to-air and air-to-ground combat teams, a t-test for independent samples was conducted to assess differences between the scores of the two types of teams. Significant differences were found between the mean performance scores, $t(196)=2.71$, $p<.01$, with air-to-air teams typically scoring higher

($\underline{M}$ =33.64, $\underline{SD}$ =34.34) than air-to-ground teams ($\underline{M}$ =22.07, $\underline{SD}$ =25.07). This finding is most likely the result of the method of assignment of participants to positions among teams; since both the pilot and wis0 scored higher on the spatial ability measure than did their respective counterparts on the air-to-ground teams, it is not surprising that the air-to-air teams would possess the necessary skill to perform better, even despite the slightly more difficult nature of their assignment.

The initial analysis revealed several relationships among key variables and possible covariates that should be addressed prior to discussing the two primary hypotheses. Most notably, gender composition and simulation experience were found to be significant predictors of performance. Gender composition of the teams was significantly correlated with performance ($\underline{r} = -.20$, $p < .01$), as well as deliberate planning and contingency planning during transition phases ($\underline{r} = -.21$, $p < .01$ and $\underline{r} = -.16$, $p < .03$, respectively); that is, as the number of males on a team increased (zero, one, or two), the team typically performed better overall and showed greater skill in the development of deliberate and contingency plans during transition periods. The potential roles of gender composition in the relationship between the three types of strategy and performance were further explored. A series of moderator regression analyses were conducted to investigate the possible role of gender composition as a moderator of the relationship between the three types of strategy development and team performance. No significant interaction was found between any of the three types of strategy development and gender composition in their predictions of team performance.

Previous experience in video gaming and computer simulations was also significantly correlated with the quality of team strategy development. Specifically, pilot

experience on computer simulations and videogames was significantly correlated with deliberate planning during transition phases ($r = .29, p < .01$) and wiso experience was significantly correlated with both deliberate planning and contingency planning during transition phases ($r = .16, p < .03$ and $r = .17, p = .02$, respectively). Of course, it is further expected that simulation experience and gender composition would be highly related to one another. To test this, an averaged composite of simulation experience for the pilot and wiso was computed and a correlational analysis was conducted to assess the relationship between simulation experience and gender composition. As would be expected gender composition and simulation experience were significantly correlated ($r = -.23, p < .01$). That is, the level of simulation experience reported by a team typically increases with the number of males on the team. Since there was no significant relationship between simulation experience and performance, no further supplemental analyses were conducted to test for its potential moderation between any of the planning processes or gender composition with team performance.

Hypothesis 1

Hypothesis 1 states that environmental complexity will moderate the relationship between strategy development and performance, such that in complex situations strategy development will be positively related to performance and in less complex situations strategy development will be unrelated to performance. To test this hypothesis a series of three moderator regression analyses were conducted, one with each of the three proposed types of strategy development. In view of support for hypothesis 2, which will be discussed later in detail, analyses were conducted with the following variables: deliberate planning during transition phases, contingency planning during transition phases and

reactive adaptation during action phases of team performance. Results of these analyses are presented in Tables 4, 5, and 6.

To test the relationship between deliberate planning and task complexity in their prediction of team performance, the results indicated that deliberate planning and complexity did account for a significant amount of the variability in the performance indices ($R^2 = .03$, $F(2,195) = 3.45$, $p = .03$). However, in reviewing the regression coefficients for the two variables, only complexity was shown to be a significant predictor of performance ($\beta = -2.48$, $t = -2.48$, $p = .01$). The interaction statement entered in step 2 was not significant (R^2 change = .00, $F(1,194) = .020$, $p = .89$). Thus, there is no evidence that complexity moderates the relationship between deliberate planning and performance.

To test the relationship between contingency planning and task complexity in their prediction of team performance, the results indicated that contingency planning and complexity did account for a significant amount of the variability in the performance indices ($R^2 = .03$, $F(2,195) = 3.40$, $p < .04$). However, in reviewing the regression coefficients for the two variables, only complexity was shown to be a significant predictor of performance ($\beta = -.17$, $t = -2.45$, $p = .02$). The interaction statement entered in step 2 was not significant (R^2 change = .01, $F(1,194) = 2.46$, $p = .12$). Thus, there is no evidence that complexity moderates the relationship between contingency planning and performance.

To test the relationship between reactive adaptation and task complexity in their prediction of team performance, the results indicated that reactive adaptation and complexity did account for a significant amount of the variability in the performance

indices ($R^2 = .04$, $F(2,195) = 3.80$, $p = .02$). Again, in reviewing the regression coefficients for the two variables, only complexity was shown to be a significant predictor of performance ($\beta = -.18$, $t = -2.51$, $p = .01$). The interaction statement entered in step 2 was not significant (R^2 change = .00, $F(1,194) = .21$, $p = .65$). Thus, there is no evidence that complexity moderates the relationship between reactive adaptation and performance.

Overall, the results have failed to provide any significant support for the stated hypothesis; that is, complexity was not found to be a moderator of the relationship between strategy development and team performance. What's more, contrary to findings of previous studies (Hackman et al., 1976; Hackman & Morris, 1975; Jehn & Shah, 1997; Saavedra et al., 1993; Yetton & Bottger, 1982), strategy development was not found to be a significant predictor of team performance, at least not as conceptualized in the framework presented herein. In order to address the overall utility of strategy development as a predictor of performance, the three types of strategy were combined to yield an additive composite of team strategy development. A correlational analysis was conducted between the strategy composite and performance, but provided no evidence of a significant relationship between strategy and team performance ($r = -.05$, $p = .48$).

Hypothesis 2

To test Hypothesis 2a, 2b, and 2c, a series of three two-sample chi-square tests were conducted. Hypothesis 2a states that deliberate planning occurs exclusively during transition phases of team performance. In order to test this hypothesis, a two-sample chi-square test was performed between performance phase (i.e., transition, action) and occurrence of deliberate planning (i.e., occurred, did not occur). The results of the test

were significant ($\chi^2(1, N=396)=78.82, p<.01$) with deliberate planning occurring in transition phases 50.5% of the time, versus only 9.5% in action phases. Therefore, performance phase and deliberate planning were found to be significantly related, thereby providing support for the hypothesis that deliberate planning occurs, if not exclusively, at least significantly more frequently during transition phases of team performance than during action phases.

Hypothesis 2b states that contingency planning occurs exclusively during transition phases of team performance. In order to test this hypothesis, a two-sample chi-square test was performed between performance phase (i.e., transition, action) and occurrence of contingency planning (i.e., occurred, did not occur). The results of the test were significant ($\chi^2(1, N=396)=16.46, p<.01$) with contingency planning occurring in transition phases 13.6% of the time, versus only 2.5% in action phases. Therefore, performance phase and contingency planning were found to be significantly related, thereby providing support for the hypothesis that contingency planning occurs, if not exclusively, at least significantly more frequently during transition phases of team performance than during action phases.

Hypothesis 2c states that reactive adaptation occurs exclusively during action phases of team performance. In order to test this hypothesis, a two-sample chi-square test was performed between performance phase (i.e., transition, action) and occurrence of reactive adaptation (i.e., occurred, did not occur). The results of the test were significant ($\chi^2(1, N=396)=49.50, p<.01$) with reactive adaptation never occurring during transition phases, versus occurring 22.2% of the time during action phases. Therefore, performance phase and reactive adaptation were found to be significantly related, thereby providing

support for the hypothesis that reactive adaptation occurs exclusively during action phases of team performance.

CHAPTER IV

DISCUSSION

Summary of Findings

The results of this study provided mixed findings. Correlational analyses provided discriminant evidence for the uniqueness of the three processes in their relationships with one another and with other variables. Furthermore, support was found for hypothesis 2, providing evidence that the three processes occur primarily during specific periods of team performance. However, contrary to the existing literature, complexity was not found to be a moderator of the relationship between strategy development and team performance. In fact, strategy development was not found to be significantly correlated with team performance.

Complexity as a Moderator of Strategy Development and Team Performance

Contrary to the existing literature, this study provided no evidence in support of the hypothesized role of task complexity as a moderator of the strategy development and team performance relationship. The failure of this study to find evidence for this relationship could be the result of several factors. To begin, none of the three types of strategy development (either individually or together as a composite) were significantly correlated with performance. This makes it unlikely that the interaction between planning and complexity in their joint prediction of performance would be significant either; that is, since strategy development accounts for a non-significant portion of the

variability of performance scores when taken alone, the amount of “shared” variance between it and complexity would logically be non-significant as well.

This prompts another question - why did this study fail to replicate previous findings of a significant relationship between strategy development and team performance? It may be due to the nature of the task itself. First, it may be that the difficulty of the task was such that participants lacked the skill or adequate training necessary to successfully develop appropriate plans that would contribute to the successful performance of the task. Therefore, had the task been less difficult or had additional time been allocated for further training, it is possible that teams may have shown greater skill and improved success in their development and implementation of appropriate strategy.

Furthermore, since multiple teams performed simultaneously within a shared performance environment, interacting and coordinating efforts to meet combined goals, it is possible that the more significant planning activities occurred at the multi-team level rather than the team level. It is conceivable that a stronger relationship may exist among the variables at the multi-team level. Being that the literature on multi-team process is relatively young and yet undefined, little is known about the relationship between team and multi-team processes, specifically, planning activities; therefore, future studies should investigate the relationship between planning processes at the team and multi-team levels in their prediction of performance.

The complexity manipulation may also be a contributing factor to the lack of significant results. Although complexity and team performance were significantly correlated, this relationship was not as strong as would be expected. This, again, may be

due to the general difficulty of the task. There are incremental differences in the complexity elements of the “medium” and “high” complexity missions. However, according to the manipulation check, participants exhibited an inability to distinguish between the complexity of these two missions. Therefore, it is possible that the incremental differences were not adequate to fully capture differences in team skill and performance on those two missions, thereby truncating the variability of performance from one to the other. If this were the case, the complexity manipulation would essentially be rendered a dichotomy with two levels of complexity rather than three, and the resulting analysis would be considerably less robust, thus accounting for the rather weak relationship with performance. To test this, the complexity variable was dichotomized and a supplemental correlational analysis was conducted between the dichotomized complexity variable and performance; the results were non-significant.

There are also criticisms of the moderator regression analysis procedures typically used in testing for moderator effects. This study used the regression procedure outlined in Baron and Kenny’s (1986) landmark article on moderator and mediator analysis. However, despite its popularity and widespread use, it is not without its critics. Several researchers (Aguinis & Stone-Romero, 1997; Cronbach, 1987; Cortina, 1993; Stone & Hollenbeck, 1989) have identified various shortcomings in the use of multiple regression in the testing for moderation effects, including issues such as nonlinearity, multicollinearity, and statistical power. According to critics, multiple regression is frequently unsuccessful in detecting hypothesized moderator effects (Cronbach, 1987). It is thought that multiple regression frequently underestimates interaction effects among variables, thus failing to detect hypothesized interactions that may truly exist. Although

this is always a concern in the use of moderator regression analysis, it is not thought to have played a significant factor in the failure of this study to provide support for the role of complexity as a moderator of the relationship between strategy development and performance. The sample size for this study well exceeded the size necessary to detect even a small interaction effect among the variables; therefore, it is unlikely that the non-significant results for this hypothesis are due to the statistical procedures used to test for moderation.

Strategy Development in Transition and Action Phases

The results of this study provided evidence for the hypothesis that different types of strategy development occur during different phases of team performance. Specifically, it was found that deliberate and contingency planning occur primarily in transition phases, whereas reactive adaptation occurs primarily in action phases. This finding is important for two reasons. First, it provides evidence for the distinctiveness of the three types of planning, thus supplying credence to the proposed tripartite framework of strategy development presented in the current thesis.

Second, it provides increased insight into the strategy development process itself. This is the first study to observe and assess the occurrence of strategy development throughout the performance period, including both transition and action phases. It is important because it provides greater understanding of how and when teams strategize, providing evidence that strategy development is an on-going process (or set of processes) that spans a team's performance of the entire task, not merely transition periods prior to task engagement. The potential contribution of this finding is notable. Future studies that further explore the timing of various types of strategy development promise to

provide fruitful insight into how team strategy development impacts performance or other key outcome variables. By better understanding when teams engage in different types of planning activities, it is possible to better design and develop training to enhance a team's effectiveness in the development of strategy, as well as its transfer to task performance.

Implications for Future Research

The results of this thesis have several implications for future study into the team strategy development process. Perhaps most significantly, the present study provided some initial evidence in support of the tripartite framework of strategy development presented herein. The relationships among the three planning processes (deliberate planning, contingency planning, and reactive adaptation) with themselves and other key variables provided discriminant evidence for their distinctiveness and individuality. This taxonomy represents an important shift in the research of team strategy development - it represents a departure away from a single global dimension to a multi-faceted framework of strategy development. Therefore, future research should continue to explore the multi-faceted nature of team planning activities and how these distinct processes may contribute differentially to performance in various settings.

This thesis also acts as the first study to directly explore the occurrence of team strategy development throughout task performance, including both transition and action phases. According to Zaheer, Albert, and Zaheer (1999), temporally based theory is quite rare in organizational research. However, the inclusion and consideration of time scales in research promises to make significant contributions to new and existing theories for any variety of organizational phenomena (Zaheer et al., 1999). It is for this reason that the present thesis is significant. The finding that different types of planning activities occur

during different periods of team performance is a very important finding; it provides greater insight into how and when teams plan, thereby elevating research to a new level of specificity previously lacking in the bulk of the team strategy literature. Future studies should continue to look at how different types of planning at different stages of performance directly impact team performance. Given this focus, we may begin to unearth a wealth of knowledge regarding the impact of strategy development on team performance as well as other key factors, thereby making it possible to design training that could vastly improve the planning activities of teams on numerous tasks in a variety of settings.

The lack of support for the role of task complexity as a moderator of the relationship between strategy development and performance runs contrary to the few studies that have directly tested this relationship previously. Although limited, the existing literature has provided evidence for the moderating role of complexity in the planning/performance relationship (Hackman et al., 1976; Wood & Locke, 1990). This finding brings into question the true nature of the relationship and merits further investigation. Future studies should attempt to further explore this relationship, preferably with in tact real-world teams in applied settings.

Limitations

This thesis was conducted in a laboratory setting using a low-fidelity F-22 combat flight simulator. As with any laboratory experiment, there are issues of external validity to be considered. First, this experiment used ad hoc teams with a total lifespan of only five hours, two of which were spent performing the actual task. As such, these teams are not representative of existing teams with a long history of performance; instead, they

likely represent the performance of teams in the initial stages of formation and development. For this reason, it is difficult to generalize these findings from the lab setting to applied settings such as organizations. Therefore, until researchers move the study of team strategy development from the laboratory to the applied settings, the external validity of this study, like most of its predecessors, will remain unknown.

As noted previously, the simulation used in the current study may have been too difficult to adequately elicit the development of appropriate strategies for the task at hand. That is, the task may have been too difficult to adequately train teams (in the limited time allotted) to the level of proficiency necessary to formulate plans that may have contributed to their overall performance. This may have played an integral role in the lack of a significant relationship between the strategy development processes and performance; although teams did engage in planning activities, the difficulty of the task may have prevented them from proper implementation.

Another limitation of the study may be in the design itself. In the current study, multiple teams operated and interacted within the same performance environment simultaneously. Therefore, it is possible that much of the significant strategy development occurred at the multi-team level rather than at the team level. Although this may have been an obstacle to the present study, it poses new questions regarding the interaction and coordination of various processes among multi-team systems. Specifically, future studies should elaborate on the role of planning activities on performance among multiple teams with shared goals and performance environments; better understanding how different teams plan individually and jointly to reach performance goals would be a vast contribution to both applied and academic domains,

especially in the increasingly high-tech performance environments of the modern work world.

Conclusion

According to McGrath, strategy is a “description of a time-and-function-linked series of actions that, if executed, will (it is supposed) lead to a specific goal/outcome/consequence” (1984, p. 128). Although few would argue with this definition of what is strategy, there exists a controversy over how it is developed. Most of the literature conceptualizes strategy development as a single, global process. However, some researchers have proposed that it is more likely a set of distinct but related processes (e.g., Jehn & Shah, 1997; Marks, et al., In press; Wood & Locke, 1990). This thesis attempted to build off the strengths of the taxonomies introduced in the work of Marks et al. (In press) and Wood and Locke (1990). Specifically, this thesis attempted to test a tripartite framework of team strategy development which posits that strategy development is not a single process, but three distinct, interdependent processes: deliberate planning, contingency planning, and reactive adaptation.

The results of this thesis provided new insights into the strategy development process of teams in the performance of difficult and complex tasks. One of the more significant findings of this study is the support garnered for the multi-faceted nature of team strategy development. This study provided limited evidence in support of the tripartite framework presented herein, thereby acting as a springboard for future studies to further explore the multiple facets and processes of strategy development. Also, this study stands as the first to observe the process of strategy development throughout the entire performance period, including both transition and action phases of team

performance. It provided additional insight into how and when teams strategize, opening new directions for future research that promise improved understanding of the development process and how we may work to enhance the effectiveness of a team's planning activity. Contrary to existing literature, this study failed to provide evidence of either the link between strategy development and performance or the potential role of complexity as a moderator of that relationship.

Although mixed, the results of this thesis have made important contributions to the literature and offer significant insights into the strategy development of work teams. Future studies should continue to advance the literature and further explore the new findings and improved insights borne out of the current research. With continued effort, we can make vast strides and increasingly greater contributions to our understanding of this and other team processes.

Table 1

Descriptive Statistics

	N	Mean	SD	Min	Max
Performance	198	27.85	30.54	-20	140
Pilot Performance	198	2.53	.93	1	5
Wiso Performance	198	2.44	.94	1	5
Pilot Age	198	21.42	5.29	18	55
Wiso Age	198	21.11	3.48	17	34
Deliberate Planning Transition Phase	198	1.83	1.04	1	5
Contingency Planning Transition Phase	198	1.17	.48	1	3.5
Reactive Adaptation Transition Phase	198	1.00	.00	1	1
Deliberate Planning Action Phase	198	1.05	.179	1	2
Contingency Planning Action Phase	198	1.00	.036	1	1.5
Reactive Adaptation Action Phase	198	1.12	.30	1	2.5

Table 2

Intercorrelations Between Key Variables

	1	2	3	4	5	6	7
1. Deliberate Planning Transition							
2. Contingent Planning Transition	.454**						
3. Reactive Adaptation Transition ¹	--	--					
4. Deliberate Planning Action	-.086	-.052	--				
5. Contingent Planning Action	-.057	-.025	--	.181*			
6. Reactive Adaptation Action	.154*	-.004	--	.009	.092		
7. Performance	-.061	-.063	--	-.009	.000	.080	
8. Task Complexity	.000	.039	--	-.139	-.053	.021	-.175*

* = $p \leq .05$ ** = $p \leq .01$

Note: N = 198

¹ No variability was found in Reactive Adaptation during transition phases

Table 3
Correlations Between Covariates and Key Variables

—	X	SD	Deliberate Planning Transition	Contingent Planning Transition	Reactive Adaptation Transition	Deliberate Planning Action	Contingent Planning Action	Reactive Adaptation Action	Performance	Task Complexity
Mission Order	2	.82	-.08	-.18*	--	.14	.09	.10	.00	.12
Pilot Performance	2.53	.93	-.01	-.02	--	.18*	.04	.13	.56**	-.05
Wiso Performance	2.44	.94	-.08	.01	--	.21**	-.03	.13	.40**	-.06
Pilot Age	21.42	5.29	-1.0	-.06	--	.13	.09	-.03	.21**	.00
Wiso Age	21.42	5.29	-.07	-.11	--	.01	.06	-.03	-.05	.00
Gender Composition ¹	3.32	.63	-.21**	-.16*	--	-.05	-.04	-.06	-.20**	.00
Pilot Sim Experience	4.73	5.21	.29**	-.03	--	-.03	-.05	.02	.07	.00
Wiso Sim Experience	3.44	3.61	.16*	.17*	--	.04	.03	.09	.10	.00
Team Sim Experience	4.05	3.32	.32**	.07	--	-.00	-.02	.15*	.10	.00

* = $p \leq .05$

** = $p \leq .01$

Note: N = 198

¹ Gender composition was scaled according to the number of females on a team (0, 1, or 2).

Table 4

Summary of Hierarchical Regression Analysis for Variables Predicting Team Performance

Variable	B	SE B	β	R^2	R^2 -Change
Step 1					
Deliberate Planning Complexity	-1.792	2.067	-.061	.03	
	-6.515	2.626	-2.481*		
Step 2					
Deliberate Planning x Complexity	-.369	2.609	-.033	.03	.00

* = $p \leq .05$

Note: N = 198

Table 5

Summary of Hierarchical Regression Analysis for Variables Predicting Team Performance

Variable	B	SE B	β	R^2	R^2 -Change
Step 1					
Contingency Planning Complexity	-3.60	4.49	-.06	.03	
	-6.43	2.63	-.17*		
Step 2					
Contingency Planning x Complexity	8.20	5.23	1.57	.05	.01

* = $p \leq .05$

Note: N = 198

Table 6

Summary of Hierarchical Regression Analysis for Variables Predicting Team Performance

Variable	B	SE B	β	R^2	R^2 -Change
Step 1					
Reactive	8.665	7.287	.084	.04	
Adaptation					
Complexity	-6.581	2.622	.176*		
Step 2					
Reactive	-5.228	11.448	-.192	.04	.00
Adaptation x					
Complexity					

* = $p \leq .05$

Note: N = 198

LIST OF REFERENCES

- Aguinis, H. & Stone-Romero, E. F. (1997). Methodological artifacts in moderated regression and their effects on statistical power. Journal of Applied Psychology, 82, 192-206.
- Argote, L. (1982). Input uncertainty and organizational coordination in Hospital Emergency Units. Administrative Quarterly, 27, 420-434.
- Casner, S. M. (1994). Understanding the determinants of problem-solving behavior in a complex environment. Human Factors, 36, 580-596.
- Chronbach, L. J. (1987). Statistical tests for moderator variables: Flaws in analyses recently proposed. Psychological Bulletin, 102, 414-417.
- Cortina, J. M. (1993). Interaction, nonlinearity, and multicollinearity: Implications for multiple regression. Journal of Management, 19, 915-922.
- Entin, E. E. & Serfaty, D. (1999). Adaptive team coordination. Human Factors, 41, 312-325.
- Gersick, C. J. G. & Hackman, J. R. (1990). Habitual routines in task-performing groups. Academy of Management Journal, 32, 274-309.
- Hackman, J. R., Brousseau, K. R., & Weiss, J. A. (1976). The interaction of task design and group performance strategies in determining group effectiveness. Organizational Behavior and Human Performance, 16, 350-365.
- Hackman, J. R. & Morris, C. G. (1975). Group tasks, group interaction process, and group performance effectiveness: A review and proposed integration. In L. Berkowitz (Ed.), Advances in experimental social psychology (Vol. 8). San Diego, CA: Academic Press.
- Jehn, K. A., & Shah, P. P. (1997). Interpersonal relationships and task performance: An examination of the mediation processes in friendship and acquaintance groups. Journal of Personality and Social Psychology, 72, 775-790.
- Marks, M. A., Mathieu, J. E., Zaccaro, S. J. (In press). A temporally based theory and taxonomy of team processes. Academy of Management Review.
- McGrath, J. (1984). Groups: Interaction and performance. Englewood Cliffs, NJ: Prentice-Hall.
- McGrath, J. E. (1991). Time, interaction, and performance (TIP): A theory of groups. Small Group Research, 22, 147-174.

Meyer, A. D. (1982). Adapting to environmental jolts. Administrative Science Quarterly, 27, 515-537.

Orasanu, J. & Salas, E. (1993). Team decision making in complex environments. In G. A. Klein, J. Orasanu, R. Calderwood, and C. E. Zsombok's (Eds.), Decision making in action: Modes and methods. Norwood, NJ: Ablex Publishing Corporation.

Saavedra, R., Earley, P. C., & Van Dyne, L. (1993). Complex interdependence in task-performing groups. Journal of Applied Psychology, 78, 61-72.

Stone, E. F. & Hollenbeck, J. R. (1989). Clarifying some controversial issues surrounding statistical procedures for detecting moderator variables: Empirical evidence and related matters. Journal of Applied Psychology, 74, 3-10.

Weick, K. E. (1993). The collapse of sensemaking in organizations: The Mann Gulch Disaster. Administrative Science Quarterly, 38, 628-652.

Weldon, E., Jehn, K. A., & Pradhan, P. (1991). Processes that mediate the relationship between a group goal and improved group performance. Journal of Personality and Social Psychology, 61, 555-569.

Weldon, E. & Weingart, L. R. (1993). Group goals and group performance. British Journal of Social Psychology, 32, 307-334.

Wood, R. E. (1986). Task Complexity: Definition of the Construct. Organizational Behavior and Human Decision Processes, 37, 60-82.

Wood, R. E. & Locke, E. A. (1990). Goal setting and strategy effects on complex tasks. In B. M. Staw & L. L. Cummings (Eds.), Research in organizational behavior (Vol. 12). Greenwich, CT: JAI Press.

Yetton, P. W. & Bottger, P. C. (1982). Individual versus group problem solving: An empirical test of a best-member strategy. Organizational Behavior & Human Decision Processes, 29, 307-321.

Zeheer, S., Albert, S., & Zaheer, A. (1999). Time scales and organizational theory. Academy of Management Review, 24, 725-741.

Appendix A—Training Materials

Appendix A: Team Training

Team Task Training Protocol

Note: Italicized type is notes to the experimenter. Plain type is what should be told to the participants. It is not necessary to follow the scripted parts word for word although it is important that the participants do receive this information. The important point is that participants attain the competencies listed on the task training competency checklists.

- I. In this training segment, you will learn the basics of how to fly the F22 simulator. Some of you may have had previous experience with flight simulators or even with the simulation being used in this study. If you are familiar with this simulation, we ask that you only use those functions demonstrated in the training. Otherwise, the results of this study could be jeopardized.

II. **Begin Navigating a Flight Route**

In the first part of this mission you will learn the basic operations of the joystick, throttle, and how to read information on the Heads-up-Display, or HUD. Then you will learn how to perform the following maneuvers with the joystick: 1) climbing and diving; 2) rolling from side to side; and 3) turning left and right. You will also learn how to speed up and slow down the plane. Finally, you will learn how to look around in the cockpit.

A. Click on “Practice Mission 1” to begin the simulation.

B. Pause the game as it begins, and point out the following (use pictures of the HUD to point these out) :

- 1. Point out the roles of the Weapons Specialist and the Pilot:*

The Pilot is responsible for maneuvering the aircraft, controlling its speed, and firing weapons.

The Weapons Specialist is responsible for the aircraft’s radar settings, choosing the appropriate weapons, releasing chaffs and flares, and communication system.

- 2. As the simulation begins, ask participants to push “SHIFT and PILOT AIDS.” This brings up two radar screens. The screen on the bottom left shows your plane in relation to other planes in the sky. The second screen, on the bottom right shows your plane in relation to the flight plan. Notice that on the latter of these, there are lines. This is the path that you are supposed to follow. Also, these lines have circles with numbers on them. These are waypoints. You are supposed to follow waypoints in the order given. For example, you proceed from waypoint two to three and then to four, etc. The pilot is responsible for watching the display on the left. The Weapons Specialist is responsible for watching the display on the right. The W.S. should routinely update the pilot on their relation to the flight route.*
- 3. Altitude Display, right of the HUD’s center.*
- 4. Speed Display, just left of the HUD’s center.*

5. *The Horizon bars.* These are two long “L” shaped bars. When these are in the middle of the screen, the plane is flying level.
 6. *The Pitch Ladder.* These are smaller “L” shaped bars above and below the Horizon bar. They have numbers to the left of them. The numbers tell you what angle the plane is pointed up or down.
 7. *The HUD mode.* At the top of the HUD display it currently reads “AA HUD.” This stands for Air-to-air HUD. In this mode you can obtain information about, target and fire at enemy aircraft. You can switch the HUD mode by pressing “HUD MODE” on the keyboard. Press “HUD MODE” now. Notice that it now reads “AG HUD.” This stands for Air-to-ground HUD. In this mode you can target and fire at enemy ground targets. Press “HUD MODE” until you see “NAV HUD.” This stands for Navigation HUD. In this mode, you can obtain information about how well you are following your flight plan.
 8. *The clock.* There is a clock at the bottom left of the screen. In later missions, you will use this clock to accomplish certain goals within a given amount of time. The weapon specialist will have to take responsibility for watching this clock.
- C. *Release pause on the game.* Allow the participants to practice maneuvering the plane.
- D. *Demonstrate the following, using a toy plane as visual aid:*
1. *Climbing* – Pull the joystick back. Notice that the pitch ladder moves. Identify the angle you are flying at. Notice the altimeter rising and the speed falling. Pull back until the pitch ladder reads “80” for an eighty degree angle of ascent. Point out that the speed is rapidly falling. *Allow the participants to fly nearly straight up until their planes loose momentum and stall.* If your plane should stall, you need to point the nose down to gain speed. As the plane tumbles, it will gain speed, and at around 200 knots it will gain maneuverability again. Level the plane off.
 2. *Diving* – Now push the joystick forward. Notice the pitch ladder is now displaying negative numbers for a negative angle from level flight. Notice that the altimeter is falling and the speed is rising.
 3. Straighten the plane out so that you are flying level.
 4. Pull the joystick to the right. Hold it to the right. Notice that the plane is rolling but is still flying in the same direction. Straighten the plane out again. Simply pushing the joystick to the left or right will not allow you to turn the plane.
 5. *Turning* - To turn the plane requires two steps. We will first practice a right turn. First, pull the joystick to the right until the plane is on its side or perpendicular to the ground. Now, pull back on the joystick. Straighten the plane and turn to the left.
 6. *Speed Control* – To accelerate, push the throttle all the way forward. Notice that the Engine Power display in the bottom right of the HUD now reads “ENG 140%.” You are now flying at 140 percent of the engine’s capacity, the aircraft’s maximum throttle. This is the F22’s fastest setting,

but flying at 140% for too long could cause you to run out of fuel and crash. Notice that the speed is increasing. Now, pull the throttle all the way back. Notice the Engine Power now reads “ENG 51%.” This is the engine’s lowest setting. Notice that your air speed is decreasing. At this setting, the aircraft will soon lose momentum and tumble towards the ground. The normal setting is at 100% power. The F-22 performs best when flying at between 400 and 550 knots per hour.

7. *Braking* – You’ve just seen how to slow the plane down using the throttle, another way to quickly slow the plane down is by using an airbrake. Using your pinky finger, push the maroon button on the bottom side of the joystick that is facing away from you. Notice that when you push it “ABK ON” appears at the bottom right side of the screen. Notice that the plane is slowing down. Now push the button again. Notice that the HUD now reads “ABK OFF.”
8. *Looking around* – You can use a switch on the joystick to simulate head movement. You can use this switch to “look around” in the cockpit and out of the plane. Using your thumb, move the round gray knob on the joystick. Notice that its movement parallels that of your virtual head. You can push the red button, next to the gray knob, to snap back to the front view.
9. Now, fly towards the ground. At 2500 feet, level off and fly straight. Attempt to fly as close as you can to the ground. *Make sure they notice the “ground proximity warning” and PULL UP on the HUD.* When you hear this warning, you should pull up quickly to avoid crashing. Notice that you need to anticipate changes in the altitude of the ground.

E. Basic Maneuvering Competencies:

Here, we want to make sure the participants have learned the important task competencies for this mission. The experimenter should ask them to do the following. If the participants cannot do so, show them how and quiz them again later.

1. Now I would like you to climb to 25,000 feet.
2. Now dive to 15,000 feet.
3. Accelerate to 550 knots.
4. Slow down to 300 knots.
5. Look to the left of your plane...and now look straight ahead.
Then ask them, “What is your...”
6. Altitude.
7. Speed.
Grab the joystick and put the plane at a 30 degree angle.
8. Are you flying up or down...and at what angle?
9. ***Stall out their plane and have them recover.***

IV. Part Two of Navigating a Flight Route.

The second part of the practice mission builds upon the skills that you have developed during your previous mission and introduces you to new concepts:

- 1) following a flight plan and waypoints; 2) using the navigation HUD to follow a flight plan and; 3) identifying other aircraft.

Click on “Practice Mission 2” to begin the simulation.

Make sure you are in the NAV HUD mode.

Release the pause on the game. Instruct the participants to fly towards waypoint two at 20,000 feet. At waypoint two, point out how the waypoint carets on the HUD move and position so that you can fly to waypoint three. Pause the game. When you fly directly over a waypoint, your computer will automatically switch the HUD settings to the next waypoint. However, in later missions, you may not be able to fly directly over a waypoint due to the need to attack a target or if you are under attack. In these cases, you can manually switch to the next waypoint by pressing ADVANCE WAYPOINT. Point out how the carets and “WP2” readout in the NAV HUD changes. Also point out how the circle around the next waypoint changes on the right pilot’s aid. If you goof and press W more than once and accidentally advance to the wrong waypoint, you can press “WAYPOINT BACK” to move the waypoint back one. Have them press WAYPOINT BACK and watch the waypoint indicators.

Pause the game. Explain EMCOM.

1. EMCOM refers to the plane’s radar systems. There are five EMCOM levels. One is the stealthiest. It is very hard for enemy’s to see you in EMCOM level one. However, it is also harder for you to see enemy’s and to lock onto them. EMCOM five allows you to gather the best information concerning enemies near you. However, it is also much easier for enemies to see and to shoot at you.
2. EMCOM can be changed by pushing “EMCOM” and then a number, 1 through 5, for the desired EMCOM level. *Have them change EMCOM levels. Release pause.*

Have the subjects drop to 2000 feet and fly towards waypoint three at exactly 500 knots.

When it looks like the participants have the hang of it, end the mission.

At waypoint three the game should end.

F. Navigating a Flight Route Competencies.

1. *Take the stick and put the participants off course. Turn off their pilot aids and switch the HUD to AG. Fly towards waypoint two.*
2. *If the participants did not demonstrate how to do so in finding their way back to waypoint two, ask them to:*
 - a. Increase the range of the pilot aids.
 - b. Decrease their range.
 - c. Switch to the Navigation HUD.
 - d. Advance the waypoint.
 - e. Move the waypoint back.
3. *If the participants are on course, ask them how they know that.*
4. *Ask them:*
 - a. What is your speed?

- b. What is your altitude?
- c. What do you look at to find the next waypoint?
- d. Change EMCOM to the level where enemies will have the hardest time “seeing” you.
- e. Change EMCOM level where you can “see” the most but enemies can also “see” you best.

V. Begin Basic Air-to-Ground.

In the first part of this mission you will learn air-to-ground combat tactics including: 1) how to identify enemy ground targets; 2) how to target enemy ground vehicles; 3) how to fire air-to-ground weapons; and 4) how to identify surface-to-air weapons, or SAMS and the importance of avoiding them.

Here, the subjects will practice blowing up things on the ground. When it appears that they’ve attained their air-to-ground competencies, have them proceed to waypoint four where they will receive a brief overview of air-to-air tactics.

A. *Click on “Practice Mission 4” to begin the simulation.*

B. Since your objective here is to destroy ground targets, you must be in the AG HUD mode. Switch to this mode by pressing “CHANGE AG WEAPONS” or the “HUD MODE” key until you see “AG HUD” at the top of the HUD.

C. *As the subjects approach the first enemy ground target, pause the game.*

There are several types of enemy ground targets. In this mission, you will attack tanks, fuel tanker trucks, and SAM, AAA sites. The tanks and fuel trucks are displayed on the HUD as crosses. There are also SAM and AAA sites. These are surface to air weapons that fire at aircraft. They are displayed in the HUD as pentagons. These are the only type of ground target that can also fire at you. Water targets are upside down Ts.

D. Notice that we are approaching a ground target that has not been targeted.

The dotted lines indicate that this target hasn’t been added to our shootlist. Targets that aren’t in the shoot list cannot be fired at. Add it to the shoot list by pressing “T,”. Identify the type of ground target we are approaching by looking at the infrared display just below the HUD. Your mission will be to destroy enemy ground targets. *Use pictures of these to show what they look like to the players.* There will also be friendly troops on the ground. *Point out the friendly ground weaponry on the visual aids. Note that friendly M1 tanks look similar to enemy T-80s. M1’s have flatter more elongated turrets. Or, if they can’t see the difference, tell them to look for HUMVEEs. If HUMVEEs are with the tanks then they are friendly forces. Point out differences between SAMs and AAAs on the pictures.* Do not fire at the friendly forces.

E. Now that the plane is targeted, notice that a circle has appeared around it on the HUD display. When you fire missiles, they will only lock onto this target. If you have more than one target on your screen and you push “ADD TARGET” to target, the computer automatically selects the one closest to you. If you do not want to fire at the target because it may be a jeep, you must push “CYCLE TARGET” to cycle.

- F. The distance to the ground target is displayed next to a vertical bar near the bottom right side of the HUD. Next to this bar, the distance is displayed in nautical miles.
- G. We want to shoot the ground target, so we have three choices of weapons. *(As you discuss their weapons choices, have them cycle the weapons by pressing backspace so that the appropriate weapon appears on the screen. Point out in the HUD where the weapon's name and number available are displayed.)*
 The first is CANNONS. This is the same weapon we discussed in the last practice mission. To use CANNONS you must be perfectly lined up with the target and within two miles. These should be used only as a last resort. Another choice are AGM 88's. These are specially designed to lock onto SAM sites and AAAs. Our other choice is AGM65. These are heat-seeking missiles. They are lethal within about 10 miles. Unless firing at SAM sites, these should be your first choice of weapons. They can however, shoot SAMs at a closer range.
- H. Select the AGM65. When you are within the optimum range, the words "SHOOT" will appear on the HUD and you will hear "SHOOT SHOOT." To fire the AGM65, pull the trigger on the joystick. After you fire at one target, the computer will automatically select the next closest ground target. You should check your infrared screen every time you fire to make sure that a ground target objective is what is targeted. Every time you fire, the computer will automatically advance to the next target in the shoot list. Sometimes, when a group of tanks are right next to each other, it appears that you are firing at the same target. If you pulled the trigger, heard the missile fire, or saw the missile leave the plane then the target in the infrared display will not be the same that you just fired at.
- I. The AGM 88's which are used against SAM launchers and AAA, can be fired the same way with one exception: the higher the level of EMCOM you are in, the farther the distance you can shoot from. You should always be in EMCON 4 or 5 when shooting an AGM 88.
- J. An "X" will appear over a ground target after it has been fired at. Do not waste missiles firing at the same target. You only have a limited number of missiles and should be used only for your primary targets.
- K. *If they haven't already done so, ask them to fly towards a SAM site. Point out the threat rings of the SAM's radar to the participants. Within these circles, the SAM can "see" you. And if they can see you, they can shoot at you. When a SAM fires a missile at them, demonstrate evasive maneuvering techniques*
 - 1. *Turning away from the SAM, moving erratically.*
 - 2. *Launching chaffs and flares.*
- L. *Allow participants to practice as needed.*
- M. **Basic Air-to-Ground Competencies**
 - 1. **What weapon is currently selected?**
 - 2. **How many do you have?**
 - 3. **Where are the enemy ground targets in relation to you?**

4. *Pick one of the ground targets on the HUD and ask them "What kind of target is that (e.g., a tank, fueltruck, etc.)?" Participants should use their MFD (or infrared display) to ID the target.*
 5. *Hit the "C" key a number of times to cycle through the ground targets. Ask them where the primary target is at. They should look for the target with the circle around it on the HUD and pilot aids.*
 6. *Ask them to pick the appropriate weapon and to fire at the target when ready. They should pick a AGM 88 if it is a SAM site and a AGM 68 if it is anything else. They should wait until they here and see "SHOOT SHOOT" to fire.*
 7. *After firing, ask them how they know a missile is heading towards the target. (An "X" will appear over the target.)*
 8. *Tell them to pretend that a missile has been fired at them. Ask them to show you how they would keep the missile from hitting them. (They should turn and launch chaffs and flares.*
- N. *When the subjects appear competent on air-to-ground segment, instruct them to fly to waypoint four. At waypoint four, pause the game and explain that they will now receive some basic air-to-air training. This training is just in case they are attacked by an enemy jet and need to fight their way out. However, you should emphasize that their main mission is to attack enemy ground targets and that they should not waste time going after enemy planes. If they died getting away from the missiles, go ahead and put them into the AA mission to teach them AA combat.*
- O. *To fire at an enemy plane, you must be in the air-to-air HUD mode. Display the AA HUD mode by pressing "CHANGE AA WEAPONS" or the "HUD MODE" key until you see "AA HUD" at the top of the HUD.*
- P. *As the subjects approach the first enemy,(it comes up quickly) pause the game. Notice that an aircraft is approaching that has not been targeted. Add it to the shoot list by pressing "ADD TARGET." Identify the type of plane that is approaching. It is a MIG-21. Any plane that's name begins with SU or MIG is an enemy plane. These planes will attempt to shoot you down. You must then attempt to either avoid the plane or to shoot them down. All other planes should not be considered a threat and should be ignored.*
- A. *Now that the plane is targeted, notice that a circle has appeared around it on the HUD display. When you fire missiles, they will only lock onto this plane.*
- B. *We want to shoot down the targeted plane, so we have two choices of weapons. One is CANNONS. These are basically bullets. In order to hit a plane with the CANNONS, you must be within two miles and be perfectly lined up with the target. Our other choice is AIM9xs. These are heat-seeking missiles. They are lethal within about 10 miles. You can switch between these missiles by pressing the "CHANGE AA WEAPONS" key. Do that now several times. Watch the HUD display to see what weapons you have selected. Look next to the "WEP" display.*
- C. *Select the AIM9x. A heat seeking box will appear on the screen. This box will enclose the circle representing the enemy aircraft on the HUD display*

when you have “locked on” to the target. When within firing range, a circle will appear in the middle of the HUD. The larger the circle is, the better the chances are of hitting the primary target with an AIM9X. Also, when you are within the optimum range, the words “SHOOT” will appear on the HUD and you will hear “SHOOT SHOOT.” To fire the AIM9x, pull the trigger on the joystick.

- D. After you fire a missile at a plane, notice that an “X” will appear over the circle. That means that the missile is on its way to the target. Do not fire any additional missiles unless the “X” disappears. If it does, that means that the plane has outmaneuvered the missile. You will have a limited number of missiles in these missions and should not waste them.

- E. *Release pause on the game and allow participants to finish the simulation.*

- F. **Basic Air-to-Air Competencies**

Ask participants to:

1. **Point out an enemy air target on the HUD and the pilot aids.**
2. **Point out a targeted enemy air target.**
3. **Which target is your primary target?**
4. **Where are you in relation to the target?**
5. **Identify the range of the target.**
6. **Which weapon should be used to fire at the target?**
7. **How many missiles do you have left?**
8. **Are you on course? If not, get back on course.**
9. **What is your speed?**
10. **What is your altitude?**

VI. *Participants receive the team training or control condition.*

VII. *Participants fill out the task and team training manipulation checks.*

VIII. *Practice Mission 5 (MTS Mission) In-Basket Exercise. Follow In-Basket protocol.*

IX. **Begin Practice Mission 5.**

In this mission you will fly a mission with another live team. You must work together with this other team, your “wing”, to achieve the mission objectives. *Tell the teams what their partner looks like on screen and on the radar. Remind them that it is difficult to “see” their flight partner, so they should use WPs, speed, and altitude to check out where they are.*

- A. *Before the mission begins, present participants with a briefing of their mission.* In this mission and all following missions, it is very important that you follow the objectives. Do not get caught up in engagements that are not related to your mission.

- B. In this mission you will have a large number of weapons at your disposal. However, in later mission you won't have as many and you will need to be careful not to waste any of your weapons.
- C. *Explain how the communications switchboxes work.*
 - 1. *The participants will work through the mission. During and afterwards, they will be given feedback about where they can improve and what they did well on.*
- D. *REMEMBER to have them say their name and position over their headsets. Also remind them to call each other by the appropriate call signs.*

Appendix A: Team Training

Task Training Competency List

Basic Maneuvering Competencies:

Subjects should be able to:

- 10. climb. ☐
- 11. dive. ☐
- 12. accelerate. ☐
- 13. break. ☐
- 14. turn. ☐
- 15. recover from a stall. ☐
- 16. look around (using the joystick). ☐
- 17. ascertain their altitude. ☐
- 18. identify their speed. ☐
- 19. determine their angle of ascent/descent. ☐

Navigating a Flight Route Competencies.

Subjects should be able to:

- 5. Follow a flight path. ☐
- 6. Change waypoints (advance/move back). ☐
- 7. Turn on pilot aids. ☐
- 8. Increase/decrease range of pilot aids. ☐
- 9. Switch HUDs. ☐
- 10. Identify current HUD. ☐
- 11. Change EMCOM levels. ☐
- 12. Identify stealthiness of EMCOM levels. ☐

Basic Air-to-Ground Competencies

Subjects should be able to:

- 9. Identify enemy ground targets. ☐
 - a. identify their range to target. ☐
 - b. on the infrared display. ☐
 - c. on the HUD. ☐
 - d. identify SAMS. ☐
 - e. identify targets added to shootlist. ☐
- 10. Choose appropriate weapons. ☐
- 11. Determine the number of available weapons. ☐
- 12. Fire weapons. ☐
- 13. Add targets to shoot lists. ☐
- 14. Cycle targets. ☐
- 15. Evade enemy missiles. ☐

Basic Air-to-Air Competencies

Subjects should be able to:

- 11. Identify enemy air targets. ☐
 - a. their range to the target. ☐
 - b. identify a targeted enemy plane. ☐
- 12. Identify the appropriate weapon to be used. ☐
- 13. Identify the number of available weapons. ☐

Appendix B—Planning Materials

Appendix B: Pre-Performance Strategy Session

In-Basket Exercise

The in-basket exercise must be completed prior to entering the MTS simulation. The package of materials provides information the teams need during the transition phase (i.e., strategy planning). This exercise will be conducted for each experimental mission, including the MTS practice.

Pre-MTS mission/start of planning session:

1. Select appropriate pack of materials for the MTS session (i.e., Practice, Ridge Jumper, etc.).
2. Briefly review the nature of the materials and what the subjects may take into the simulation with them. **Give the mission commander/designated team leader the package of materials for his/her team.** He/she should distribute them to the rest of the team. Inform the team members that they have *fifteen (15) minutes to consider the information and plan for their upcoming mission.* Also, *inform the team leader that you will be interviewing him about their plans at the end of the planning session.* Hand him/her a copy of the questions for the interview to help him/her prepare. Each MTS package contains:
 - a. **MISSION BRIEF -- (one copy per team member)** The mission brief contains important information for successfully completing the mission. Teams should pay very close attention to the mission objectives, flight requirements (i.e., route, altitude requirements, airspeed requirements), and weapons resources. Subjects may make notes on or annotate their copy. **Subjects will be allowed to take mission briefs into the simulation.**
 - b. **GRID REFERENCE MAP – (one copy per team member)** The map provides a basic overview of their required flight route and way points. Subjects may make any annotations to the map that they desire. **Subjects will be allowed to take grid maps into the simulation.**
 - c. **TARGETS (PICTURES) – (one copy per team member)** This sheet contains a picture of each assigned and bonus target specified in the mission. This provides the team members with a more specific picture reference than the more general collages posted in the lab.
 - d. **OPERATIONS REPORTS -- (one copy of each report per MTS team)** The “Situation Reports” (SITREPS) provide additional information on friendly forces and their activities that is not included in their mission brief. Subjects must review this information and decide what is relevant to accomplishing their mission objectives. **Subjects are NOT allowed to annotate these reports nor take them into the simulation.** They may transfer any information to either their maps or mission briefs.

- e. INTELLIGENCE REPORTS -- (one copy of each report per MTS team) The “Intelligence Reports” contain information about the activities of enemy and neutral nations in the simulation. Since these are “intelligence” reports, they represent assessments of enemy and neutral actions and not hard fact. Subjects must review this information and decide what is relevant to accomplishing their mission objectives. **Subjects are NOT allowed to annotate these reports nor take them into the simulation.** They may transfer any information to either their maps or mission briefs.

Pre-MTS mission /end of planning session:

1. Ask the team to collectively place each report into one of three stacks: important/essential to mission plan, helpful, but not essential to mission plan, and not relevant to mission plan. Once the sorting is completed, record the contents of each stack by title (i.e., SITREP 01).
2. Begin the interview with the team leader. (While the rest of the team is present, they may not answer any of the questions.) Inform the team that the interview will be recorded for later analysis. Before initiating audio recording, ask the team leader to identify their team by their MTS number, the date and time of the interview, and their position (i.e., mission commander/pilot lead blue 1)
 - A. This identification will be used to ensure that the audio tape is correctly encoded. You must accomplish this identification at the beginning of the Practice mission. Since all the subsequent pre-mission interviews for that team will immediately follow this one, there will be no requirement to repeat the leader identification.
3. Follow the following protocol:
 - A. Now that you’ve had a chance to plan your mission, I would like for you to answer the questions that I posed when I gave you the materials. To make sure that I remember your answers accurately, I’m going to tape record your answers. As with the rest of the information that we’re collecting, these recordings will remain confidential. Referencing just your map and notes

Goal Specification

- B. What are your primary objectives for this mission?
- C. What are your secondary, or “bonus” objectives?

Mission Analysis

- D. What, in your team's estimation, were the most important pieces of information that you received? Why were they the most important pieces of information for your planning?**
- E. From the information that you were provided, what else is going on in this mission that might relate to your assignments? How is that related to your mission?**

Strategy Formulation

- F. How do you plan on achieving the objectives you've identified for this mission? What exactly will the lead aircraft be doing? How about the wing aircraft – anything different?**
 - G. What could go wrong with your plans? If that happens, what will you do? When will you decide whether to carry out that action(s) (i.e., what are your decision points)?**
 - H. Finally, tell me which weapons load you selected for this mission. Why that one?**
- 4. Conclude the taping by stating, "This concludes the interview for the ????? (i.e., practice, ridge jumper, canyon sweep, river run) MTS Mission."
 - 5. Collect all materials from the team that they do not take into the simulation (i.e., all operations and intelligence reports). Place them in a file for review and reuse (if not marked).

Post-MTS mission:

- 1. Collect any materials the subjects took into the simulation (i.e., maps and notes).
- 2. Label each document with the subject's session (date and time), position (i.e., lead pilot – blue 1, wing WSO – green 2), and MTS team designation. File for later analysis. (It's important that all completed materials for any one team are filed together and appropriately labeled.)

FOLLOWING COMPLETION OF THE FINAL MTS SIMULATION, BE SURE TO DEBRIEF THE SUBJECTS ON THE IMPORTANCE OF NOT DISCUSSING THE DETAILS OF THE SIMULATION OR THE IN-BASKET MATERIALS WITH ANY OTHER STUDENTS OR POTENTIAL SUBJECTS. ENSURE THAT ALL REQUIRED PAPERWORK AND TAPES HAVE BEEN COMPLETED AND APPROPRIATELY LABELED/FILED.

Appendix B

ACES MTS – PRACTICE MISSION BRIEF

SAUDI ARABIA

YOUR MISSION

Saudi rebels are attempting to overthrow the Saudi Arabian government. The royal family has requested U.S. intervention to stop the revolt and restore order to the nation. For your current mission, you will be flying as part of an eight aircraft strike team. It will be your responsibility to protect a group of three A10s and a group of three F18s while they attack their targets. You will be working closely with these teams and it is extremely important to the success of your mission that the A10s and F18s destroy their targets.

OTHER IMPORTANT INFORMATION

The group of 3 A10s, team name **Beast**, will be flying at an altitude of 2000 ft and airspeed of approximately 400 knots. They will be attacking a group of T80 tanks located around D7.

The group of 3 F18s, team name **Tiger**, will be flying at an altitude of 2000 ft and airspeed of approximately 450 knots. They will be attacking another group of T80 tanks located around E5.

Wolf team should **descend** from their initial altitude of **10,000 ft** to an altitude **2000 ft** and **slow** to an airspeed of approximately **450 knots**. When entering combat situations, Wolf should climb to an altitude of **5000 ft** but then return to **2000 ft** when enemy targets or threats have been destroyed.

Eagle team should generally maintain their initial altitude of **10,000 ft** and airspeed of approximately **450 knots** throughout the mission.

YOU HAVE 15 MINUTES TO COMPLETE THIS MISSION

YOUR MISSION OBJECTIVES AND SCORING

*Your **Main Objective** is to ensure the survival of your entire 8-aircraft strike team (3 A-10s, 3 F-18s, and your 2 F-22s).*

<u>Wolf and Eagle:</u>	Dead	= 0 points
	Damaged	= 20 points
	Undamaged	= 45 points

TOTAL POSSIBLE F-22 SURVIVAL POINTS = 90

F-18s (3) and A-10s (3):

Dead	= 0 points each
Damaged	= 10 points each
Undamaged	= 20 points each

TOTAL POSSIBLE F-18 & A-10 SURVIVAL POINTS = 120

Note. At Least One Player Team Must Survive to Earn F18 & A10 Points

In order to meet your main goal, you will need to destroy primary targets. Your Primary Targets are as follows:

Wolf (10 points each):	2 AAAs and 2 SAMs around WP3
	2 AAAs and 2 SAMs around WP5

Eagle (20 points each):	2 SU27s around WP2
	2 SU27s around WP5

TOTAL POSSIBLE PRIMARY TARGET POINTS = 160

Your secondary (bonus) targets are as follows:

Wolf (5 points each):	2 BMZ between WP4 and WP5
	1 BMZ around WP5

Eagle (5 points each):	1 Mig 21 around WP3
	1 Mig 21 around WP5
	1 M1-24 helicopters around WP6

TOTAL POSSIBLE MTS BONUS POINTS = 30

Any other enemy targets (not listed above):	<i>0 points</i>
---	-----------------

Penalty for destroying friendly aircraft and vehicles:	<i>Wolf (-20 points each)</i>
	<i>Eagle (-40 points each)</i>

TOTAL POSSIBLE MTS MISSION SCORE = 400

WAYPOINT TIMING

Timing will be critical to mission success.

Estimated elapsed mission time of arrival at designated WPs:

Total time allotted for mission: 15 minutes

Wolf		Eagle	
<u>WP</u>	<u>Mission timing</u>	<u>WP</u>	<u>Mission timing</u>
1	15:00	1	15:00
2	12:46	2	12:18
3	10:54	3	08:54
4	08:58	4	06:01
5	04:07	5	03:04
6	02:27	6	01:09

WEAPONS

Your Weapons include:

Wolf:

1760 Cannon rounds (multipurpose) – optimal range = <2mi

6 AGM65Gs (air-to-ground, hard targets) missiles – optimal range = <10mi

6 AGM88s (high-speed anti-radiation missiles) – optimal range = <15mi

Eagle:

1760 Cannon rounds (multipurpose) - optimal range = <2mi

6 AIM120s (air-to-air) missiles – optimal range = <25mi

6 AIM9Xs (air-to-air) missiles – optimal range = <10mi

ACES MTS – YEMEN MISSION BRIEF

YOUR MISSION

A conflict has erupted along the Yemen/Saudi Arabia border between a powerful terrorist group and U.S. forces operating in the area. During this mission, you will be flying as part of an eight aircraft strike team. It will be your responsibility to protect a group of three A10s and a group of three F18s while they attack their targets. You will be working closely with these teams and it is extremely important to the success of your mission that the A10s and F18s destroy their targets.

OTHER IMPORTANT INFORMATION

The group of 3 A10s, team name **Beast**, will be flying at an altitude of 2000 ft and airspeed of approximately 400 knots. They will be attacking a group of T80 tanks located around D5.

The group of 3 F18s, team name **Tiger**, will be flying at an altitude of 2000 ft and airspeed of approximately 450 knots. They will be attacking another group of T80 tanks located around D3.

Wolf team should **descend** from their initial altitude of **10,000 ft** to an altitude **2000 ft** and **slow to** an airspeed of approximately **450 knots**. When entering combat situations, Wolf should climb to an altitude of **5000 ft** but then return to **2000 ft** when enemy targets or threats have been destroyed.

Eagle team should generally maintain their initial altitude of **10,000 ft** and airspeed of approximately **450 knots** throughout the mission.

YOU HAVE 15 MINUTES TO COMPLETE THIS MISSION

YOUR MISSION OBJECTIVES AND SCORING

*Your **Main Objective** is to ensure the survival of your entire 8-aircraft strike team (3 A-10s, 3 F-18s, and your 2 F-22s).*

<u>Wolf and Eagle:</u>	Dead	= 0 points
	Damaged	= 20 points
	Undamaged	= 45 points

TOTAL POSSIBLE F-22 SURVIVAL POINTS = 90

<u>F-18s (3) and A-10s (3):</u>	Dead	= 0 points each
	Damaged	= 10 points each
	Undamaged	= 20 points each

TOTAL POSSIBLE F-18 & A-10 SURVIVAL POINTS = 120

Note. At Least One Player Team Must Survive to Earn F-18 and A-10 Points

In order to meet your main goal, you will need to destroy primary targets. Your Primary Targets are as follows:

Wolf (10 points each):

- 2 AAAs and 2 SAMs around WP3
- 2 AAAs and 2 SAMs around WP5

Eagle (20 points each):

- 2 SU27s around WP2
- 2 SU27s between WP3 & WP4

TOTAL POSSIBLE PRIMARY TARGET POINTS = 160

Your secondary (bonus) targets are as follows:

Wolf (5 points each):

- 1 BMZ around WP3
- 1 BMZ between WP4 & WP5
- 1 BMZ around WP5

Eagle (5 points each):

- 1 Mig 21 around WP3
- 1 Mig 21 between WP4 & WP5
- 1 M1-24 helicopters between WP5 & WP6

TOTAL POSSIBLE MTS BONUS POINTS = 30

Any other enemy targets (not listed above): *0 points*

Penalty for destroying friendly aircraft and vehicles: *Wolf (-20 points each)*
Eagle (-40points each)

TOTAL POSSIBLE MTS MISSION SCORE = 400

WAYPOINT TIMING

Timing will be critical to mission success.

Estimated elapsed mission time of arrival at designated WPs:
Total time allotted for mission: 15 minutes

Wolf		Eagle	
<u>WP</u>	<u>Mission timing</u>	<u>WP</u>	<u>Mission timing</u>
1	15:00	1	15:00
2	12:02	2	11:46
3	09:51	3	08:08
4	07:48	4	04:09
5	03:12	5	00:52
6	03:05	6	00:00

WEAPONS

Your Weapons include:

Wolf:

- 1760 Cannon rounds** (multipurpose) – optimal range =< 2mi
- 6 AGM65Gs** (air-to-ground, hard targets) missiles – optimal range =< 10mi
- 6 AGM88s** (high-speed anti-radiation missiles) – optimal range =< 15mi

Eagle:

- 1760 Cannon rounds** (multipurpose) - optimal range =< 2mi
- 6 AIM120s** (air-to-air) missiles – optimal range =< 25mi
- 6 AIM9Xs** (air-to-air) missiles – optimal range =< 10mi

ACES MTS – ETHIOPIA MISSION BRIEF

YOUR MISSION

Civil war has just broken out in the North African country of Ethiopia. The United Nations has asked the United States to step in as peacekeepers to restore order to the area. During this mission, you will be flying as part of an eight aircraft strike team. It will be your responsibility to protect a group of three A10s and a group of three F18s while they attack their targets. You will be working closely with these teams and it is extremely important to the success of your mission that the A10s and F18s destroy their targets.

OTHER IMPORTANT INFORMATION

The group of 3 A10s, team name **Beast**, will be flying at an altitude of 2000 ft and airspeed of approximately 300 knots. They will be attacking a group of T80 tanks located around E6.

The group of 3 F18s, team name **Tiger**, will be flying at an altitude of 2000 ft and airspeed of approximately 550 knots. They will be attacking another group of T80 tanks located around D5.

Wolf team should **descend** from their initial altitude of **10,000 ft** to an altitude **2000 ft** and **slow to** an airspeed of approximately **450 knots**. When entering combat situations, Wolf should climb to an altitude of **5000 ft** but then return to **2000 ft** when enemy targets or threats have been destroyed.

Eagle team should generally maintain their initial altitude of **10,000 ft** and airspeed of approximately **450 knots** throughout the mission.

YOU HAVE 15 MINUTES TO COMPLETE THIS MISSION

YOUR MISSION OBJECTIVES AND SCORING

*Your **Main Objective** is to ensure the survival of your entire 8-aircraft strike team (3 A-10s, 3 F-18s, and your 2 F-22s).*

<u>Wolf and Eagle:</u>	Dead	= 0 points
	Damaged	= 20 points
	Undamaged	= 45 points

TOTAL POSSIBLE F-22 SURVIVAL POINTS = 90

<u>F-18s (3) and A-10s (3):</u>	Dead	= 0 points each
	Damaged	= 10 points each
	Undamaged	= 20 points each

TOTAL POSSIBLE F-18 & A-10 SURVIVAL POINTS = 120

Note. At Least One Player Team Must Survive to Earn F-18 and A-10 Points

In order to meet your main goal, you will need to destroy primary targets. Your Primary Targets are as follows:

Wolf (10 points each):	2 AAAs and 2 SAMs around WP3 2 AAAs and 2 SAMs between WP4 & WP5
Eagle (20 points each):	2 SU27s around WP3 2 SU27s between WP4 & WP5

TOTAL POSSIBLE PRIMARY TARGET POINTS = 160

Your secondary (bonus) targets are as follows:

Wolf (5 points each):	1 BMZ between WP3 and WP4 1 BMZ around WP4 1 BMZ around WP5
Eagle (5 points each):	1 Mig 21 around WP3 1 Mig 21 between WP4 & WP5 1 M1-24 helicopters between WP5 & WP6

TOTAL POSSIBLE MTS BONUS POINTS = 30

Any other enemy targets (not listed above): *0 points*

Penalty for destroying friendly aircraft and vehicles: *Wolf (-20 points each)
Eagle (-40 points each)*

TOTAL POSSIBLE MTS MISSION SCORE = 400

WAYPOINT TIMING

Timing will be critical to mission success.

Estimated elapsed mission time of arrival at designated WPs:

Total time allotted for mission: 15 minutes

Wolf		Eagle	
<u>WP</u>	<u>Mission timing</u>	<u>WP</u>	<u>Mission timing</u>
1	15:00	1	15:00
2	13:17	2	12:06
3	10:54	3	08:56
4	09:08	4	06:28
5	05:49	5	01:32
6	03:28	6	00:00

WEAPONS

Your Weapons include:

Wolf:

- 1760 Cannon rounds** (multipurpose) – optimal range =< 2mi
- 6 AGM65Gs** (air-to-ground, hard targets) missiles – optimal range =< 10mi
- 6 AGM88s** (high-speed anti-radiation missiles) – optimal range =< 15mi

Eagle:

- 1760 Cannon rounds** (multipurpose) - optimal range =< 2mi
- 6 AIM120s** (air-to-air) missiles – optimal range =< 25mi
- 6 AIM9Xs** (air-to-air) missiles – optimal range =< 10mi

ACES MTS – EGYPT MISSION BRIEF

YOUR MISSION

Iraq has invaded Egypt by the sea, disrupting all major ports preventing the import and export of all commerce. The Egyptian government has asked for U.S. help to push back and force a withdrawal of Iraqi forces. In this mission, you will be flying as part of an eight aircraft strike team. It will be your responsibility to protect a group of three A10s and a group of three F18s while they attack their targets. You will be working closely with these teams and it is extremely important to the success of your mission that the A10s and F18s destroy their targets.

OTHER IMPORTANT INFORMATION

The group of 3 A10s, team name **Beast**, will be flying at an altitude of 2000 ft and airspeed of approximately 400 knots. They will be attacking a group of T80 tanks located around D4.

The group of 3 F18s, team name **Tiger**, will be flying at an altitude of 2000 ft and airspeed of approximately 450 knots. They will be attacking another group of T80 tanks located around D5.

Wolf team should **descend** from their initial altitude of **10,000 ft** to an altitude **2000 ft** and **slow to** an airspeed of approximately **450 knots**. When entering combat situations, Wolf should climb to an altitude of **5000 ft** but then return to **2000 ft** when enemy targets or threats have been destroyed.

Eagle team should generally maintain their initial altitude of **10,000 ft** and airspeed of approximately **450 knots** throughout the mission.

YOU HAVE 15 MINUTES TO COMPLETE THIS MISSION

YOUR MISSION OBJECTIVES AND SCORING

Your **Main Objective** is to ensure the survival of your entire 8-aircraft strike team (3 A-10s, 3 F-18s, and your 2 F-22s).

<u>Wolf and Eagle:</u>	Dead	= 0 points
	Damaged	= 20 points
	Undamaged	= 45 points

TOTAL POSSIBLE F-22 SURVIVAL POINTS = 90

<u>F-18s (3) and A-10s (3):</u>	Dead	= 0 points each
	Damaged	= 10 points each
	Undamaged	= 20 points each

TOTAL POSSIBLE F-18 & A-10 SURVIVAL POINTS = 120

Note. At Least One Player Team Must Survive to Earn F-18 and A-10 Points

In order to meet your main goal, you will need to destroy primary targets. Your Primary Targets are as follows:

Wolf (10 points each):	2 AAAs and 2 SAMs around WP3 2 AAAs and 2 SAMs around WP5
Eagle (20 points each):	2 SU27s around WP2 2 SU27s around WP5

TOTAL POSSIBLE PRIMARY TARGET POINTS = 160

Your secondary (bonus) targets are as follows:

Wolf (5 points each):	1 BMZ around WP3 1 BMZ between WP4 and WP5 1 BMZ around WP5
Eagle (5 points each):	1 Mig 21 around WP3 1 Mig 21 around WP5 1 M1-24 helicopters around WP6

TOTAL POSSIBLE MTS BONUS POINTS = 30

Any other enemy targets (not listed above): *0 points*

Penalty for destroying friendly aircraft and vehicles: *Wolf (-20 points each)
Eagle (-40 points each)*

TOTAL POSSIBLE MTS MISSION SCORE = 400

WAYPOINT TIMING

Timing will be critical to mission success.

Estimated elapsed mission time of arrival at designated WPs:

Total time allotted for mission: 15 minutes

Wolf		Eagle	
<u>WP</u>	<u>Mission timing</u>	<u>WP</u>	<u>Mission timing</u>
1	15:00	1	15:00
2	12:50	2	12:46
3	09:22	3	09:20
4	07:26	4	07:20
5	04:37	5	04:00
		6	01:11

WEAPONS

Your Weapons include:

Wolf:

- 1760 Cannon rounds** (multipurpose) – optimal range $\leq 2\text{mi}$
- 6 AGM65Gs** (air-to-ground, hard targets) missiles – optimal range $\leq 10\text{mi}$
- 6 AGM88s** (high-speed anti-radiation missiles) – optimal range $\leq 15\text{mi}$

Eagle:

- 1760 Cannon rounds** (multipurpose) - optimal range $\leq 2\text{mi}$
- 6 AIM120s** (air-to-air) missiles – optimal range $\leq 25\text{mi}$
- 6 AIM9Xs** (air-to-air) missiles – optimal range $\leq 10\text{mi}$

ALLIED and ENEMY OPERATIONS INFORMATION
Saudi Arabia

SITUATION REPORT 01

Saudi government is using an airstrip near grid D11 to evacuate important members of the civilian populations from combat areas. A Boeing 767 and a Lear Jet are both scheduled to be flying south through the area during your mission.

SITUATION REPORT 02

Enemy helicopters will be conducting a search and rescue mission for the pilot of a downed MIG in grids C6 through A6 during your mission.

SITUATION REPORT 03

A group of SPGs is scheduled to be engaging a group of enemy BMPs in grid F5. Time of engagement will likely overlap with your mission.

SITUATION REPORT 04

Enemy forces near grid C3 are mounting for a counter offensive. As a result, all U.S. bases in the area are at heightened defensive status.

SITUATION REPORT 05

Convoys of medical supply trucks have been spotted around grid G11. These trucks are carrying much needed supplies to the civilian population in the area.

SITUATIONAL REPORT 06

Two groups of enemy T-80 tanks have been seen traveling north through grids F8 and D7. Sources say that enemy MIGs may be providing air cover.

ALLIED and ENEMY OPERATIONS INFORMATION

Yemen

SITUATION REPORT 01

Ignoring the danger, Egyptian passenger air-travel continues to operate throughout the region. As an ally in the region, the Egyptians insist US forces must help keep this important commercial route open. Flights were have been seen moving south from grids C3 and A4 toward a commercial airfield located in grid A9.

SITUATION REPORT 02

A number of enemy SU-37s have been spotted flying through an area from grid E2 to G3 for the past three days. US F-16s have been patrolling this area to confirm these reports.

SITUATION REPORT 03

Several Mig 21s have been sighted flying through the area in recent weeks. Intelligence believes that at least two of these aircraft will be operating in your area during your mission.

SITUATION REPORT 04

Several groups of US AAAs and SPGs are positioned in grids E8, and D8. These forces will help secure that area once your attack is completed.

SITUATION REPORT 05

Enemy attack helicopters have been sighted operating between grids C5 and A5. These helicopters appear to be providing air support for enemy ground forces moving in the area.

SITUATION REPORT 06

Convoys of supply and fuel trucks have been spotted around grid C8. It is unknown whether enemy forces are operating these trucks.

ALLIED and ENEMY OPERATIONS INFORMATION

Ethiopia

SITUATION REPORT 01

A group of SPGs are scheduled to be engaging a group of BMPs in grid E9. Time of engagement will likely overlap with your mission.

SITUATION REPORT 02

Civilian fuel and Bedford trucks have been seen traveling through C9.

SITUATION REPORT 03

A flight of 3 F-16 jets are scheduled to begin a search-and-destroy mission in grids H11 through G11 just prior to the start of your mission.

SITUATION REPORT 04

Enemy M1-24 attack helicopters have been sighted operating in grids B8 and A8. These helicopters appear to be providing air support for enemy ground forces moving in the area.

SITUATION REPORT 05

A commercial airstrip located in grid D9 has remained open despite the government's orders to cancel all arriving or departing flights. Be aware of possible commercial or private aircraft that may be in the area during your mission.

SITUATIONAL REPORT 06

Enemy ground forces have been strengthening their position near grid E8. Satellite photos have identified T-80 tanks, SAMs, and AAAs among the enemy units present.

ALLIED and ENEMY OPERATIONS INFORMATION

Egypt

SITUATION REPORT 01

Enemy M1-24 attack helicopters have been sighted operating in grid A5. These helicopters appear to be providing air support for enemy ground forces as well as searching for any US ground units operating in the area.

SITUATION REPORT 02

A group of SPGs is going to be attacking a group of BMPs in grid E5. The SPGs will begin their attack as soon as you begin your mission.

SITUATION REPORT 03

Enemy trucks are traveling through grid E6. These trucks are carrying supplies and ammunition for enemy troops that have taken an offensive position near the south shore of a lake.

SITUATION REPORT 04

A commercial airstrip located in grid E6 has remained open despite the government's orders to cancel all arriving or departing flights. Be aware of possible commercial or private aircraft that may be in the area during your mission.

SITUATION REPORT 05

A US Air Force reconnaissance aircraft has identified two enemy planes travels in grid D11 and heading west. A pair of F-16s has been scrambled to intercept and will be already en route at the start of your mission.

SITUATIONAL REPORT 06

US spies have confirmed the report that an important enemy officer is overseeing enemy operating near grid B6. Because of this the number of air defense units (SAMs and AAAs) has increase in that area.

Appendix C—Coding Materials

Appendix C: Coding Instructions

Coding Instructions

The following provides operational definitions for each of three types of strategy development and examples of various levels of occurrence.

Deliberate Planning

Operational Definition:

- Creating a plan for enemy engagement
- Creating a plan for navigation

Examples

Low

“Let’s just wing it.”

Average:

“Let’s destroy all of the targets.”

High:

“We will follow the waypoints up along the river and then prioritize and destroy the targets in the canyon first.”

Contingency Planning

Operational Definition:

- Developing a plan to respond if targeted
- Developing a plan to prioritize if confronted with multiple targets

Examples

Low

“If we get targeted, just ignore it.”

“If we confront multiple targets, just shoot like crazy.”

Average

“If we get targeted, try not to get shot.”

“If we confront multiple targets, destroy the closest target first.”

High

“If we’re being targeted, destroy the most threatening first.”

Reactive Adaptation

Operational Definition

- Adjusting the flight plan in response to increased enemy activity

- Adjusting the flight of the helicopter to compensate for damage acquired during battle.

Examples

Low

Wizzo: "There are more enemies than we thought."

Pilot: "Ignore them and follow the flight path."

Average:

Wizzo: "The right engine is out."

Pilot: "Let me take her down."

High:

Wizzo: "The right engine is out."

Pilot: Let me increase the power going to the other engine to compensate."

Strategy Coding Sheet

YEMEN

ETHIOPIA

EGYPT

- 0 = Did not occur
- 1 = Hardly any skill
- 2 = Some skill
- 3 = Adequate skill
- 4 = Very much skill
- 5 = Complete skill

Deliberate Planning _____

Contingency Planning _____

Reactive Adaptation _____