A Comparative Study Analyzing the Value of Air-Carrier Pilot Surface-to-Air Fire Risk-Reduction Training

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Abstract

The terrorist-controlled surface-to-air fire (SAFIRE) threat places U.S. air-carrier pilots and passengers at significant risk. The problem addressed in this study is that air-carriers do not provide pilots with risk-reduction training designed to prepare them to deny, detect, defeat, and report SAFIRE attacks, and there is limited scholarly research to address this topic. The purpose of this quantitative, comparative study was to analyze U.S. air-carrier pilot SAFIRE risk-reduction training as related to the principles of adult learning theory that state adult learners will be more successful when they perceive training as valuable and applicable to their daily tasks and responsibilities. The analysis included descriptive statistics to determine the majority (70.5%) of 112 U.S. air-carrier pilots contained in the self-selected purposive sample perceived SAFIRE risk-reduction training as valuable. The analysis conducted using comparative statistics indicated there was not a statistically significant difference in the perception of the value of SAFIRE risk-reduction training between the four sample groups. The findings indicated the majority (85.7%) of air-carrier pilots believed an effective SAFIRE risk-reduction training program must consist of a combination of computer-based training, classroom training, and simulator training methods. Recommendations for future research are to determine if the results of this study apply to non-U.S. air-carrier pilots, identify parameters for specific countertactics, and generate specific objectives for potential training programs.

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Introduction

U.S. air-carrier pilots face the threat of a surface-to-air fire (SAFIRE) terrorist attack when conducting both domestic and international flights. Over time, the aviation industry has experienced air-carrier bombings, aerial suicides, and hijackings. These incidents have driven leaders in the Federal Aviation Administration (FAA) and the aviation industry to develop new procedures, policies, and training in an effort to mitigate the risk associated with these events. The aviation industry has recently faced an increase in risk of terrorist SAFIRE attacks against air-carrier aircraft (Elias, 2010). A SAFIRE attack occurs when a terrorist or criminal uses a ground-based weapon in an attempt to destroy an aircraft in flight. Armament designers have engineered some weapons, such as the Infrared (IR) Man-Portable Air Defense System (MANPADS), to target and destroy aircraft flying at various altitudes. Additionally, some terrorists and criminals have used ground attack weapons, such as the AK-47 assault rifle, against aircraft when dedicated weapons such as IR MANPADS are unavailable (Chivers, 2010). Some improvised weapons, such as high-power laser illuminators, also pose a serious SAFIRE threat to air-carrier pilots (Nakagawara, Montgomery, & Wood, 2011). Although leaders in the U.S. air-carrier industry could mitigate the burgeoning threat of SAFIRE attack, they have not. Two SAFIRE risk-mitigation options are available to air-carrier pilots.

Leaders in the air-carrier industry can exercise two options to deal with the SAFIRE threat. First, they could use a technological solution that will mitigate the risk associated with the IR MANPADS, but the solution would be ineffective against all other types of weapons. Second, they could provide pilots with SAFIRE risk-reduction training. This training would give air-carrier pilots the knowledge required to identify

potential threats, avoid attacks, manage the consequences associated with an attack, and report the attack incident after it is over. Government officials at the U.S. Department of Homeland Security (DHS) explored technological solutions in an effort known as the Counter-MANPADS (C-MANPADS) program, but rejected this option when the estimated cost of $1.6 million per aircraft proved to be prohibitive. To date, leaders of neither the federal government nor the aviation industry have seriously explored the SAFIRE risk-reduction training solution (Downing, 2009; Elias, 2010). In this study, I used previous research that emphasized technological solutions as the springboard for exploring the SAFIRE threat. This research provided insight into the nature of the threat, chronicled the history surrounding the issue, and gave a description of potential technological risk-mitigation tools. The existing research, however, failed to address issues related to SAFIRE risk-reduction training for air-carrier pilots. I conducted the study to address knowledge gaps by examining them through the lens of adult learning theory.

Adult learning theory states that an adult learner's perception of topic value directly influences the success of adult learning programs, including potential SAFIRE risk-reduction training programs. A higher level of perceived value equates to a higher level of motivation and an improved chance of success (Knowles, Holton, & Swanson, 2012). This study was designed to determine if (a) air-carrier pilots perceived SAFIRE risk-reduction training as valuable; (b) pilots with, when compared to those without, a military flying background perceived the value of the training differently; (c) line pilots, when compared to nonline pilots, perceived the value of the training differently; and (d) air-carrier pilots place a different level of perceived value on the various methods of

SAFIRE risk-reduction training. I identified experts within academia, the federal government, and the aviation industry as the potential recipients of the results of the study. These individuals could subsequently use the results as the foundation for future research into SAFIRE risk-reduction training for air-carrier pilots. The next section introduces a number of SAFIRE-related issues, relevant principles of adult learning theory, and illustrates the study's relevance within the aviation industry.

Background

U.S. air-carrier pilots could be better prepared to face the various types of SAFIRE threats that they could encounter while flying domestic or international routes. The SAFIRE threat places the U.S. air-carrier industry at significant risk, especially when considering that pilots of U.S. air-carriers do not receive formal training to handle these threats (J. Denton, personal communication, July 12, 2011). U.S. air-carriers currently face the global threat of terrorist groups and criminals equipped with IR MANPADS, manually aimed weapons, and laser illuminators (Elias, 2010). Each type of threat is unique in terms of capability and air-carrier pilots must use specific countertactics to mitigate the corresponding threat. The IR MANPADS threat has received the greatest amount of attention in recent years.

The design and operating characteristics of IR MANPADS make them well suited for attacks against air-carrier aircraft. IR MANPADS are portable, shoulder-fired missiles designed specifically to destroy military aircraft and helicopters in flight. Although designed for use against military aircraft, IR MANPADS are extremely effective when used against air-carrier aircraft. Widely proliferated IR MANPADS use missiles with IR seekers to identify the target aircraft and employ a guidance system to

track the target aircraft after launch (Barrios, 2009). Experts have noted approximately 20 countries (Downing, 2009), including the United States, China, Russia, Iran, and North Korea, have manufactured between 350,000 and 500,000 MANPADS since the 1970s (Elias, 2010). Terrorists have used IR MANPADS to destroy 24 civilian aircraft, of all types, since 1975 (Downing, 2009). Researchers highlighted six attacks against air-carrier type aircraft, two of which destroyed the aircraft in flight and three that damaged the aircraft beyond repair. These six attacks resulted in 171 deaths (Elias, 2010). Terrorists often seek IR MANPADS because of their affordable cost (with values typically ranging between $5,000 and $30,000 per unit) and their effectiveness (IR MANPADS have a lethality rate of approximately 33% when used against civilian aircraft). In an effort to mitigate this threat, researchers working in the DHS C-MANPADS program tested several laser countermeasure systems suitable for the U.S. air-carrier fleet. Aviation industry leaders have not implemented this solution due to the estimated $1.6 million cost per aircraft associated with installing this technology. There are countertactics that pilots could employ to reduce the effectiveness of an IR MANPADS attack (Elias, 2010), but U.S. air-carriers do not provide the training necessary for their pilots to understand the threat and use these procedures (J. Denton, personal communication, July 12, 2011). IR MANPADS are potentially the deadliest, although not the most widely proliferated, threat faced by air-carrier pilots today. In addition to IR MANPADS, air-carrier pilots face manually aimed weapons, which cannot be defeated using existing technological solutions.

The manually aimed SAFIRE weapons are unguided weapons that terrorists and criminals could use to prosecute a SAFIRE attack on an air-carrier aircraft (Elias, 2010).

To attack a target, the operator of the weapon must aim and fire projectiles at the target. If the unguided projectile misses the target, the operators must correct their aim and fire again because the rounds from these weapons do not automatically seek an aircraft like an IR MANPADS. Manually aimed weapons include the assault rifle, the ruchnoy protivotankovy granatomyot (RPG), and the antiaircraft artillery (AAA) piece. The AK-47 assault rifle, for example, is one example of the many weapons that fall within this category. Experts believe manufacturers have produced and distributed over 10 million of these rifles across the globe, making it the most proliferated assault rifle in history. The AK-47's reliability and ease of operation have made it a common choice for numerous criminal and terrorist groups around the world (Chivers, 2010). Chivers (2010) stated that the AK-47 has come to represent "the guerilla, the terrorist, the child soldier, and the thug—all of whom have found it to be a ready equalizer against morally or materially superior foes" (p. 9). The AK-47 is well suited for a SAFIRE attacks, specifically when used against a low flying aircraft on departure or arrival. Technology cannot blind or confuse the unguided rounds from a manually guided weapon such as the AK-47. Instead, air-carrier pilots must employ specific countertactics to avoid or out maneuver the projectiles. U.S. air-carrier leadership does not provide the training necessary for pilots to understand and defeat manually aimed threats. Air-carrier pilots may also encounter laser illuminators, which they must defeat using appropriate countertactics.

Terrorists and criminals can use handheld laser illuminators to distract, flash blind, and permanently injure air-carrier pilots in an attempt to blind the pilots to cause a crash (Houston, 2011). Experts initially considered laser attacks against aircraft to be a

mere nuisance, but they have become a more significant threat as laser-manufacturing technology has matured. It is now possible to purchase inexpensive laser pointers, in violation of the Food and Drug Administration legal limits, which are capable of causing retinal damage to air-carrier pilots in flight. Laser illumination incidents against aircraft in the United States increased by a factor of 37 between 2004 and 2008. Seventy-three percent of the 2,492 reported laser illumination incidents involved air-carrier aircraft (Nakagawara et al., 2011). The frequency of laser incidents within the United States, the impact on flight safety, and the potential physiological damage to pilots illustrate the need to mitigate the risk associated with this threat. Air-carriers do not employ technology capable of reducing the risk associated with laser attacks (Houston, 2011). Instead, air-carrier pilots must employ countertactics to reduce the effectiveness of a laser illuminator attack. Experts have developed countertactics for laser illuminator attacks (Nakagawara et al., 2011) but U.S. air-carriers do not provide the formal training necessary for their pilots to understand the laser illuminator threat and use the necessary risk-mitigation procedures (J. Denton, personal communication, July 12, 2011). The success of this type of training program would be at risk of failure if air-carrier industry leaders did not develop and administer the training in accordance with the principles of adult learning theory.

Air-carrier pilots are adult learners, and a SAFIRE risk-reduction training program should incorporate the relevant tenets of adult learning. Adult learning theory researchers state that training is more successful if the learner believes that the material is relevant and applicable to their lives or jobs (Knowles et al., 2012). I used this study to determine if air-carrier pilots, divided into four sample groups for analysis, believe that

SAFIRE risk-reduction training is relevant. Additionally, I used air-carrier pilots' experiences to determine which method of training would be most effective if air-carrier industry leadership develops SAFIRE risk-reduction training. Existing material shows how leaders in the aviation industry practically apply the principles of adult learning theory contained in academic sources, which include *The Adult Learner* (Knowles et al., 2012) and *Aviation Education and Training* (Henley, 2003). I augmented this literature with industry specific sources to include the *Aviation Instructor's Handbook* (FAA, 2008) and the *IFALPA Pilot Training Standards* (IFALPA, 2012). The *Aviation Instructor's Handbook* contains a synopsis of adult learning theory and makes it applicable to individuals who do not have a formal background in education and the *IFALPA Pilot Training Standards* offer instructional techniques for individuals designing air-carrier pilot training programs. Finally, I synthesized SAFIRE-related background material, scholarly adult learning theory information, literature describing practical application of adult learning theory within the aviation industry, and statistical analysis to generate a number of conclusions that may be relevant to training and security experts within academia, the federal government, and the aviation industry. Ultimately, the lack of effective air-carrier SAFIRE risk-reduction training programs put air-carrier crewmembers, passengers, the U.S. air-carrier industry, and the U.S. economy at risk. The scholarly research in this study provides a foundation for future research that could help air-carrier pilots mitigate the risks associated with the SAFIRE threat. Until then, the problem will continue to exist and the lack of knowledge regarding SAFIRE risk-reduction training will continue to leave air-carrier pilots unprepared to face a growing number of widely proliferated SAFIRE threats.

Statement of the Problem

Modern-day air-carriers do not provide pilots with formal risk-reduction training designed to prepare them to avoid, detect, defeat, and report SAFIRE attacks. The focus of aviation industry and DHS risk-reduction efforts to date has been on C-MANPADS technology, while SAFIRE risk-reduction training options have received no scholarly investigation or professional discussion (Elias, 2010). There is also a lack of research to indicate if air-carrier pilots perceive this training as valuable (J. Denton, personal communication, July 12, 2011). In addition, it may be that a lack of existing research on SAFIRE risk-reduction training has prevented leaders in the FAA and air-carrier industry from developing SAFIRE risk-reduction training programs. The problem addressed in this study is that air-carriers do not provide pilots with risk-reduction training designed to prepare them to deny, detect, defeat, and report SAFIRE attacks, and there is limited scholarly research to address this topic.

Purpose of the Study

The purpose of this quantitative, comparative study was to analyze air-carrier pilot SAFIRE risk-reduction training and its value as related to the principles of adult learning theory. U.S. air-carrier pilots lack formal training in SAFIRE risk-reduction techniques and are not able to mitigate the risk associated with most SAFIRE threats (T. Shackouls, personal communication, October 18, 2012). Leaders in the air-carrier industry could rectify this shortfall with training, but that training would only be effective if the air-carrier pilots believe that it is relevant and applicable. Prior to developing any training program for adult learners, adult learning theory highlights the importance of ensuring the learner perceives the training as valuable (Samaroo, Cooper, & Green,

2013). Adult learning theory indicates that a lack of perceived value can reduce or eliminate the effectiveness of training. The study examined this issue by determining the level of value air-carrier pilots place on SAFIRE risk-reduction training by using quantitative analysis and comparative research designs. This quantitative survey study included four research questions regarding SAFIRE risk-reduction training within the air-carrier pilot community. These questions helped quantify the perceived value of SAFIRE risk-reduction training and determined the desired training method or methods appropriate for this training. After completing data collection in accordance with the methodology outlined in Chapter 3, I analyzed the results and determined that the learners (air-carrier pilots) believed that SAFIRE risk-reduction training is valuable and that the respondents viewed the combination of Computer Based Training (CBT), classroom training, and simulator training as the most desirable training method. I selected individuals from academia, the air-carrier industry, and the federal government as potential recipients for the information from the study, because of their influence over the development of future policies and training programs. The four research questions have a theoretical foundation rooted in adult learning theory and have generated results that will contribute to the body of scholarly knowledge within the fields of business, aviation, education, and homeland security.

Theoretical Framework

The theoretical framework for this study included material produced by adult learning scholars, information from homeland security researchers, and instructional material generated by experts within the aviation industry. Adult learning theory, with an emphasis on two key andragogical principles, was explored using the texts *The Adult*

Learner (Knowles et al., 2012), and *Aviation Education and Training* (Henley, 2003) as the primary sources of information. The primary sources of scholarly information on aviation security were *Airport and Aviation Security* (Elias, 2010), *Missile and Defensive Systems and the Civil Reserve Air Fleet* (Downing, 2009), and *Valuing a Homeland Security Policy: Countermeasures for the Threats from Shoulder Mounted Missiles* (Smith et al., 2009). The two primary texts that provided instructional material from within the aviation industry, the *Aviation Instructor's Handbook* (FAA, 2008) and the *IFALPA Pilot Training Standards* (IFALPA, 2012), were not scholarly in nature but effectively demonstrated the practical application of adult learning theory in aviation. The wealth of theoretical information on adult learning theory helped to define the objectives of this study. The aviation-security-related research material helps the reader understand context and shows why the results of the study are relevant. The aviation instructional material illustrates how aviation instructors practically apply adult learning theory principles. The adult learner's perception of the topic was the first element of adult learning theory leveraged as part the theoretical framework of the study.

Perceived importance of topic value to an adult learner. The theory of andragogy states that training is more successful if adult learners perceive the topic as being relevant and applicable to their lives. Adult theory scholars identify two key andragogical principles that are relevant to this research (Knowles et al., 2012). Adult learners need to see the relevance of the training program and understand its importance for a training program to be successful (Henley, 2003). Knowles et al. (2012) contended that adult learners should experience a real-world requirement that they believe the training program would fill. This theoretical concept is significant and experts should

consider the ramifications of this andragogical tenet when developing SAFIRE risk-reduction training programs. The results of this study could help academics, researchers, and curriculum development experts tailor SAFIRE risk-reduction training material to the preconceived notions of adult learners, increasing the likelihood of developing successful SAFIRE risk-reduction training programs. The high level of perceived value identified by the descriptive and comparative analysis validated the need for developing SAFIRE risk-reduction training programs. By contrast, a low level of perceived value, or the failure to employ this theoretical foundation properly, would have been indicative of a SAFIRE risk-reduction training program's potential failure. The second tenet of adult learning theory establishes a relationship between life experience and the potential success of training programs.

Leveraging an adult learner's experience in training. Adult learning theory indicates that adult learners are more successful if training relates to actual life experience. According to Knowles et al. (2012), a learner's life experience broadens as the individual transitions from childhood to adulthood. Instructors must consider this when developing training programs for adult learners. Training programs for adults are most successful when the developers take into account the broad range of life experiences that adults carry with them to the training program (Knowles et al., 2012). The independent life experience variables selected for this study were determined to have little effect on an air-carrier pilot's perception of the value of SAFIRE risk-reduction training. The research determined that military experience (military or nonmilitary) did not significantly influence the adult learners' perception of the topic, but that job position (line or nonline pilot) did appear to very slightly influence the adult learners' perception.

The study also involved leveraging the prior experience of adult learners to determine what training method or methods were most suitable for a potential SAFIRE risk-reduction training program.

Using air-carrier pilot input to determine desired training methods. The final portion of this study determined which potential SAFIRE risk-reduction training methods air-carrier pilots prefer. Air-carrier pilot instructors frequently prepare their pilots using CBT, classroom training, and simulator training methods (Henley, 2003). This training often involves using a constructivist approach, which aviation instructors often refer to as the building block theory, to administer training. Trainers begin by using CBT to introduce a topic. In some cases, the topic will require additional classroom training. Additionally, classroom topics that require specialized psychomotor skills may include flight simulators. The study determined that air-carrier pilots believed that SAFIRE risk-reduction training would be most effective if it used all three methods (CBT, classroom training, and simulator training). This portion of the study leveraged respondent knowledge of training methods, based on their previous training experiences, and identified the best option for potential SAFIRE risk-reduction training programs. I leveraged respondent experience to identify the level of value air-carrier pilots place on SAFIRE risk-reduction training and the level of value they place on the three potential training methods. Academia, individuals from the federal government, and aviation curriculum experts could use the results from this portion of the study to develop and implement SAFIRE risk-reduction training programs. The success of this study hinged on my ability to combine three categories of disparate information into a single product with applicability to multiple disciplines.

Synthesis of the theoretical framework underpinning this study. The theoretical framework for this study contained specific elements of adult learning theory, aviation security, and aviation instruction. I used the work of adult learning theory pioneer Malcolm Knowles (Knowles et. al, 2012) and other education scholars to include Thorndike, Dewey, and Kolb (FAA, 2008) as the foundation for my theoretical framework. The product produced by this synthesis of theoretical concepts served to produce scholarly information that is of interest to researchers from multiple disciplines. The synthesis of concepts began following the realization that the aviation industry was not taking steps to mitigate the risk of SAFIRE attack against air-carrier aircraft. Research indicated that the aviation industry has rejected the risk-mitigation technology and has not pursued risk-mitigation training. Before developing the research questions and hypotheses, it was important to understand how the aviation industry applies adult learning theory when instructing aviation professionals. The relationship between theory and practical application became the foundation for my SAFIRE risk-reduction training-based research questions and hypotheses by using adult learning theory to identify principles capable of influencing the success of training within the aviation industry. The study integrated material from the disciplines of education (adult learning theory), security (mitigation of risks associated with criminal and terrorist attacks), aviation (an understanding of aviation training), and business (the potential financial incentives for SAFIRE risk-reduction training) and generated scholarly research useful for educational scholars, federal policy experts, and aviation professionals. This synthesis of theory is apparent in the study's research questions and hypotheses.

Research Questions and Hypotheses

The study included four research questions and eight corresponding hypotheses to define the objectives of this quantitative study. *Educational Research: Competencies for Analysis and Applications* (Gay, Mills, & Airasian, 2012) and *Statistics in a Nutshell: A Desktop Quick Reference* (Boslaugh, 2013) contained the research techniques used to develop the research questions and hypotheses. I developed these questions to define the study's objectives. My first research objective defined the need to determine whether respondents believe there is a need for training to develop the skills necessary to avoid, detect, defeat, and report SAFIRE threats. My second research objective identified the requirement to determine whether the perceived level of value of the proposed training differs between the active air-carrier community and the air-carrier professional instructor corps. My third research objective highlighted the need to explore the possibility that air-carrier pilots with military experience may perceive the importance of SAFIRE risk-reduction training differently than pilots without military experience. My final research objective identified the necessity to determine if air-carrier pilots believe a particular method of training is best suited for SAFIRE risk-reduction training. The more than 12,000 air-carrier pilots employed by a major U.S. air-carrier were eligible to receive the Likert-type survey electronically. A group of 132 air-carrier pilots chose to participate and 112 respondents provided usable anonymous survey responses. A detailed discussion of the following research questions and hypotheses appears in Chapter 3. The following questions and hypotheses guided me throughout the project:

RQ1: What value, if any, do air-carrier pilots place on SAFIRE risk-reduction training?

$H1_0$: The majority of air-carrier pilots sampled do not value SAFIRE risk-reduction training.

$H1_a$: The majority of air-carrier pilots sampled do value SAFIRE risk-reduction training.

RQ2: What difference in value, if any, do air-carrier pilots place on the potential SAFIRE risk-reduction training methods?

$H2_0$: There is no significant difference in the value air-carrier pilots place among the three potential SAFIRE risk-reduction training methods (CBT, classroom, and simulator training).

$H2_a$: There is a significant difference in the value air-carrier pilots place among the three potential SAFIRE risk-reduction training methods (CBT, classroom, and simulator training).

RQ3: What is the difference, if any, between air-carrier pilots with prior military flying experience and those without prior military flying experience in terms of the value placed on SAFIRE risk-reduction training?

$H3_0$: Prior military flying experience makes no difference in the level of importance that air-carrier pilots place on SAFIRE risk-reduction training.

$H3_a$: Prior military flying experience makes a difference in the level of importance that air-carrier pilots place on SAFIRE risk-reduction training.

RQ4: What is the difference, if any, between line air-carrier pilots and nonline air-carrier pilots in terms of the level of importance placed on SAFIRE risk-reduction training?

$H4_0$: There is no difference in the level of importance of SAFIRE risk-reduction training based on pilot type (air-carrier line pilots and air-carrier nonline pilots).

$H4_a$: There is a difference in the level of importance of SAFIRE risk-reduction training based on pilot type (air-carrier line pilots and air-carrier nonline pilots).

Nature of the Study

The study utilized a quantitative research design. A quantitative design was appropriate for this study because ratings of perceived importance of SAFIRE risk-reduction training and ratings of the relative value of various types of SAFIRE risk-reduction training are readily quantifiable (Gay et al., 2012). A qualitative research design was not appropriate for this study because a qualitative design would not have effectively answered the research questions regarding the perceived value of different kinds of training, the differences in perception between the sample groups, and the respondent's perceptions of the importance of SAFIRE risk-reduction training. The research included a comparative study to compare the mean scores of different pairs of four sample groups.

The population of interest in this study consisted of U.S. commercial air-carrier pilots (both air-carrier line pilots and air-carrier nonline pilots). The study population was from a U.S flagged air-carrier that flies both domestic and international routes and employs approximately 12,000 pilots (T. Shackouls, personal communication, October 18, 2012). The four sample groups consisted of air-carrier line pilots, air-carrier nonline pilots, air-carrier pilots with military experience, and air-carrier pilots without military

experience. The study included a Kruskal-Wallis test to compare line air-carrier pilots against nonline air-carrier pilots and air-carrier pilots with military flying experience against air-carrier pilots without military flying experience to determine if there were differences in perceived values between these groups. I determined the minimum sample size using G*Power software, generating a minimum desired purposive sample of 73 respondents for the possible Analysis of Variance (ANOVA) analysis (with a medium effect size $f = .15$ and an alpha significance level of .05). Since the sample group distributions proved to be nonnormal, I used a Kruskal-Wallis test in lieu of an ANOVA analysis. The study also involved identifying the overall level of value air-carrier pilots place on SAFIRE risk-reduction training and preferred method of training using an analysis of descriptive statistics (Boslaugh, 2013). This population provided results that are applicable to air-carrier pilots across the U.S. aviation industry. The results have contributed to the body of scholarly knowledge and may be of interest to researchers and individuals developing SAFIRE risk-reduction training programs.

Significance of Study

The study was significant because the results contribute to existing SAFIRE risk-reduction training efforts from academia, the federal government, and the aviation industry. This study involved analyzing air-carrier pilot SAFIRE risk-reduction training as related to the principles of adult learning theory. The results helped determine if air-carrier pilots believe there is a legitimate requirement for SAFIRE risk-reduction training. The results also helped to identify an optimal method of training. Results indicating a low level of perceived interest from the air-carrier pilot population would have indicated a reduced possibility of success for potential SAFIRE risk-reduction training programs

(Knowles et al., 2012). Academic researchers, federal regulators, and aviation industry leadership could use these results to develop programs to help alleviate this shortfall within the aviation industry. This type of solution would equip air-carrier pilots with SAFIRE risk-reduction capabilities to mitigate the risk associated with a SAFIRE attack and the potential loss of life and economic backlash associated with an air-carrier loss. The next section contains definitions relevant to this study.

Definition of Key Terms

This section contains operational definitions for the following terms. I used these terms to identify specialized topics and to provide context for the reader throughout the study.

Air-carrier. An air-carrier is an airline that provides air transportation of passengers and cargo (Nolly, 2011).

Air-carrier line pilot. An air-carrier line pilot is an air-carrier captain or first officer of an air-carrier aircraft whose only duty is to conduct scheduled passenger or cargo transportation flights. A typical air-carrier line pilot flies approximately 85 hours per month (J. Denton, personal communication, July 12, 2011).

Air-carrier nonline pilot. An air-carrier nonline pilot is an air-carrier pilot whose primary duties are other than conducting scheduled passenger and cargo flights. This population includes pilots in management, training, and evaluation positions. An air-carrier nonline pilot flies approximately 15 hours per month and focuses on optimizing procedures to reduce air-carrier costs (J. Denton, personal communication, July 12, 2011).

Captain. The captain is the pilot-in-command who is responsible for the safe operation of the aircraft (Nolly, 2011).

Civilian-only flying experience. Civilian-only flying experience refers to one of two sample groups of air-carrier pilots examined within the study. The term refers to an air-carrier pilot who has not completed training as a crewmember serving in the U.S. Air Force, U.S. Army, U.S. Marines, U.S. Navy, U.S. Coast Guard, or foreign equivalent (T. Shackouls, personal communication, October 18, 2012).

Crewmember. An individual assigned to perform duties aboard an aircraft, which include the pilots (captains), copilots (first officers), and flight attendants (Nolly, 2011).

First officer. The first officer is the copilot aboard an aircraft. This individual is qualified to operate the aircraft but is not in command and does not hold the same level of responsibility as the captain (Nolly, 2011).

Prior military flying experience. Prior military flying experience refers to one of two sample groups of air-carrier pilots examined within the study. The term refers to an air-carrier pilot who has completed training as a crewmember serving in the U.S. Air Force, U.S. Army, U.S. Marines, U.S. Navy, U.S. Coast Guard, or foreign equivalent. An assumption is that pilots with prior military flying experience have, at some point during military service, had exposure to formal or informal training associated with SAFIRE threats (T. Shackouls, personal communication, October 18, 2012).

Summary

The goal of this quantitative, comparative study was to analyze air-carrier pilot SAFIRE risk-reduction training as related to the principles of adult learning theory. This

quantitative study involved an examination of the perceived value air-carrier line pilots place on SAFIRE risk-reduction training, compared to the perceptions of air-carrier nonline pilots, and determined if formal military training resulted in influenced perceptions within either group. The study also indicated which training methods air-carrier pilots preferred if an air-carrier implemented a SAFIRE risk-reduction training program. The sample, consisting of self-selected air-carrier pilots, used an online Likert-type survey to quantify the respondents' perceptions of SAFIRE risk-reduction training. The four research questions and eight hypotheses supported the quantitative research design, which consisted of a descriptive statistical analysis and a comparative statistical analysis. The research questions and hypotheses helped to determine the level of value the population of air-carrier pilots, and the four sample groups, placed on SAFIRE risk-reduction training and which SAFIRE risk-reduction training methods air-carrier pilots considered the most effective. The population consisted of approximately 12,000 line and nonline air-carrier pilots. G*Power software generated the minimum desired purposive sample of 73 respondents for a potential ANOVA analysis. The study included four paired sample groups. One paired sample group consisted of pilots with civilian-only flying experience, and the other consisted of pilots with prior military flying experience. The other paired sample consisted of line pilots and nonline pilots. The study compared the difference in perception between the paired sample groups to determine if there is a significant difference between groups. The sample groups determined which method of SAFIRE risk-reduction training they perceived as the most effective. The study also involved analyzing the results to determine if the air-carrier pilots believed that SAFIRE risk-reduction training is valuable. Results indicated that air-carrier pilots

deemed SAFIRE risk-reduction training as valuable and that a combination of CBT, classroom, and simulator training were the most desirable. Furthermore, decision makers within academia, the air-carrier industry, and the federal government can use the results as the foundation for further research into SAFIRE risk-reduction training (Boslaugh, 2013). The material presented in this chapter includes an overview of the study. The literature review, contained in Chapter 2, contains additional information on SAFIRE-related issues, adult learning theory, and the practical application of adult learning theory within the aviation industry. The description of this study's research method contained in Chapter 3 includes the procedures used to gather data, conduct analysis, and maintain academic rigor and ethical assurances. Chapter 4 contains the specific results of RQ1 through RQ4, hypothesis testing, additional findings, and an evaluation of the findings. Chapter 5 includes the study's implications, recommendations, and conclusions.

Chapter 2: Literature Review

The purpose of this quantitative, comparative study was to analyze air-carrier pilot SAFIRE risk-reduction training and its value as related to the principles of adult learning theory. The quantitative method was suitable for gathering, storing, and analyzing the large amounts of data required for testing the theories within the research questions and hypotheses (Wiggins, 2011). Additionally, quantitative research is a recognized research method commonly used when researching topics related to psychology, criminology, and terrorism (LaFree & Freilich, 2011). The qualitative research method was not optimal for the study because this approach would have required developing a portfolio of case studies based on inputs from the members of the population, which may have been difficult or impossible to quantify (Creswell, 2014). The study determined the majority of members within the air-carrier pilot population desired the implementation of a SAFIRE risk-reduction training program and identified which training methods air-carrier pilots viewed as most valuable. The study also determined there was no difference of perception of value between the two sample groups. Additionally, respondents indicated that air-carrier pilots would prefer SAFIRE risk-reduction training programs that use a combination of CBT, classroom, and simulator training. The logical organization of the main areas within this literature review consists of material on SAFIRE-related issues, adult learning theory, and the practical application of adult learning theory within the aviation industry. The first section includes information on the post-9/11 threat environment, proliferation of the SAFIRE threat, and methods of risk reduction. The second section contains scholarly information on adult learning theory and andragogy. The third section shows how

instructors apply adult learning theory within the aviation industry and how tenets of adult learning theory relate to SAFIRE risk-reduction training. The fourth section contains a synthesis of empirical research related to this study, and the fifth section includes a description of the gaps in literature. The sixth section contains a summary of the literature review. Before discussing these topics, I will recap the process used to identify relevant literature in the documentation section.

Documentation

Online database research led to relevant articles, studies, reports, and books for the literature review. The following Northcentral University library databases contained a preponderance of the literature needed for this study: Ebrary, LexisNexis, ProQuest, SAGE Journals Online, Roadrunner, and SAGE Knowledge Online. The searches included simple and Boolean searches containing terms including, but were not limited to, adult learning theory, air defenses, airline pilot training, andragogy, antiaircraft artillery, counter-MANPADS, education, e-learning, insurgent, laser, MANPADS, nonstate actors, simulator, Somalia, targeting process, and terrorist. The literature review opens with an examination of the post-9/11 threat environment. This section indicates that SAFIRE threats pose a legitimate threat to air-carrier aircraft and that the aviation industry recognizes the threat (Barrios, 2009; Dawson, 2011; Downing, 2009; Elias, 2010; Finucane, 2012; Grismer, 2010; Houston, 2011; Nakagawara et al., 2011; Smith et al., 2009). The review also includes a number of relevant adult learning theory principles (Knowles et al., 2012; Phipps, Prieto, & Ndinguri, 2013; Samaroo et al., 2013), demonstrates how to apply these principles within the aviation industry, and shows how they apply to the topic of SAFIRE risk-reduction training (FAA, 2008; Henley, 2003;

Jethro, Grace, & Thomas, 2012; Lateef, 2010; Radovic-Markovic, 2010). Research found that adult learning theory, including some of the principles of andragogy, would directly affect the potential success of SAFIRE risk-reduction training programs (Henley, 2003; Knowles et al., 2012). Finally, the review closes with an examination of three empirical studies (which illustrate the current state of academic research surrounding this effort) and a section identifying gaps in the existing literature. The process begins by providing a context for the research topic by examining the threat posed by post-Cold War terrorism.

Air-Carrier Aircraft as Targets of SAFIRE Attack

The threat posed by terrorist groups, and the corresponding SAFIRE risk to air-carrier operations, has increased in the decades following the Cold War. The end of the Cold War and the collapse of the Soviet Union empowered a number of dangerous nonstate organizations to emerge onto the world scene (Boyle, 2011). The post-Cold War destabilization of global security triggered the emergence of numerous nonstate groups willing to use terrorist tactics against larger foes. These organizations employ terrorist tactics because this approach often gives the weaker nonstate group the ability to strike against its larger foe in a cost-effective manner. Many terrorist groups use violence as a means of drawing attention to their political message (Alimi, 2011) or as a way to strike an economic blow against a foe. These groups often attempt to stage spectacular attacks, like the al Qaeda attack of 9/11, in an attempt to garner attention from the news media (Asthappan, 2009). A U.S. air-carrier aircraft carrying hundreds of passengers is a prime target for a terrorist group seeking to execute a spectacular attack. A successful SAFIRE attack may have a cascading effect that could affect the occupants of the

aircraft, their families, the U.S air-carrier industry, and the global economy. A successful SAFIRE attack on even a single U.S. air-carrier aircraft could trigger global economic losses in the estimated range of $40 billion to $400 billion, based on the level and duration of confidence loss suffered by air travelers (Elias, 2010). Overseas operations often increase the level of risk faced by the crew and passengers because the flight moves the aircraft closer to the terrorist threat while simultaneously moving it farther away from the protection of U.S. law enforcement organizations. Additionally, weapon availability, aircraft vulnerability, potential media reaction, and potential economic impact make this type of attack an effective tool for terrorist groups seeking to strike against American interests. To mitigate the risk associated with this threat, air-carrier leadership can equip the aircraft with protective technology or can provide crewmembers with training to help them mitigate the risk when facing the SAFIRE threat. DHS experts have pursued a technological solution, which has not been a cost-effective option. The potential loss of life and economic impact associated with a successful SAFIRE attack justifies scholarly research into the topic of SAFIRE risk-reduction training. The Civil Reserve Air Fleet (CRAF) program, which uses civilian air-carriers to support U.S. military operations, may make some U.S. air-carrier aircraft even more desirable as terrorist SAFIRE targets.

The Civil Reserve Air Fleet. The CRAF is a voluntary program for U.S. air-carriers administered by U.S. Transportation Command, which rapidly and inexpensively expands military airlift when a crisis arises. Participation within the program earns the participating air-carrier domestic and international military contract incentives (Imbriani, 2012). The CRAF makes it possible for leaders in the U.S. Department of Defense to use U.S air-carrier aircraft to meet emergency airlift requirements. The U.S. military is an

expeditionary force equipped to conduct operations across the globe. The success of the U.S. military hinges on its ability to deploy, sustain, and recover troops and equipment. The responsibility of U.S. Transportation Command is to provide the U.S. Department of Defense with the ability to transport personnel, supplies, and equipment across the globe. Airlift aircraft provide a rapid response, when compared to mobilization using ships, railways, or land vehicles, and provide reliable access to remote and landlocked areas. When a crisis arises, military airlift requirements often overwhelm the existing military airlift capability. The CRAF uses U.S. air-carrier aircraft to augment U.S. military airlift capability (Grismer, 2010). U.S. Transportation Command can task the CRAF to move up to 90% of America's troops and 40% of its cargo in time of war, emergency, or other military conflict and has done so in the past (Imbriani, 2012). The CRAF is critical to the U.S. national defense and it is possible that terrorists could focus on the vulnerable CRAF aircraft and prosecute a SAFIRE attack similar to the 2003 IR MANPADS attack against a DHL Airbus A300 near Baghdad International Airport. The SAFIRE threat during CRAF operations has been minimal to date, but CRAF pilots operating near war zones could benefit from SAFIRE risk-reduction training.

Currently, CRAF pilots do not receive SAFIRE risk-reduction training, even though they are flying missions in support of U.S. military operations, because CRAF aircraft do not operate from airfields with a SAFIRE threat rated as high (Downing, 2009). Historical events have shown, however, that SAFIRE threats can appear unexpectedly with little warning before an attack (Elias, 2010). Terrorist organizations could target CRAF aircraft as targets for SAFIRE attacks in environments previously assessed as permissive. Air-carrier pilots who volunteer to fly CRAF missions could

benefit from SAFIRE risk-reduction training due to their proximity of operations to nonpermissive environments and the potential that terrorist groups hoping to disrupt CRAF operations could specifically target their aircraft. A successful attack could be capable of slowing or stopping the flow of troops, cargo, and equipment in support of military actions and may justify the expense associated with SAFIRE risk-reduction training. This study examined three types of SAFIRE threats, beginning with IR MANPADS.

The SAFIRE Threat Posed by IR MANPADS

Terrorists have used a number of different weapons to prosecute SAFIRE attacks against transport aircraft similar to those in use by many U.S. air-carriers, including IR MANPADS. Statistics from Elias (2010) indicate that terrorists have used IR guided antiaircraft missiles (like the U.S. Stinger missile), known as IR MANPADS, to attack 36 civilian aircraft since 1983. Of these 36 attacks, terrorists destroyed 24 aircraft, including propeller-driven aircraft, helicopters, small business jets, and large air-carrier aircraft. These statistics show the effectiveness of the weapon, but "do not provide any particular insight into the political motivation behind shooting attacks carried against civilian aircraft in the current context of the global war on terrorism and the global terror threat" (Elias, 2010, p. 314). IR MANPADS are portable, shoulder-fired missiles designed specifically to destroy aircraft. These systems use an IR seeker to identify the target aircraft in flight and employ a guidance system to steer a missile toward the target aircraft after launch (Barrios, 2009). Over two dozen groups, including al Qaeda, the Taliban, the Chechen rebels, Hezbollah, Somali National Alliance, and the Revolutionary Armed Forces of Columbia, have acquired IR MANPADS. The proliferation of IR MANPADS

has been difficult to track and experts estimate that anywhere between 5,000 and 150,000 IR MANPADS may be under the control of terrorist organizations. Terrorist groups seeking IR MANPADS may be able to purchase them on the black market with typical prices ranging between $5,000 and $30,000. U.S forces have captured more than 5,000 IR MANPADS in Afghanistan alone (Elias, 2010). U.S. authorities are aware of the threat of IR MANPADS, both domestically and globally, and use air traffic control to announce potential IR MANPADS events if they occur near U.S. airfields. One of the most recent reported incidents occurred on April 25, 2012 near Zamperini Field, California. When pilots tuned into a recorded broadcast of airfield conditions, they heard a message that contained an alert that stated, "Attention all aircraft: reported MANPADS threat, exercise extreme caution for the LA [Los Angeles] area and surrounding airports, reported by internal security at 1200 local time" (Aero News Network, 2013 p. 1). No SAFIRE attacks occurred and air traffic control eventually removed the warning from the airfield conditions recording. This incident shows that FAA authorities recognize the potential impact posed by the IR MANPADS threat and have developed procedures to notify pilots of pending attacks. Despite FAA progress, individual air-carriers have not trained their pilots in effective SAFIRE countertactics or equipped their aircraft with C-MANPADS capable of mitigating the risk posed by IR MANPADS. Failure to provide air-carrier pilots with risk-mitigation tools, in the form of either equipment or training, reduces the effectiveness of the FAA MANPADS notifications. The DHS and aviation industry have pursued C-MANPADS, but the leaders of U.S. companies have not widely implemented these systems.

The DHS Counter-MANPADS program. The C-MANPADS program is a DHS-led initiative designed to take existing military counter-MANPADS technology and adapt it for use within the U.S. aviation industry. The U.S. Congress chartered this program in the wake of a failed 2002 IR MANPADS attack against an Israeli Boeing 757 operating out of Mombasa, Kenya. DHS leaders tasked researchers from the DHS Science and Technology Directorate to determine how to use military-style IR MANPADS defensive systems on air-carrier aircraft. The researchers examined a pyrotechnic countermeasures option and a laser-based countermeasures system. Aircraft carrying pyrotechnic countermeasures eject flares as decoys to confuse or blind the missile's IR seeker head. Leaders at DHS rejected this option after determining that it was too dangerous for use by U.S. air-carrier aircraft. DHS researchers also examined Directed Infrared Countermeasure Systems that use lasers to blind IR missile-seeker heads. The results of the Directed Infrared Countermeasure Systems tests were promising but the cost of installation ($1.6 million per aircraft) and the cost of annual operations and sustainment ($310,000) was too high to implement on the more than 6,000 aircraft within the U.S. air-carrier fleet (Elias, 2010). Additional research indicated that a $14 billion program would cost each U.S. citizen approximately $100 to $200 per year (Smith et al., 2009). The technologically focused DHS approach has failed to render significant results for two primary reasons. First, although the technology is effective, the installation and operation costs associated with counter-MANPADS systems makes this solution cost prohibitive. Additionally, this solution fails to address non-MANPADS threats. Although the bulk of the effort has focused on C-MANPADS, research has

shown that pilots can learn to use countertactics to mitigate the risk associated with various SAFIRE threats.

Countertactics for IR MANPADS. Air-carrier pilots can use a number of countertactics to avoid the threat, detect the attack, and defeat IR MANPADS operators. Air-carrier pilots can complicate terrorists' targeting solution by varying approach and departure patterns, flying above 20,000 feet, delaying landing-light activation, and executing specific procedures when operating out of high threat airfields (Elias, 2010). Downing discussed the utility of countertactics and indicated that air-carrier pilots cannot employ countertactics without formal training and authorization from their company (Downing, 2009). The lack of C-MANPADS and the absence of air-carrier pilot SAFIRE risk-reduction training may encourage air-carrier pilots to try to develop untrained, untested, and unsafe tactics that could place the aircraft and its occupants at greater risk than the potential threat. The second category of threats, manually aimed weapons, further justifies the need for SAFIRE risk-reduction training.

The SAFIRE Threat Posed by Manually Aimed Weapons

The manually aimed threat category refers to all unguided weapons, both dedicated and improvised, that terrorists could use in a SAFIRE attack. Manually aimed weapons are devices that fire unguided projectiles, which include high-caliber firearms, rocket-propelled antiarmor munitions, mortars, and missiles (Elias, 2010). The operator of a manually aimed weapon must aim the weapon before prosecuting an attack because the projectile does not actively seek the target like an IR MANPADS. If the shot misses the target aircraft, the operator must adjust the aim and fire again. I will examine three

representative types of manually aimed weapons include the assault rifle, the RPG, and the AAA gun.

The first example of a common manually aimed weapon is the AK-47 assault rifle. Soldiers typically use the AK-47 for ground combat but can use it to prosecute successful SAFIRE attacks against low flying aircraft. The AK-47 uses visual aiming, has a magazine that typically holds up to 30 rounds of 7.62-mm ammunition, and is the most widely proliferated assault weapon in the world with over 10 million rifles in production (Chivers, 2010). The second example of a manually aimed weapon is the widely proliferated RPG anti-tank weapon.

The RPG, often referred to as a rocket-propelled grenade by Western military forces, is a shoulder-fired weapon used to launch explosive rounds against ground targets. Somali militants improvised tactics and used RPG attacks to destroy a pair of U.S. Army Black Hawk helicopters over Mogadishu, Somalia, in 1993 (Dawson, 2011). The RPG demonstrates that terrorists and criminals can repurpose surface-to-surface weapons to achieve successful SAFIRE attacks. The third example of a manually aimed weapon is the ZU-23 AAA gun.

The ZU-23 is a crew-served lightweight AAA gun that is available in single and multi-barrel configurations. Many ZU-23s can fire up to 800 23-mm antiaircraft rounds per minute (Barrios, 2009). Operators visually aim the gun and can attack an aircraft during takeoff, landing, or in flight. The high availability and low cost of many manually aimed weapons make them an attractive option for many terrorist groups (Elias, 2010). To defeat the threat of manually aimed weapons, air-carrier pilots must make their aircraft an elusive target using countertactics, which will help them to avoid the threat. If

avoidance fails, then the air-carrier pilot should immediately execute a maneuver to complicate the operator's shot without over stressing the airframe or crashing the aircraft. Fortunately, there are a number of countertactics well suited to minimize the effects manually aimed threats.

Countertactics for manually aimed weapons. Air-carrier pilots can use a number of countertactics to mitigate the risk associated with manually aimed weapons. Air-carrier pilots can climb quickly in an attempt to use rapid altitude gain to reduce exposure, vary approach and departure patterns, delay landing-light activation at night, and maneuver the aircraft (within prescribed operational limits) if they detect an attack (Elias, 2010). Air-carrier pilots mitigating the threat of manually aimed weapons should begin by determining likely locations for attacks and avoiding those locations when possible. If this is impossible, the air-carrier pilot must identify the threat and execute the appropriate countertactic upon detection of an attack. Air-carrier pilots also routinely face the threat posed by individuals using laser illuminators, which has increased in frequency and risk in recent years.

The SAFIRE Threat Posed by Lasers Illuminators

In recent years, researchers have identified an increase in the number of incidents of laser illumination attacks against aircraft. U.S. pilots reported 2,492 laser illumination incidents between January 1, 2004, and December 31, 2008, with air-carrier aircraft being the target in over 73% of these incidents (Nakagawara et al., 2011). In these encounters, individuals on the ground targeted air-carriers with handheld laser pointers, which are capable disorienting the pilot, blinding the pilot, and placing the aircraft at risk of crash. Initially, air-carrier pilots faced little risk from handheld lasers but the risk has increased

as high-powered lasers have become available through Internet outlets. In *Aircrew Exposure to Handheld Laser Pointers: The Potential for Retinal Damage,* Houston (2011) noted,

> At one website, it is possible to purchase a green laser pointer pen with a 532-nm wavelength and an average power output of 2000 mW for less than $150. . . Such devices have the potential to produce immediate retinal injury when aircrew operating at low altitude are exposed. These high-power lasers are advertised as "laser pointers" and may look identical to low-power pointers. (p. 921)

To illustrate the proliferation of this threat, researchers indicate that there was a 37-fold increase in incidents between 2004 and 2008. The spike in reported incidents in the U.S. and the increased strength of commercially available laser pointers makes laser illuminators a legitimate threat to U.S. air-carriers. Fortunately, countertactics exist to counter the hand-held laser illuminator threat.

Countertactics for laser illuminators. To defeat a laser attack, air-carrier pilots should first anticipate the possibility of the incident and prepare to transfer controls if blinded by a laser illuminator. If illuminated, pilots should turn the aircraft away from the laser, shield their eyes, increase cockpit lighting, and report the incident. If blinded, pilots should transfer aircraft control or engage the autopilot. Pilots should also seek medical attention if their eyes become irritated or if vision impairment occurs (Nakagawara et al., 2011). These countertactics are both simple and effective. Trained air-carrier pilots could employ these in conjunction with other countertactics if they encountered an attack that used a combination of threats. Although pilots can use countertactics to mitigate the risk associated with SAFIRE attacks, the countertactics will

not eliminate all risk. Trained air-carrier pilots can increase the odds of achieving a favorable outcome if trained effectively. To develop training capable of preparing pilots to defeat these threats, it is necessary to design a training program that builds upon the tenets of adult learning theory.

Adult Learning Theory

I selected adult learning theory as the theoretical foundation for this study because this theory shows that an adult learner's perception of topic value directly influences the success of adult learning programs, including potential SAFIRE risk-reduction training programs (Knowles et al., 2012). I found it necessary to understand the theoretical basis for adult learning theory, and its relationship to the *Aviation Instructor's Handbook* (FAA, 2008), before I examined the methods of training used within the aviation industry. I began the process by examining the concepts associated with the three common educational perspectives, the five learning orientations, and the adult learning theory of andragogy. Next, I identified how aviation instructors practically apply adult learning theory concepts using the *Aviation Instructor's Handbook* and the International Federation of Air Line Pilots' Associations' (IFALPA) document *IFALPA Pilot Training Standards: Guide for Best Practices* (IFALPA, 2012). This section includes synthesized information from the primary sources.

The main source on adult education theory was *The Adult Learner: The Definitive Classic in Adult Education and Human Resource Development* (Knowles et al., 2012). The source used to show how aviation instructors apply adult learning theory within the global aviation industry was *Aviation Training and Education* (Henley, 2003). Also used were the *Aviation Instructor's Handbook*, which is a federally recognized standard for

U.S. aviation instructors, and the *IFALPA Pilot Training Standards* to show the relationship between adult learning theory and practical application within the aviation industry. The first section contains a summary of adult learning theory, beginning with an examination of the three common educational perspectives normally recognized by instructors within the aviation industry.

Common educational perspectives in adult learning. Many educational researchers describe the adult learner using three common educational perspectives: the developmental and psychological perspective, the sociological perspective, and the integrated perspective. Advocates of the developmental and psychological perspective emphasize the adult's role in the learning process. Supporters of this theory assume that adult learners are self-directed and will leverage their prior experience when learning new tasks (Henley, 2003). The humanistic learning theory known as andragogy includes elements of the developmental and psychological perspective (Samaroo et al., 2013). Advocates of the sociological perspective describe the adult learner in terms of individual background and believe that an instructor must take adult learners' gender, age, socioeconomic background, and marital status into account when providing instruction. They also believe this approach ensures adult learners who fall outside of the perceived norm (which is affluent, white, and middle class) receive an effective education (Henley, 2003). Advocates of the integrated perspective describe the learner using physiological, psychological, sociological, and developmental terms. These individuals postulate that an instructor must understand the learner before creating an effective plan of instruction. Researchers believe this approach encourages instructors to tailor training material to the adult learner's individual background (Henley, 2003). Educational scholars use these

three perspectives to create generalizations about the characteristics of adult learners. Although these generalizations are valuable, they may not always be accurate. Despite possible exceptions, instructors regularly apply elements of each of these perspectives while instructing adult learners within the aviation industry. In addition to describing the adult learner, educational researchers describe the learning process using five common learning orientations: behaviorist, cognitive, social orientation, constructivist, and humanistic orientations.

Common learning orientations. Many education researchers use five common learning orientations to describe the learning process. These scholars have classified characteristics of learning into behaviorist, cognitive, social orientation, constructivist, and humanistic orientations. My examination of these five learning orientations acts as a primer and provides a framework of reference while reviewing adult learning theory as applied by the aviation community. Later sections show how the *Aviation Instructor's Handbook* (FAA, 2008) employs several common learning orientations. It is likely that any SAFIRE risk-reduction training program would use instruction crafted to meet multiple learning orientations, because trained aviation instructors can identify and respond to an adult learner's specific learning orientations. I will begin by describing the behaviorist orientation, which draws heavily on stimulus–response models of conditioning.

Advocates of the behaviorist orientation, also known as behaviorism, state that human and animal behaviors are explainable in terms of stimulus–response. Proponents of this theory believe the goal of learning is behavior change and that learners can achieve this through conditioning induced by observable stimuli. The learner's reaction

to the observable stimulus then triggers a reward or a punishment (Henley, 2003). Behaviorists tend to focus on observable behavior, believe that stimulus shapes all behavior, and claim that conditioning can modify behavior. Psychologist E. L. Thorndike's connectionist conditioning theory states that the consequences of an action can strengthen or weaken the relationship between stimulus and response. Arguably, Thorndike's best-known contributions to the field of adult learning are included in Thorndike's laws of learning, which appear within many FAA instructional texts (FAA, 2008). Detractors of the behaviorist orientation believe that not all of Thorndike's results, which he frequently derived from animal experimentation, are applicable to human learning. Furthermore, they believe that education goes beyond the simple relationship between stimulus and response. Despite this criticism, education texts still refer to elements of the behaviorist orientation when they reference Pavlov's classical conditioning of dogs and Thorndike's laws of learning (Henley, 2003). A portion of SAFIRE risk-reduction training could utilize stimulus-response training. The syllabus development team would need to ensure that SAFIRE risk-reduction training provides the learner with the ability to correctly identify specific visual threat signatures and immediately respond with the correct corresponding countertactic. The syllabus development team could use stimulus-response training as one way to achieve this goal. In the next section, I will now describe of the cognitive orientation, which focuses on the learner's internal mental processes in lieu of stimulus–response conditioning.

Advocates of the cognitive orientation, also known as cognitive theory, emphasize the mental processes necessary for learning to occur. Proponents of this theory believe the learner takes an active role in all learning and consider how the learner pays attention,

relates new knowledge to old knowledge, and understands the learning process. Cognitive orientation theorists have identified five different types of learning: learning intellectual skills, cognitive strategies, information, motor skills, and attitudes (Henley, 2003). Although the *Aviation Instructor's Handbook* does not specifically list these five types of learning, it does differentiate between them when discussing the differences between giving instruction in a classroom, which may focus on information learning skills, and giving instruction while operating an aircraft, which may focus on learning motor skills. In the next section, I will examine the social learning orientation, which focuses on incidental learning.

Advocates of the social learning orientation, also known as the social learning theory, recognize that a significant amount of learning occurs outside formal instruction venues. Social learning occurs when learners observe a model or behavior and then imitate the example (Henley, 2003). Aviation professionals employ social learning theory inadvertently while conducting day-to-day operations. Less experienced pilots will observe the behavior and decisions made by more experienced pilots as they fly together. This behavior, positive or negative, will often mold junior pilots' approach to making decisions, leading a crew, and enforcing discipline within the crew (FAA, 2008). Aviation instructors may not set out to accomplish social learning but they must be aware of the concept to ensure inadvertent learning is positive. Instructors must not cut corners or willingly violate procedures, because it is likely that their students may follow this example, despite the instructors' verbal instruction to the contrary. In the next section, I will explore the constructivist orientation, which focuses on the learning process.

Advocates of the constructivist orientation, also known as constructivism, focus on the learning process and posit that learning occurs when learners meld new information with previous experiences. As a result, students reevaluate old information and integrate existing knowledge with new information. The synthesis leads to an improved understanding of concepts. Aviation instructors frequently employ constructivism in the workplace when pilots participate in on-the-job training (Henley, 2003). In these situations, instructors may serve more as learning coaches than lecturers providing formal instruction. Instructors may find constructivism more applicable to simulator training than to classroom training. The fifth section contains a description of the humanistic orientation, which emphasizes learners' role within the education process.

Advocates of the humanistic orientation, also known as the humanist theory, emphasize the learner's role in the education process and place a heavy emphasis on personal freedom and learner enrichment. Proponents of this theory support instructors acting as facilitators, and for their being responsible for providing a safe and comfortable environment for learners. They also view the education process as a journey and often place little emphasis on specific goals or the development of technical skills. Practitioners of humanist theory focus on the learner and the learner's goals instead of the instructor or the curriculum. Educational researcher Malcolm Knowles used humanist theory as the foundation for his andragogical learning model, which is a widely recognized theory of adult learning (Henley, 2003). Knowles used the theory of andragogy to define many tenets of adult learning theory recognized by contemporary scholars of adult learning. The final section of the adult learning theory portion of this study contains a description of Knowles's andragogical model.

Andragogy. Malcolm Knowles pioneered adult learning theory by developing andragogy and identifying a series of characteristics to differentiate between adult and child learners. Knowles's theory, derived from the common learner orientations presented earlier, provides a framework for some of the tenets of adult learning theory that directly affect this study. Advocates of Knowles's research believe that adults are normally more self-motivated than children, adults possess experience that they can leverage during instruction, adult learning readiness improves if the learner perceives the task is useful, and adult learners will want to apply their new skills quickly (Samaroo et al., 2013). Conaway (2009) identified four principles unique to adult learners (a) adult learners must know why they need to learn something before learning the material; (b) adult learners will be more successful if they build upon prior experiences; (c) adults become ready to learn when they have a real-world need for the learning; and (d) adult learners have internal motivation. Critics argue that andragogy fails to address a number of types of adult learners and use examples to show that not all adult learners comply with Knowles's andragogical model. One example, citied by the theories detractors, arises when an adult learner lacks prior relatable skills and fails to take control over their learning. When this occurs, the adult learner has failed to comply with the basic tenets of andragogy. Despite this criticism, leaders in the aviation industry frequently recognize value in the theory and apply the tenets of andragogy in practical learning situations. Most air-carrier pilots fit the andragogical model and are likely to understand why they need to attend SAFIRE risk-reduction training; they will have a sufficient level of professional aviation experience to build upon. To comply with the andragogical principles related to motivation and applicability, air-carrier pilots must believe SAFIRE

risk-reduction training is relevant and valuable or the training may be unsuccessful. In the next section, I demonstrate how aviation industry instructors practically apply the adult learning principles discussed in this section.

Practical Application of Adult Learning Theory within the Aviation Industry

The *Aviation Instructor's Handbook* is the industry-recognized standard for practical instruction within the U.S. aviation industry. The authors of the *Aviation Instructor's Handbook* effectively integrate elements of psychology and adult learning theory into a product specifically geared toward adult learners in aviation. The text contains a set of approved instruction principles that serve as the theoretical foundation for instructors within the U.S. aviation industry. The handbook is the instructional standard for aviation training programs throughout the industry (FAA, 2008). FAA instructional techniques are a synthesis of a number of principles selected from adult learning theory, and the *Aviation Instructor's Handbook* indicates how aviation professionals will apply adult learning theory during day-to-day instruction. FAA evaluators ensure aviation instructor candidates demonstrate an understanding of these techniques during written, oral, and practical instructor certification evaluations. In the following section, I compare and contrast the concepts contained within the *Aviation Instructor's Handbook* and the adult learning theory principals contained in *The Adult Learner* (Knowles et al., 2012), and *Aviation Education and Training.*

Learning theories emphasized within the *Aviation Instructor's Handbook.*

The authors of the *Aviation Instructor's Handbook* use four learning theories to describe instruction within the aviation industry. An examination of each theory identifies differences between the scholarly material and practical application. The authors initially

summarize behaviorism and information processing theory. They subsequently present information on cognitive theory and constructivism in detail (FAA, 2008). The learning theories included in the text emphasize the learner's active participation in learning process, and overshadow the behaviorism model. The authors indicate that students learn better by taking a participatory role in the instruction, and support this theory using Thorndike's laws of learning (Henley, 2003). The *Aviation Instructor's Handbook* contains material describing the information processing theory, cognitive theory, constructivist theory, and behaviorist theory, with material that is sometimes incomplete and out of context. Despite these shortfalls, the FAA instructional approach appears to provide aviation instructors with a solid overview of the four learning theories. The next section contains a summary of the information processing theory and focuses on how an adult learner uses their memory during instruction.

Use of the information processing theory by aviation instructors. FAA instructors use the information processing theory to explain how the human mind records and accesses data. Proponents of this theory believe experience acts as a filter and places greater emphasis on knowledge that relates to an individual's prior learning. The authors of the *Aviation Instructor's Handbook* (FAA, 2008) use this theory to describe how the human mind filters new information and emphasizes a learner's use of sensory memory, short-term memory, and long-term memory. An aviation instructor who understands this theory may be able to present information in patterns that support productive adult learning by effectively using repetition and review techniques. The next section covers the information processing theory and contains information on the concepts of sensory memory, short-term memory, and long-term memory.

The *Aviation Instructor's Handbook* contains a discussion on how learners process information through sensory memory, short-term memory, and long-term memory. Learners begin to process information after receiving input from one or more of the five senses. After receiving the input, learners will either discard the input or store it within short-term memory. Additionally, learners are more likely to retain an input if it stimulates multiple senses. When learners transfer sensory input into short-term memory, they normally retain it for approximately 30 seconds. At this point, they will either discard the input or transfer it to long-term memory. Information transfer occurs more effectively with repetition, or if learners consciously or unconsciously attach significance to the information. Long-term memory is most effective when new information relates to previous learning. Aviation instructors can encourage information transfer to long-term memory by employing a building-block approach with periodic lesson reviews. Instructors and learners must recognize that long-term memory is imperfect and that personal bias, perception errors, and natural forgetfulness influence learners' ability to recall information (FAA, 2008). Instructors within the aviation industry frequently use a building-block approach to relate new knowledge to existing knowledge. Research shows this approach is applicable to potential SAFIRE risk-reduction training programs. If instructors use a single training method, the objectives and syllabus should ensure the material provides a sufficient amount of repetition. If instructors use multiple training methods, they should ensure each training session builds on the information from the previous session. The instructor should also highlight critical concepts in a way that encourages learners to recognize the topic's significance. The next section contains information on the cognitive theory, which focuses on learners' mental processes.

Use of the cognitive theory by aviation instructors. FAA-trained instructors use the cognitive theory to explain the relationship between adult learning and learners' perceptions, awareness, problem-solving methods, and decision-making processes. John Dewey, a pioneer of cognitive theory, introduced the concept of reflective thought and believed it is necessary for learners to relate new concepts with existing experiences and ideas. Scholars and educators refer to reflective thought as critical thinking (FAA, 2008). D. A. Kolb elaborated on the concept by noting the learning cycle consists of two components. The first component is the experience and the second component is the reflective activity associated with the experience (Henley, 2003). The authors of the *Aviation Instructor's Handbook* (FAA, 2008) do not cite Kolb directly, but instead provide a synthesis of Dewey and Kolb's ideas. Aviation professionals must understand and apply academic material in a dynamic environment while ensuring adult learners have the critical thinking ability to react to fast-paced or abnormal situations, including those associated with SAFIRE attacks. In the next section, I will provide background on the constructivist theory, which focuses on the cumulative nature of adult learning.

Use of the constructivist theory by aviation instructors. FAA-trained instructors use the information cognitive theory to explain the relationship between learner experiences and new learning. The authors of the *Aviation Instructor's Handbook* (FAA, 2008) identify constructivist theory as a derivative of cognitive theory and highlight the cumulative nature of learning. Additionally, Knowles et al. (2012) highlights the importance of relating new and preexisting information. The term constructivism refers to learning when "humans construct a unique mental image by combining preexisting information with the information received from sense organs"

(FAA, 2008, p. 2-4). Aviation industry instructors often apply constructivism using the building-block style of teaching. Aviation instructors employ the building-block concept by organizing objectives that use adult learners' prior knowledge, sometimes gleaned from earlier lessons, as the foundation for new learning. Proper execution of the building-block concept begins with the instructor becoming familiar with the learner's knowledge of the topic. The instructor then uses objectives and lesson plans that build on the preexisting background. Instructors use the building-block training concept because it is effective and it makes learning more manageable for learners. Adult learners often benefit from this approach when they receive a boost in confidence upon completing individual blocks of training (FAA, 2008). Instructors use building-block theory throughout the aviation industry to leverage adult learners' previous experience. Instructors can also use this predictable format to design training sessions that provide repetition of relevant information. Instructors developing SAFIRE risk-reduction training programs are likely to use the building-block theory when designing the training material. The final theory contained in the *Aviation Instructor's Handbook* is the behaviorist theory, which highlights the need for instructors to provide positive reinforcement to the learner.

Use of behaviorist theory by aviation instructors. FAA-trained instructors use the behaviorist theory to illustrate instruction techniques that effectively use the stimulus–response model to change behaviors of adult learners. Authors of the *Aviation Instructor's Handbook* (FAA, 2008) recognize the validity of behaviorist theory, but recommend that instructors apply the theory using positive, and not negative, reinforcement. The individual controlling the learning environment should provide

positive feedback when the adult learner performs in a desired manner. The authors recommend against the use of negative physical or verbal reinforcement (FAA, 2008). Aviation instructors can best employ this approach when dealing with observable behaviors and measurable performance standards, and by integrating behaviorist reinforcement techniques with other instructional techniques. Instructors could face difficultly providing positive feedback if the behavior is difficult to observe (e.g., cognitive processes) or if success is difficult to quantify (e.g., teamwork building). Aviation instructors must blend their instructional technique with the training methods to ensure learners achieve the training objectives. Potential SAFIRE risk-reduction training program instructors will need to select appropriate adult learning theory principles and apply them to a selected training method, which could be CBT, classroom, or simulator training.

Air-Carrier Pilot Training Methods

It is necessary to understand the three complementary air-carrier pilot training methods (CBT, classroom, and simulator training) in use by U.S. air-carriers before examining the methodology, results, and recommendations contained in this study. Air-carrier instructors use CBT, classroom training, and simulators to provide pilots with training that would be too expensive or dangerous to conduct in an actual aircraft (Henley, 2003). It is necessary to have some familiarity with various training methods prior to determining which method the population and sample groups identify as being the best suited for SAFIRE risk-reduction training. In the following section, I will discuss the advantages and disadvantages of the various training methods (CBT, classroom, and simulator training) used in the aviation industry.

Professionals within the aviation industry have embraced CBT and work to maximize its advantages while minimizing its disadvantages (FAA, 2008). CBT is an efficient way to transfer standardized knowledge and gives students the opportunity to set the pace of training (Jethro et al., 2012). CBT is cost effective as it reduces instructor and facility expenses (Radovic-Markovic, 2010). According to the *Aviation Instructor's Handbook* (FAA, 2008), instructors should not use CBT as a stand-alone method of instruction.

> For most aviation training, the computer should be thought of as a valuable instructional aid and entrusting an entire aviation training program to a computer is not practical. Even airline simulator programs require tailoring and hands-on interaction with a human instructor. (p. 4-19)

Instructor interaction provides feedback to the student, and the key to the success of CBT is feedback. The CBT material must give learners timely and accurate feedback or the training may be ineffective (Henley, 2003). CBT is a low-cost training method suitable for introduction of topics, but it is a method with limitations, particularly if the learner has detailed questions or if the learner requires psychomotor skills training. In the next section, I explore the characteristics of classroom training.

The classroom training method, which often takes place in either lecture or discussion format, has several notable strengths and weaknesses. Instructors can use classroom training to process real-time learner feedback actively and modify their presentation to meet learner requirements (FAA, 2008). An instructor can also plan lectures and discussion sessions to meld learning objectives with the learners' backgrounds. Classroom instructors should strive to capitalize on spontaneous

occurrences that may complement the session's objectives (Henley, 2003). The classroom method is a flexible and effective way to present information and evaluate student performance, but it is not always an effective way to train psychomotor skills. Classroom instruction is time consuming for both the instructor and the student, and is often more expensive than CBT but less expensive than simulator training. There is also the chance that classroom-training sessions may have less standardization due to presentation variations between instructors (J. Denton, personal communication, July 12, 2011). In aviation, some air-carriers use classroom training both as a stand-alone training method and in conjunction with CBT or simulator training. I will conclude by discussing the strengths and weaknesses the simulator training method.

Simulator training, like CBT and classroom training, has a number of advantages and disadvantages worthy of consideration. Simulators provide air-carrier pilots with a venue for learning psychomotor skills, decision-making, and teamwork. Simulators provide a high-fidelity training environment that emulates an aircraft in flight. Instructors often use simulators to provide psychomotor training to deal with situations that would be too expensive or dangerous to perform in flight in an actual aircraft (Henley, 2003). Many aviation professionals view simulators as excellent training tools, but simulators are typically very expensive to operate and are often in short supply (J. Denton, personal communication, July 12, 2011). Simulator training is also time intensive, because the training sessions require the presence of both an instructor and a student. Instructors must be available to prepare students before the session, administer the training, evaluate the performance, and review the training session with the students (Henley, 2003). A search of the existing literature revealed only one attempt at

implementing a civilian SAFIRE risk-reduction training program, which used the classroom training method exclusively.

Existing risk-reduction training courses. Although three training methods are available, the only civilian SAFIRE risk-reduction training program I identified used the classroom training method exclusively. Alion Science and Technology instructors briefly offered an Aviation Threat Awareness and Counter-Tactics Training Course for pilots flying small business aircraft for private companies in 2003, but discontinued the course in 2005. Alion representative David McClure, a former C-130 pilot for the U.S. Air Force, noted that the course received positive reviews from students, yet faced resistance from upper-level corporate management owing to concerns regarding insurance and liability issues (personal communication, February 13, 2009). McClure also felt that the economic downturn of the aviation industry "really closes the door on adding anything that would increase training costs (such as adding course content and/or simulator scenarios)" (personal communication, February 13, 2009). Alion instructors first offered the course at the National Business Aircraft Association Convention in 2003 as a three to four hour course in a classroom setting. The instructors discussed threat capabilities, vulnerability reduction, and consequences management following an incident. The Alion staff administered the final version of the course one additional time to a corporate customer in August 2005. Empirical data was not available to quantify the level of learner interest or motivation, and no formal feedback was available for review (D. McClure, personal communication, February 13, 2009). Additional details regarding the Alion curriculum and courseware were unavailable. The lack of existing SAFIRE risk-reduction training programs motivated me to create four notional objective categories for

potential SAFIRE risk-reduction training. The four notional objectives, discussed below, categorize key skills that would be valuable to air-carrier pilots facing a SAFIRE threat.

Notional objective categories for SAFIRE risk-reduction training programs. A number of desired air-carrier pilot SAFIRE risk-reduction skills exist and fit into four notional categories. Aviation education researcher Henley (2003) highlighted the importance of developing well-defined objectives when developing training programs. Instructors can use these objectives to categorize information, evaluate performance, and allocate resources (Henley, 2003). Four notional objective categories will serve as a framework for this and future research on SAFIRE risk-reduction training. Each skill will fall within one of the following objective categories: deny, detect, defeat, or report. The basis for the objective category names is the U.S. Army targeting process, which uses a decide, detect, deliver, and assess framework (Gomez, 2011). Captain J. Denton, air-carrier pilot, validated the notional objective categories and suggested the training use a building-block approach by injecting SAFIRE risk-reduction training objectives into existing air-carrier training syllabi. Denton believed this approach, instead of building a training syllabus focusing specifically on SAFIRE risk-reduction training, would be less expensive and potentially more palatable to air-carrier company leadership (personal communication, July 12, 2011). Individuals from academia, the aviation industry, and the federal government can use these categories to identify key goals prior to building a standalone SAFIRE risk-reduction training program or by integrating these objectives into existing training events. These categories might help to identify desired areas of expertise during data collection. I will use the next paragraph to discuss the deny objective.

When air-carrier pilots apply tactics that deny an adversary the opportunity to prosecute a SAFIRE attack, they have mitigated the risk effectively. The deny objective category may help air-carrier pilots develop the skills necessary to prevent an adversary from easily acquiring and attacking the air-carrier aircraft. The deny objective differs from the decide term used in the U.S. Army targeting process, because the objective is to prevent the adversary from gaining an opportunity (Gomez, 2011). The SAFIRE risk-reduction training program will prepare students by training them in existing techniques that reduce predictability of an aircraft's flight path and minimize the aircraft's visual signature by moderating the use of aircraft lighting. This tactic can make the air-carrier aircraft a less desirable target and may increase the aircraft's survivability (Elias, 2010). If air-carrier pilots are able to deny an attack, they have eliminated the need to detect, defeat, or report the threat. When the air-carrier pilot is unable to deny the attacker the opportunity to engage the target, it becomes necessary to detect the threat.

An air-carrier pilot must be able to detect the SAFIRE attack before applying countertactics to defeat the threat. Instructors should use the detect objective category to train air-carrier pilots to identify pre-attack activity and recognize visual indications associated with weapons utilization. The term detect, adapted from the U.S. Army targeting process, refers to the pilot's ability to notice, identify, classify, and locate a threat (Gomez, 2011). SAFIRE risk-reduction training would provide air-carrier pilots with methods of visually identifying various types of SAFIRE threats. This objective category would make it possible for air-carrier pilots to recognize that an attack is occurring, identify the weapon, spot the projectile, and understand the weapon's capabilities. Failure to identify suspicious activity or actual weapons employment will

make it impossible for air-carrier pilots to respond to an attack. After detection, air-carrier pilots must be able to apply the proper countertactic to defeat the SAFIRE attack.

To defeat the attack, air-carrier pilots must avoid the threat, if possible, and land the aircraft safely. Instructors should use the defeat objective category to train air-carrier pilots to outmaneuver the threat, which is impossible in many cases, or to land an aircraft with damage from an attack. Defeat training should prepare air-carrier pilots to execute specific avoidance maneuvers without putting the aircraft at risk. These maneuvers may be as simple as initiating a climb if attacked by small arms fire or changing heading if a laser is blinding a pilot. Aviation security expert Elias (2010) noted noncatastrophic attacks are likely to be survivable if the pilots have received proper training. The term defeat replaces the U.S. Army targeting process term deliver. In this situation, the term deliver represents air-carrier pilots' ability to employ or deliver effective countertactics against the threat. I have replaced the term deliver in an effort to reduce potential confusion within the aviation community. A potential SAFIRE risk-reduction training program should prepare pilots to execute specific maneuvers when encountering various threats because a trained air-carrier pilot is less likely to employ a dangerous improvised tactic. Additionally, instructors should ensure air-carrier pilots have the piloting skill and decision-making ability to fly and land a damaged aircraft following a SAFIRE attack. After the attack, the air-carrier pilots must also be able to report the incident in an effort to prevent further attacks against other aircraft.

Air-carrier pilots trained to make an effective report may help mitigate risk for other aircraft operating in the area. Instructors should ensure that air-carrier pilots understand the need to note the position of their aircraft when the attack occurred, the

visual indications associated with the attack, and the point of origin of the attack. SAFIRE risk-reduction training should also provide air-carrier pilots with techniques for reporting the incident to other aircraft and air traffic controllers (Elias, 2010). I replaced the term analyze, from the U.S. Army targeting process, with the term report, because the air-carrier pilots will serve as witnesses in an incident but are not trained or qualified to conduct formal intelligence analysis (Gomez, 2011). Instructors should ensure air-carrier pilots understand what information is important when providing an immediate report to air traffic control, their company, and other aircraft. The pilots should also understand what information might be necessary when completing a post incident investigative report to law enforcement and intelligence agencies after landing. After researching scholarly and industry material, I shifted my focus and reviewed a number of empirical sources related to the SAFIRE threat, business, adult learning theory, and aviation training.

Synthesis of Empirical Research Related to This Study

I categorized the relevant documents within this section as academic background material, SAFIRE-related information, business, adult learning theory-related information, or applied adult theory within aviation. The academic background material contains a quantitative dissertation that includes an analysis of the perceptions of air-carrier crewmembers. The empirical sources on SAFIRE include a cost–benefit analysis of C-MANPADS, which I also treated as a business topic (Smith et al., 2009). The research within the adult learning theory category contains information on learner motivation and contains a study, which quantifies the perceived effectiveness of air-carrier pilot abnormal procedures training. These documents represent the existing body

of knowledge surrounding relevant topics and address a number of key issues. I used the first document, a Northcentral University dissertation, as the starting point for the methodology of this study.

In the dissertation titled *Analyzing Commercial Flight Crew Perceptions' Regarding Airline Security Effectiveness, Morale, and Professionalism,* Belanger (2008) explored air-carrier crewmember perceptions of Transportation Security Administration (TSA) services using a quantitative analysis. Belanger collected the required data from 624 air-carrier crewmembers and used a two-sample *t*-test, two-way ANOVA, and Tukey Honest Significant Difference Test for analysis. The dissertation served as a starting point while developing the methodology for this study. Although the methodology has subsequently evolved, this dissertation appears in the literature review as a source of academic background material. Subsequently, SAFIRE-related material gleaned from a study on C-MANPADS implementation augmented the academic background information gleaned from the Belanger dissertation.

In the article titled "Valuing a Homeland Security Policy: Countermeasures for the Threats From Shoulder Mounted Missiles," Smith et al. (2009) discussed the economic impact of a terrorist IR MANPADS attack and provided a cost–benefit analysis regarding the cost of C-MANPADS systems. This team of researchers generated a cost–benefit analysis on a SAFIRE attack capable of grounding air-carriers for one week, which would trigger an immediate loss of $240 to $420 billion and would trigger a recovery period of one year. Their results indicated that each American citizen would be willing to pay $100 to $200 annually for a $14 billion C-MANPADS program if the risk was sufficient (Smith et al., 2009). After review, I found the results of this study are

consistent with information contained in a number of technical sources. First, it is clear that aviation and business experts recognize the potential financial impact of an aircraft loss to a SAFIRE attack. Second, I noticed the focus of the research was on IR MANPADS and that researchers failed to consider manually aimed systems (which was a common trend throughout the bulk of the research). Third, despite having results that indicate the American public supports the idea of funding C-MANPADS programs, there has been no widespread implementation of C-MANPADS technology within the aviation industry. Finally, this research included no mention of other risk-mitigation options, including SAFIRE risk-reduction training. Next, I reviewed a study conducted by adult learning researchers, which reinforced the theoretical foundation I developed for this study.

In the article titled "Teaching an Old Dog New Tricks: Investigating How Age, Ability, and Self-Efficacy Influence Intentions to Learn and Learning Among Participants in Adult Education," the researchers addressed the impact of adult learner intentions and motivations. They showed that adult learners with a high desire to learn had greater success than those with lower motivation or less interest in the topic. These results were consistent with the adult learning theory presented earlier, which states that adult learning is less successful if the learner does not believe in the importance of the topic. The information provided by Phipps et al. (2013) validates the selection of adult learning theory as the theoretical foundation for this study. The perception of value the air-carrier pilot places on a SAFIRE risk-reduction training problem will heavily influence its potential effectiveness. Determining the level of learner interest in SAFIRE risk-reduction training will help individuals from academia, the federal government, and

the aviation industry determine the potential effectiveness of future SAFIRE risk-reduction training programs. A review of the literature revealed aviation instructors regularly use adult learning theory principles when they follow the instructional practices outlined in the *Aviation Instructor's Handbook*. A limited amount of information is available on this topic, and this empirical source served to validate information contained in the *Aviation Instructor's Handbook* and in the text of the *IFALPA Pilot Training Standards*. I also discovered a relevant article describing how air-carriers train pilots to execute emergency procedures and multiple tasks during in-flight emergencies.

In the article titled *The Effectiveness of Airline Pilot Training for Abnormal Events,* Casner, Geven, and Williams (2013) recounted the findings from their study, in which they evaluated air-carrier pilot training for abnormal events. Casner et al. discovered that most airlines use a scripted approach to prepare air-carrier pilots for abnormal and emergency situations and that air-carrier pilots perform well under those circumstances. They also learned that less predictable circumstances result in a lower level of performance. Casner et al. recommended that instructors present abnormal situations in a realistic manner, which will surprise the learners and force them to rely on decision-making rather than rote memorization. Although this article did not include SAFIRE risk-reduction scenarios, I found it relevant and applicable to this study. A SAFIRE attack is an abnormal situation, and the research shows that an air-carrier pilot's ability to respond to emergencies increases if they receive simulator training. Casner et al. also highlighted the need for abnormal situation training, which could include SAFIRE risk-reduction training, and indicated that scenario-based simulator training will render better results than non-scenario-based simulator training. Using the material in

this section, I was able to leverage existing empirical studies while simultaneously ensuring that this study did not duplicate other scholarly efforts.

The empirical research contained in this study included methodological guidance, validated theoretical concepts, and showed that existing data collected through scientific observation and analysis was consistent with the other types of source material I selected for this study. The information contained in this section showed me that scholars have examined subjects related to SAFIRE risk-reduction, adult learning theory, and the practical application of this theory but they have not directly examined any SAFIRE risk-reduction training issues (Belanger, 2008; Casner et al., 2013; Phipps et al., 2013; Smith et al., 2009). Despite this limitation, I was able to use the information in this section to validate the material contained in nonempirical sources and to identify gaps in existing literature.

Gaps in the Literature

Although researchers have conducted studies on the SAFIRE threat, adult learning, and the practical application of adult learning techniques within the aviation industry, there remain several gaps in the literature regarding the perceived value of SAFIRE risk-reduction training, desired training methods, specific countertactic effectiveness, and recommendations on the most effective way to administer training. First, there is a lack of research to quantify the level of perceived value air-carrier pilots place on SAFIRE risk-reduction training. Second, researchers have not identified which SAFIRE risk-reduction training methods air-carrier pilots consider adequate. Third, there is a lack of scholarly literature identifying the effectiveness of individual countertactics. Finally, there is a lack of research to identify the most effective methods of SAFIRE risk-

reduction training. These last two topics fall outside the scope of this study, but are legitimate gaps in literature and could serve as future research topics. Researchers could work with individuals in academia and the military to determine which countertactics are most suitable for a specific aircraft, SAFIRE threat, and phase of flight. Countertactics are general and may not take advantage of differences in location, weather, and aircraft performance (Elias, 2010). Future researchers could also identify the most effective methods of administering SAFIRE risk-reduction training. In the study *The Effectiveness of Airline Pilot Training for Abnormal Events*, Casner et al. (2013) examined abnormal procedures training for air-carrier pilots and learned that the use of standardized training regimes "leaves learners with narrow, memorized understandings of problem situations that do not generalize well to situations that do not match the ones they see in training" (Casner et al., 2013). Casner et al. (2013) recommended that air-carrier pilot training present abnormal training events in a less predictable manner to improve the surprise and confusion associated with an incident in the real world. A SAFIRE attack is an abnormal event. As a result, SAFIRE risk-reduction training could be administered using methods that comply with the research by Casner et. al. Individuals developing SAFIRE risk-reduction training programs should attempt to comply with this guidance. In this section, I examined the background information, empirical research, and gaps in the literature, which I review in the summary below.

Summary

I conducted the literature review to ensure topic originality and to identify sources of relevant empirical research. The review revealed a lack of scholarly exploration of SAFIRE risk-reduction training (Downing, 2009; Elias, 2010; Grismer, 2010; Smith et

al., 2009) but showed that scholars have examined the threat, the air-carrier industry, adult learning theory, and practical instruction techniques within the aviation community (Casner et al., 2013; Elias, 2010; Samaroo et al., 2013). Additionally, the research contains information that quantifies the potential economic impact of a successful terrorist or criminal SAFIRE attack and shows how a trained air-carrier pilot could use countertactics to mitigate the risk associated with the type of attack (Elias, 2010). The review of literature indicated that (a) individuals within the U.S. government and air-carrier industry recognize the risk and potential impact of the SAFIRE threat; (b) aviation industry leaders have focused almost exclusively on C-MANPADS technology, which is not in use, and have placed little emphasis on air-carrier pilot risk-reduction training; (c) no U.S. air-carriers are conducting formal SAFIRE risk-reduction training; (d) researchers have not determined if the majority of air-carrier pilots believe that SAFIRE risk-reduction training would be valuable; and (e) the learners' perception of topic importance will affect the success of a SAFIRE risk-reduction training program. The literature review illustrated the necessity to ensure that potential SAFIRE risk-reduction training programs use the tenets of adult learning. As a result, I used adult learning and andragogy as the theoretical foundation. Adult learning theory scholars use the andragogical model to demonstrate why the success of a training program hinges on the motivation of adult learners. Andragogical theory states that adult learners are self-motivated, leverage past experiences while learning, and develop skills directly applicable to real-world situations (Knowles et al., 2012). The quantitative study accounted for these andragogical principles by determining if the interest level within the air-carrier pilot population would justify the implementation of a SAFIRE risk-reduction

training program. The potential parties who receive the results will include representatives from academia, the aviation industry, and the federal government. These individuals can then use the completed research to validate existing air-carrier training policies, to stimulate further research into the topic, and to drive future training requirements. This study consists of five chapters containing an introduction; a literature review; a description of the research methodology; findings; and a final chapter with implications, recommendations, and conclusions. The purpose of this quantitative, comparative study was to analyze air-carrier pilot SAFIRE risk-reduction training and its value as related to the principles of adult learning theory. The study included a quantitative methodology because it was most suitable for gathering and analyzing the responses from the survey respondents (Wiggins, 2011). Additionally, quantitative research is a natural choice because this approach is a recognized research method commonly used when researching topics related to psychology, criminology, and terrorism (LaFree & Freilich, 2011). The material presented in Chapter 1 contained an overview of the study. The literature review in Chapter 2 contained additional information on SAFIRE-related issues, adult learning theory, and the practical application of adult learning theory within the aviation industry. The description of the study's research method, contained in Chapter 3, includes the procedures used to gather data, conduct analysis, and maintain academic rigor and ethical assurances. Chapter 4 contains the specific results of RQ1 through RQ4, hypothesis testing, additional findings, and an evaluation of the findings. Chapter 5 contains the implications, recommendations, and conclusions of the study.

Chapter 3: Research Method

Chapter 3 contains a description of the quantitative research design necessary to enumerate the U.S. air-carrier pilot community's perceived value of SAFIRE risk-reduction training and to determine which training methods air-carrier pilots consider most appropriate for a SAFIRE risk-reduction training program. The opening section of this chapter contains a brief review of the topic, research questions, and hypotheses, as well as an explanation of the mechanics of the study, including a description of the method and design, population and sample, materials and instruments, and definitions of variables. The chapter concludes with an explanation of assumptions, limitations, delimitations, and ethical assurances. This chapter also includes a description of the data collection instrument, which was an electronically administered Likert-type survey based on an earlier survey (Belanger, 2008). The topic was suitable for a quantitative approach, and it was possible to achieve the desired results using this research design. My rationale for using a quantitative approach, which I selected in lieu of a qualitative or mixed approach, appears later in this chapter. While conducting the study, I complied with the research method described in this chapter in an effort to rectify the lack of knowledge regarding the need for SAFIRE risk-reduction training within the air-carrier pilot community.

Research on SAFIRE risk-reduction training within academia, the federal government, and the U.S air-carrier industry is lacking. Air-carrier pilots do not receive formal risk-reduction training to prepare them to avoid, detect, defeat, and report SAFIRE attacks (J. Denton, personal communication, July 12, 2011). The focus of the bulk of existing SAFIRE risk-reduction research is on using technology to defeat IR

MANPADS. A few other sources address additional SAFIRE threats and provide descriptions of appropriate countertactics required to mitigate these threats. A review of the literature revealed no scholarly or nonscholarly research on SAFIRE risk-reduction training. Such training is necessary before air-carrier pilots can employ the risk-mitigation techniques. Adult learning theory indicates that a training program of this type will be more successful if learners perceive the training as valuable, so I used the study to determine if U.S. air-carrier pilots believe that the training is valid and necessary. To achieve this objective, I developed a quantitative study, which I used to examine four research questions and eight hypotheses.

I used the research questions and hypotheses to define my examination of four overarching issues by determining the level of perceived value that air-carrier pilots place on SAFIRE risk-reduction training. I accomplished the necessary descriptive analysis in accordance with the guidance contained in *Research Design* (Creswell, 2014) and conducted the comparative analysis in accordance with the guidance contained in *Statistics in a Nutshell* (Boslaugh, 2013). I also determined if military experience (military or nonmilitary) and job position (line or nonline pilot) influence adult learners' perception of the topic. The study also identified which training method or methods air-carrier pilots believe is most appropriate for this type of training. In this portion of the study, I leveraged respondents' knowledge of training methods, based on their previous training experiences, as a means to identify the best method of training for potential SAFIRE risk-reduction training programs. The study's objectives appear in the following research questions and hypotheses:

RQ1: What value, if any, do air-carrier pilots place on SAFIRE risk-reduction training?

$H1_0$: The majority of air-carrier pilots sampled do not value SAFIRE risk-reduction training.

$H1_a$: The majority of air-carrier pilots sampled do value SAFIRE risk-reduction training.

RQ2: What difference in value, if any, do air-carrier pilots place on the potential SAFIRE risk-reduction training methods?

$H2_0$: There is no significant difference in the value air-carrier pilots place among the three potential SAFIRE risk-reduction training methods (computer-based, classroom, and simulator training).

$H2_a$: There is a significant difference in the value air-carrier pilots place among the three potential SAFIRE risk-reduction training methods (computer-based, classroom, and simulator training).

RQ3: What is the difference, if any, between air-carrier pilots with prior military flying experience and those without prior military flying experience in terms of the value placed on SAFIRE risk-reduction training?

$H3_0$: Prior military flying experience makes no difference in the level of importance that air-carrier pilots place on SAFIRE risk-reduction training.

$H3_a$: Prior military flying experience makes a difference in the level of importance that air-carrier pilots place on SAFIRE risk-reduction training.

RQ4: What is the difference, if any, between line air-carrier pilots and nonline air-carrier pilots in terms of the level of importance placed on SAFIRE risk-reduction training?

$H4_0$: There is no difference in the level of importance of SAFIRE risk-reduction training based on pilot type (air-carrier line pilots and air-carrier nonline pilots).

$H4_a$: There is a difference in the level of importance of SAFIRE risk-reduction training based on pilot type (air-carrier line pilots and air-carrier nonline pilots).

In this study, I addressed the research questions and hypotheses using a research method and research design that ensured the data collection, the comparison between dependent and independent variables, and the descriptive statistics analysis were efficient and effective. The research method and design I selected subsequently drove the development of the collection instrument in accordance with the dependent and independent variables contained within the research questions (Simon & Goes, 2013). The topic was suitable for scholarly research, and the research questions and hypotheses drove an effective quantitative study capable of generating acceptable results. The next section contains a description of the study's research method and design.

Research Methods and Design

Both quantitative and qualitative research methods received consideration for this study, but I determined the quantitative research method was the optimal methodology given the study's goals and research questions. The quantitative method was suitable for gathering, storing, and analyzing the large amounts of data required for testing the

theories presented by the research questions and hypotheses (Wiggins, 2011). Additionally, quantitative research is a recognized research method commonly used when researching topics related to psychology, criminology, and topics related to terrorism (LaFree & Freilich, 2011). The qualitative research method was not optimal for the study because this approach would require developing a portfolio of case studies based on inputs from the members of the population which may have made comparison difficult or impossible (Creswell, 2014). Additionally, a qualitative approach would have required a standardized interview or survey to gather data to ensure the data collection process provided usable information. Interview-based qualitative data collection would have been more time intensive and less accurate than survey-based quantitative data collection. Although it may have been possible to conduct this research using a qualitative or mixed approach, the quantitative approach, with a survey-based data collection instrument, best fit the topic. The quantitative analysis included a comparative research design.

I discovered the descriptive and comparative research designs were necessary for this study (Boslaugh, 2013). I used an analysis of descriptive statistics to address RQ1 and RQ2. In turn, I used a comparative design to answer RQ3 and RQ4 using a Kruskal-Wallis test (since I determined the survey group data as less than a 95% confidence level of normality, which is required for ANOVA testing). Although the comparative research design identified the relationship between variables, it does not necessarily imply causation (Simon & Goes, 2013). The descriptive and comparative research designs are both proven and replicable, and generated acceptable results for the study. Additionally, this research design gives scholars the tools to replicate and validate the results of the study and to conduct subsequent studies with other air-carriers. The results rendered

using this research method and design, based on the target air-carrier pilot population, should be applicable to the entire U.S. air-carrier pilot population.

Population

The population consisted of all U.S. commercial air-carrier pilots employed by a major U.S. air-carrier at the time of the study. Creswell (2014) highlighted the need to identify the source and the size of the population, before discussing the sampling procedure. The population for this study consists of all of the pilots flying as line and nonline pilots for the selected air-carrier. This group consists of approximately 12,000 air-carrier pilots, although the exact number could not be determined because the number varies with economic fluctuations, pilot hiring, and pilot separation (T. Shackouls, personal communication, September 15, 2013). Psychological research into pilot personalities indicates that these pilots have a number of personality traits in common with each other (Henley, 2003). As a result, the results taken from this population may be applicable to most of the pilots employed by U.S. air-carriers. However, the results of this study may not be applicable to foreign airlines due to differences in air-carrier pilot attitudes and behaviors as induced by the pilots' indigenous culture (Ghemawat & Reiche, 2011). In the future, researchers may be able to apply the results from this study to foreign air-carriers if the researchers determine that foreign pilots are sufficiently similar to U.S. air-carrier pilots psychologically. The next section contains a discussion of my sample selection process and shows how I determined the desired minimum sample size.

Sample

The sample was a self-selected purposive sample of pilots employed by a major U.S. air-carrier. A purposive sample is suitable because the population of pilots is homogenous and a high likelihood exists that self-selecting respondents are reflective of the overall population (Gay et al., 2012). The major U.S. air-carrier selected has both domestic and international routes and employs approximately 12,000 pilots (T. Shackouls, personal communication, September 15, 2013). Ghemawat and Reiche (2011) indicated that the results from the U.S. air-carrier selected for the study should be representative of other U.S. air-carriers but may not be representative of all foreign air-carriers due to authority deference commonly found in some other cultures. I determined the desired ANOVA sample size using a G*Power analysis for the parametric test (with the understanding that the procedure for the non-parametric equivalent requires a minimum desired sample size of five or more respondents), and then used this value as the corresponding sample size for the descriptive statistics analysis. Results from the G*Power analysis indicated that 73 respondents were necessary assuming the ANOVA had a medium effect size $f = 0.15$ and an alpha significance level of .05. The minimum sample size for the descriptive statistics analysis was then set to match the value generated for the ANOVA because descriptive statistical analysis is applicable to any group of two or more. The desired minimum sample size of 73 respondents ensured statistical sufficiency, and the actual sample size of 112 usable respondent surveys exceeded this requirement. The respondents within the self-selected purposive sample participated by answering questions administered using an electronically administered Likert-type scale survey developed in this study.

Materials/Instruments

For the study, I collected data using an electronically administered survey in accordance the procedures described in this chapter. I designed the Web-based electronic survey using the SurveyMonkey Website in accordance with the guidelines prescribed by Gay et al. (2012); see also (Creswell, 2014). The survey did not have a printed cover letter. Instead, the information typically included in the cover letter (i.e., the purpose of the research, participation request, assurance of anonymity, expected duration of the test, and availability of collected data) was part of the electronic survey. I requested and received permission from the webmaster/owner to post the survey instrument prior to conducting the survey in the form of a signed letter. The participation request appeared as an announcement on the pilot forum for the major U.S. air-carrier, which was restricted to pilots and former pilots associated with the company. I ensured that the announcement contained a generalized topic to prevent unintentional sampling bias (the announcement did not contain the terms SAFIRE, MANPADS, or laser illuminators). The survey contained both nominal scale and Likert-type scale questions. I defined all unique terms within the introduction to reduce ambiguity and subjectivity. I asked the respondents to identify themselves while completing the informed consent form, but I sanitized this data prior to beginning data processing. The survey contained a free-text block that allowed respondents to elaborate on their answers. Appendix A includes the full survey in its entirety. An expert panel of pilots validated all questions to ensure that each addresses only a single concept in a clear and concise manner.

I validated the survey using an expert panel review and a pilot study. I began the validation process by ensuring the questions were understandable and then ensured that

the electronic survey administration tools functioned properly (Creswell, 2014). The expert panel, consisting of 10 professional pilots (who were not associated with sample group targeted in the main study) reviewed the draft survey and provided feedback on paper copies. The expert panel identified poorly worded questions and offered suggestion to improve readability, which I incorporated into the electronic pilot survey. After incorporating feedback from the expert panel, I administered the pilot study electronically to a group of 20 professional pilots (who were also not associated with the sample group targeted in the main study) using procedures similar to those used for the main study. This process helped to identify technical glitches associated with the SurveyMonkey software. I used individuals who were not associated with the major air-carrier selected for the study in an effort to reduce the chances of compromising the sample population during the expert panel review or pilot study. I did not use data from the expert panel review or pilot study to (a) generate information on statistical validity or (b) provide data to for the main study. The purpose of this validation was to ensure the study was readable and understandable, and that the electronic survey functioned properly. Although my survey was original, I used an instrument developed by J. D. Belanger as a developmental model.

In 2008, Belanger authored a quantitative dissertation titled *Analyzing Commercial Flight Crewmember Perceptions Regarding Airline Security Effectiveness, Morale, and Professionalism*. In this study, Belanger examined air-carrier flight crewmembers' perceptions of the TSA's performance in the wake of the terrorist attacks that occurred on September 11, 2001 (Belanger, 2008). Specifically, Belanger examined how interaction with TSA employees affected the morale and professionalism of the air-

carrier flight crewmembers. Although Belanger did not address SAFIRE risk-reduction training, it did provide a starting point for this study. A review of Belanger's work revealed that my topic was well suited as a subject for quantitative research. I was also able to use Belanger's Likert-type survey as a guide while developing the SAFIRE risk-reduction training survey.

I found Belanger's (2008) Likert-type scale responses useful while developing the survey for this study. Belanger used two sets of traditional Likert-type scale responses and one set of demographic questions within the survey. In the first portion of the survey, which focused on perceptions of TSA job effectiveness and perceptions of flight crew morale, Belanger divided the five responses into five categories: *strongly disagree, disagree, neutral, agree*, and *strongly agree*. Belanger also used a five-response scale to examine flight crew confidence levels in TSA and the perceived levels of TSA professionalism using the responses of *no confidence, little confidence, some confidence, moderate confidence,* and *total confidence.* A set of basic demographic questions asked for respondents' gender (male or female) and crew position (pilot or flight attendant). Belanger's dissertation did not contain any psychometric data. Belanger's survey served as a model for the SAFIRE Risk-Reduction Training Survey. The SAFIRE risk-reduction survey included an announcement that contains assurances, definitions, demographic questions, questions investigating the importance of the topic, questions investigating the value of various methods of training, and a final statement. The survey consists of approximately 12 questions divided into four sections. I designed the first section of the survey to collect the demographic information required to categorize the

respondents within the independent variable categories required for the comparative analysis necessary to examine RQ3 and RQ4.

Survey section 1. The first section of the survey contained the demographic questions used to determine prior military training and air-carrier line pilot status (the independent variables). These questions allowed me to code independent variables comparative analysis while preserving respondent anonymity (Gay, et. al, 2012). This section of the survey contained single survey items that asked respondents; (a) if they are military-trained pilots who have previously received SAFIRE risk-reduction training from the military; and (b) if they are air-carrier line pilots or air-carrier nonline pilots. I used a binary scale to code the demographic data provided by respondents (e.g., *prior military SAFIRE risk-reduction training* = 0; *no prior military SAFIRE risk-reduction training* = 1). I used the third section of the survey address RQ1 and 2.

Survey sections 2 and 3. I used Survey Section 2 to determine the respondents' perception of the importance of SAFIRE risk-reduction training, and Survey Section 3 to determine the level of perceived value the respondents place on likely methods of air-carrier pilot SAFIRE risk-reduction training (i.e., CBT, classroom training, and simulator training). The survey contained a statement describing the 5-point interval scale to ensure the respondents understood that the value of the responses align in an interval fashion. This helped ensure the data collected by the Likert-type scale questions fulfilled the assumptions required for subsequent analysis. Sections 2 and 3 contained five Likert-type scale survey items constructed in accordance with Gay et al. (2012). A 5-point interval scale helped to quantify the level of agreement or disagreement with the statements as a means of determining the respondents' level of motivation toward the

topic. The Likert-type scale coding used in these sections contained a mid-range null value (the number 3 on a scale of 1 through 5) to indicate neutrality, to show that the surveyed individual neither agrees nor disagrees with the statement. A value of 5 indicated that the individual strongly agrees and a value of 1 indicated that the individual strongly disagrees with the statement. The eight demographic questions in Section 1 helped to identify the independent variables and the questions in Sections 2 and 3 provided the data necessary to explore respondent perceptions of the issues represented by the dependent variables.

Operational Definition of Variables

I used the study to examine two independent variables and four dependent variables in an effort to address the four research questions previously discussed. The independent variables I selected are the variables that caused, or probably caused, the outcomes observed or described within the study. Dependent variables are those variables that describe or quantify the effects or outcomes caused by the independent variables (Creswell, 2014). In the study, I identified the independent variables necessary to give me the tools by which to classify the respondents within the respondents' pilot training (military or nonmilitary) and pilot role (line pilot or nonline pilot) categories. I classified each independent variable in the study using a 2-point scale for ease of classification. The dependent variables consisted of the perceived importance of SAFIRE risk-reduction training and the perceived value of various types of SAFIRE risk-reduction methods (CBT/classroom training/simulator training). I will explore the first independent variable, prior pilot training (military or nonmilitary), in the next section of this study.

Prior pilot training (military or nonmilitary). I defined the first independent variable using terms that would make it possible for me to determine if the respondent has prior military training (or without prior training). This variable helped me to determine differences in perception between the sample groups of pilots with prior military SAFIRE risk-reduction training and those without prior training. The two groups classified within this independent variable provided me with the tools to render statistically significant responses (Creswell, 2014). The process to collect the data involved an online survey administered using the SurveyMonkey Website and measured the responses using a nominal scale in accordance with Gay et al. (2012). The scale consisted of two values coded as 0 = *no military training* and 1 = *military training*. A 2009 interview by retired United Airlines Captain Brad Bartholomew indicated that approximately 28% of pilots at his company had a military flying background (Weber, 2009). The lack of availability of specific statistics prevented a determination of a minimum desired number of responses for each category. Analysis revealed that 44% of the respondents had received military training, that 56% of the respondents had not received military training, and that neither of the group's answers followed a normal distribution. I could not control the sample size when working with a self-selected sample, so data collection was in accordance with the stated methodology. In the next section, I discuss the second independent variable, the pilot role (line pilot or nonline pilot).

Pilot role (line pilot or nonline pilot). I addressed the second independent variable by determining the pilot's role (line or nonline pilot) as an air-carrier employee. I used this variable to determine there are differences in perception between the sample

groups of pilots who serve as line pilots and those who do not. The two groups classified within this independent variable rendered statistically significant responses (Creswell, 2014). I collected the responses using an online survey administered via the SurveyMonkey Website and used a nominal scale as a measuring tool, in accordance with Gay et al. (2012). The scale consisted of two values coded as 0 = *line pilot* and 1 = *nonline pilot*. An air-carrier line pilot's duty is to conduct scheduled passenger or cargo transportation flights. Line pilots fly approximately 85 hours per month. A nonline air-carrier pilot's primary duties are other than conducting scheduled passenger and cargo flights. Nonline pilots include pilots in management, training, and evaluation positions, which are areas other than day-to-day operations. Nonline pilots fly approximately 15 hours per month and often focus on optimizing air-carrier procedures to reduce costs. Air-carrier Captain James Denton estimated that less than 10% of the population consisted of nonline pilots (personal communication, September 30, 2013). It is not possible to control the sample size when dealing with a self-selected sample, so I conducted the data collection in accordance with the stated methodology, analyzed the results, and determined statistical sufficiency based on the number of respondents who complete the survey. Through analysis, I determined that 91% of the respondents were line pilots and 9% were nonline pilots and the responses from the line pilot category were not normally distributed. I continued by examining the first independent variable, which is the level of value the respondent place on SAFIRE risk-reduction training.

Perception of the value air-carrier pilots place on SAFIRE risk-reduction training. I used the first dependent variable to identify the level of value the respondent places on SAFIRE risk-reduction training. This variable helped determine the overall

level of value air-carrier pilots place on SAFIRE risk-reduction training and illustrated how the dependent variable influenced the two previously discussed independent variables (Creswell, 2014). The data collection survey, distributed via SurveyMonkey, included an interval Likert-type scale with five values self-reported by the respondents in response to the survey questions with codes 1 = *strongly disagree*, 2 = *disagree*, 3 = *neutral*, 4 = *agree*, and 5 = *strongly agree*. Sample questions included "I believe that SAFIRE threats pose a real risk to U.S. air-carrier operations" and "I believe that SAFIRE risk-reduction training is necessary and should be included as part of my formal training as an air-carrier pilot." I computed the total score for the perceived value of SAFIRE risk-reduction training as the sum of the individual item responses. I will continue this discussion by explaining the criteria used to define with the second dependent variable, which is the level of value air-carrier pilots place on potential SAFIRE risk-reduction training methods (CBT only).

Perception of the level of value air-carrier pilots place on potential SAFIRE risk-reduction training methods (CBT only). I designed the second dependent variable to quantify the perceived level of importance the respondents place on computer-based SAFIRE risk-reduction training. This variable helped me determine the overall level of value air-carrier pilots place on the CBT as a sole method of SAFIRE risk-reduction training (Creswell, 2014). The respondent selected the best option to answer the question related to CBT and other types of training. I have operationally defined CBT as the training method that uses a computer-based lesson plan administered remotely and accessible at the learner's convenience (Jethro et al., 2012). CBT occurs at a pace set by the student and may include interactive multimedia information and a test or other type of

evaluation. The SurveyMonkey survey included an interval Likert-type scale with five values self-reported by the respondents in response to the survey questions and had the following codes: 1 = *strongly disagree*, 2 = *disagree*, 3 = *neutral*, 4 = *agree*, and 5 = *strongly agree*. To address this, I asked respondents to reply to the survey statement "Computer Based Training is an effective method of providing SAFIRE risk-reduction training to air-carrier pilots" by selecting one of the five answers listed above. The discussion continued to the third dependent variable, which is the level of value air-carrier pilots place on potential SAFIRE risk-reduction training methods (CBT and classroom training combined). In the next section, I define the third dependent variable.

Perception of the level of value air-carrier pilots place on potential SAFIRE risk-reduction training methods (CBT and classroom training combined). The third dependent variable was the level of importance the respondent places on the combination of computer-based and classroom SAFIRE risk-reduction training. This variable helped to determine the overall level of value air-carrier pilots place on the CBT in conjunction with classroom training as the desired method of SAFIRE risk-reduction training (Creswell, 2014). The operational definition of classroom-based training was the training method that uses a lesson plan administered by an instructor or other type of subject matter expert (FAA, 2008). This training method makes it possible for students to interact with the instructor or subject matter expert and ask questions and may or may not include a test or other type of evaluation. It is my stipulation, for the purpose of this study, that CBT will precede classroom training, and classroom training will precede simulator training, in compliance with the constructivist (building block) approach to learning. The data was collected via SurveyMonkey using an interval Likert-type scale

of five values self-reported by the respondents in response to the survey questions: 1 = *strongly disagree*, 2 = *disagree*, 3 = *neutral*, 4 = *agree*, and 5 = *strongly agree*. To address this, I asked respondents to reply to the following survey statement "A combination of CBT and Classroom Training is an effective method of providing SAFIRE risk-reduction training to air-carrier pilots" by selecting one of the five answers listed above. In the next section, I define the final dependent variable.

Perception of the level of value air-carrier pilots place on potential SAFIRE risk-reduction training methods (CBT, Classroom training, and Simulator training combined). I designed the final dependent variable as a means to quantify the level of perceived importance the respondents place on the combination of computer-based, classroom-based, and simulator-based SAFIRE risk-reduction training. This variable helped to determine the overall level of value air-carrier pilots place on the combination of CBT, classroom training, and simulator training as the desired method of SAFIRE risk-reduction training (Creswell, 2014). My operational definition of simulator training is a training method that uses an aircraft simulator equipped with motion and a realistic visual presentation as the training venue (IFALPA, 2012). The simulator presents the opportunity for air-carrier pilots to visually identify threats and employ countertactics in a realistic environment. Simulator training also gives students the opportunity to practice specific tasks multiple times (Lateef, 2010). I have stipulated, for the purpose of this study, that CBT and classroom training precedes any training in the simulator in accordance with the constructivist (building block) approach to learning. This stipulation is valid because it is consistent with the standard training methodology used by all large air-carrier operations (FAA, 2008). I used a Likert-type scale with five values,

administered using SurveyMonkey, to provide the respondents with the following response options: 1 = *strongly disagree*, 2 = *disagree*, 3 = *neutral*, 4 = *agree*, and 5 = *strongly agree*. To address this, I asked respondents to reply to the following survey statement, "A combination of CBT, Classroom Training, and Simulator Training is an effective method of providing SAFIRE risk-reduction training to air-carrier pilots", by selecting one of the five answers listed above. In the next section, I describe the data collection and analysis methods required to address the research questions and their associated variables.

Data Collection and Analysis

In this section, I describe the validation process, data the collection method, and data analysis process. I validated the survey to ensure that the survey accurately presented the problem, identified the context, and used unambiguous terms. Upon completing validation, I distributed the survey to the main population electronically, which provided respondents the opportunity to self-select (Gay et al., 2012). During data analysis, I used descriptive statistics to address RQs 1 and 2, and a Kruskal-Wallis Test to address RQ3 and 4 (Boslaugh, 2013). Effective data analysis and accurate study results hinged on data collection procedures.

Data collection. I collected data using a validated electronic survey. The survey validation process consisted of four distinct steps. With Belanger's previously published instrument as a starting point, I began by developing a survey that addressed the research questions and hypotheses. A handpicked expert panel of 10 military pilots provided input that helped me improve readability, correct poorly worded questions, and define the required demographic categories. After incorporating suggestions from the expert panel,

I conducted the pilot study by electronically administering the updated survey to a group of 20 handpicked professional pilots. In an effort to replicate the procedures required for the main study, I used an announcement which was the same as the main survey announcement (excepting minor changes) explained the purpose of the research, contained a participation request, offered an assurance of anonymity, and indicated the expected duration of the survey (Gay et al., 2012). The announcement, for both the pilot and main study, listed a generalized topic to prevent unintentional skewing when the respondents self-selected. It also directed the respondent to comment if the question was poorly worded or difficult to understand. Respondents were professional pilots who possessed an Air Transport Pilot Certificate, a multiengine rating, and at least one type rating. I reviewed the results of the pilot study and incorporated a series of minor corrections before submitting the final version for university approval. After I received Northcentral University Institutional Review Board approval, I administered the survey (which is available in text form in Appendix A) to the main population. The data collection for the main study began when I had the announcement, contained in the permission letter referenced in Appendix B with the link to the electronic survey, posted on an air-carrier pilots' restricted message forum. A member of the forum, who will remain anonymous, posted the announcement and reposted it periodically to ensure that the participation request received maximum visibility throughout the data collection period. For the main study, data collection took place until 17 days after posting the solicitation. By that point I had received 132 responses, well in excess of the minimum desired sample size ($n = 73$). After the data collection period was complete, I conducted data analysis in accordance with the procedures discussed below.

Data analysis. I used descriptive statistics to address RQ1 and 2, and comparative analysis using the nonparametric ANOVA equivalent to address RQ3 and 4. I accomplished the descriptive analysis required to address RQ1 and 2 in accordance with the guidance contained in *Research Design* (Creswell, 2014). I conducted the comparative analysis required to address RQ3 and 4 in accordance with the guidance contained in *Statistics in a Nutshell* (Boslaugh, 2013). The following sections describe the descriptive statistics used as the analysis method for RQ1 and 2 and the comparative statistics required for the analysis of RQ3 and 4. I will begin by addressing the data analysis associated with RQ1.

RQ1 was as follows: What value, if any, do air-carrier pilots place on SAFIRE risk-reduction training? An examination of the median of the responses was necessary to address RQ1 in accordance with guidance contained in *Research Design* (Creswell, 2014). This question helped to determine if the majority (more than 50%) of respondents indicated they value SAFIRE risk-reduction training. If $H1_0$ (The majority of air-carrier pilots sampled do not value SAFIRE risk-reduction training) was true based on more than 50% of the respondents supporting the null hypothesis, then the results would indicate that the air-carrier pilots sampled did not desire SAFIRE risk-reduction training. If $H1_a$ (The majority of air-carrier pilots sampled do value SAFIRE risk-reduction training) was true, then the results would indicate that air-carrier pilots sampled desire SAFIRE risk-reduction training. In the next paragraph, I will outline the stages required for the data analysis associated with RQ2.

RQ2 was as follows: What difference in value, if any, do air-carrier pilots place on the potential SAFIRE risk-reduction training methods? A comparison of the median

responses for survey questions 13, 14, and 15 was necessary to address RQ2 in accordance with guidance contained in *Research Design* (Creswell, 2014). RQ2 helped me determine which training method the majority of respondents indicated they value most for SAFIRE risk-reduction training. The results from this question helped to identify which method, or which combinations of methods, air-carrier pilots value the most. If $H2_0$ (There is no significant difference in the value air-carrier pilots place among the three potential SAFIRE risk-reduction training methods [computer-based, classroom, and simulator training]) was true, then the respondents would have indicated that they believe the training methods are of equal effectiveness. If the results indicated $H2_0$ is false, then $H2_a$ (There is a significant difference in the value air-carrier pilots place among the three potential SAFIRE risk-reduction training methods [computer-based, classroom, and simulator training]) would provide data to determine the desirability of the three training methods. In the next paragraph, I will discuss the steps required for the data analysis associated with RQ3.

RQ3 was as follows: What is the difference, if any, between air-carrier pilots with prior military flying experience and those without prior military flying experience in terms of the value placed on SAFIRE risk-reduction training? The results from this question helped to identify bias between sample groups. It is possible that air-carrier pilots with prior military flying experience could place a greater value on the training because they received formal SAFIRE risk-reduction training during military training and understand the topic more than pilots with civilian-only flying experience. If $H3_0$ (Prior military flying experience makes no difference in the level of importance that air-carrier pilots place on SAFIRE risk-reduction training) was true, then results would indicate that

no bias exists between air-carrier pilots with prior military flying experience and those without prior military flying experience. If $H3_a$ (Prior military flying experience makes a difference in the level of importance that air-carrier pilots place on SAFIRE risk-reduction training) was true, then the results would indicate the bias between populations. In RQ3, the independent variable was military flying experience and there were two categories to this variable. Respondents fit into two groups: those with military flying experience and those without prior military flying experience. In data analysis, a one-way ANOVA would have been used to compare the perceived level between air-carrier pilots with and without prior military flying experience, if the data proved to be appropriate, independent, and normally distributed (as determined using the Kolmogorov-Smirnov test for normality), and to have homogeneity of variance (as determined using Levene's test; Boslaugh, 2013). If the data proved nonnormal, then I would use a Kruskal-Wallis test in place of the ANOVA (Boslaugh, 2013). Results were not normally distributed, so I utilized the Kruskal-Wallis test as the analysis tool as described in Chapter 4. I concluded the discussion on data analysis by detailing the steps required for the data analysis associated with RQ4.

RQ4 is as follows: What is the difference, if any, between line air-carrier pilots and nonline air-carrier pilots in terms of the level of importance placed on SAFIRE risk-reduction training? This question served to identify perception differences between sample groups and to determine if line air-carrier pilots value SAFIRE risk-reduction training more, less, or the same as their counterparts who have become nonline air-carrier pilots. Using this comparison, the process served to determine if the management personnel, instructors, and evaluators perceive the importance of SAFIRE risk-reduction

training in the same way as line pilots. If $H4_0$ (There is no difference in the level of importance of SAFIRE risk-reduction training based on pilot type [air-carrier line pilots and air-carrier nonline pilots]), was true, then the results would indicate there is no perception difference between the sample groups. If $H4_a$ (There is a difference in the level of importance of SAFIRE risk-reduction training based on pilot type [air-carrier line pilots and air-carrier nonline pilots]) was true, the results would indicate a difference in perception between the sample groups. In RQ4, the independent variable was air-carrier pilot status, and the variable had two categories (respondents fit into two groups: air-carrier pilot vs. nonline air-carrier pilot). As with RQ3, a one-way ANOVA would have been used to compare the perceived level between air-carrier pilots with and without prior military flying experience, if the data proved to be appropriate, independent, and normally distributed (as determined using the Kolmogorov-Smirnov test for normality), and to have homogeneity of variance (as determined using Levene's test; Boslaugh, 2013). If the data proved nonnormal, then I would use a Kruskal-Wallis test in place of the ANOVA (Boslaugh, 2013). One of the two categories was not normally distributed, so I utilized the Kruskal-Wallis test as the analysis tool as described in Chapter 4. While developing the instrument, conducting data collection, and accomplishing data analysis, I took a number of assumptions, limitations, and delimitations into account.

Assumptions, Limitations, and Scope/Delimitations

Developing the methodology for the study involved addressing a number of relevant assumptions, limitations, and delimitations. The assumptions, limitations, and delimitations outlined the scope and parameters for the study's methodology (Gay et. al, 2012). Many of the study assumptions related to population, respondent self-selection,

and context issues. A number of relevant limitations existed with regard to sample size, instrument development, and population sampling. The study delimitations addressed the selection of a single air-carrier as the population source. The examination of assumptions provided insight into a number of unverified facts that could influence the outcome of the study.

Assumptions. Several methodological assumptions exist regarding the data collection process. Gay et al. (2012) defined assumptions as relevant facts presumed to be true and that could affect the execution of a study. I identified four assumptions that I find necessary to discuss. The first assumption was that the respondents were legitimate members of the population (a line pilot or nonline pilot working for the major U.S. air-carrier). It was unlikely that a significant number of individuals who were not current line pilot or a nonline pilots would have had access to the restricted pilot forum, would have decided to participate in the survey, and would have provided a false answer to indicate that they were a current employee for the major air-carrier in question. The second assumption was that the respondents would understand the questions and would answer honestly and accurately. The pilot survey helped to correct ambiguous questions, and the survey announcement encouraged respondents to provide accurate responses. The third assumption was that the self-selected sample groups accurately represented the population at large. I worded the survey announcement to minimize unintentional skewing during self-selection by avoiding key words that may attract individuals with a personal bias toward the topic. The fourth assumption was that each respondent would take the test only once. The survey announcement was written to discourage respondents from taking the survey more than once (Gay et al., 2012). The examination of limitations

in the next section highlights a number of factors that were beyond my control and capable of negatively affecting the study.

Limitations. Population access and the data collection instrument are the two primary limitations associated with this study. Gay et al. (2012) defined limitations as factors outside a researcher's control that could negatively affect a study. Access to the entire population was not possible and respondents self-selected. This self-selected group formed the purposive sample used for analysis. In an ideal situation, a mandate would have ensured participation from the entire population, but the airline pilots union would have had to mandate participation and financially reimburse the respondents for their time (T. Shackouls, personal communication, October 7, 2013). The approach would have been time consuming, would have involved legal complications, and could have rendered inaccurate results if respondents entered responses just to meet the contractual requirements of the company and the union. Using a G*power analysis, I determined the purposive sample size necessary to produce results with the statistical relevance necessary to overcome this limitation. I designed an original data collection instrument, based on Dr. J.D. Belanger's earlier survey, in an effort to minimize these limitations.

This data collection instrument had two associated limitations. First, there was a risk that the survey contained questions and responses that would fail to capture the perceptions of the respondents. To mitigate this risk, I used an expert panel and pilot survey to ensure that the survey presented understandable concepts and contained responses capable of accurately quantifying the respondent's perceptions. Additionally, a comment section followed each section of the survey, which allowed respondents to elaborate on their answers if the Likert-type scale failed to provide an adequate response

option (Belanger, 2008). Second, there are potential threats to validity when an anonymous group responds to a survey. Instrument changes during data collection can cause internal validity issues if the knowledge level or opinions of the subject change during data collection or if members of the population influence other members after completing the survey (Creswell, 2014). I minimized these risks by administering only the validated and Northcentral University approved version of the survey. The survey consisted of 16 questions and had an estimated duration of data collection time (e.g., survey completion time) of less than 15 minutes per respondent. I limited survey length to meet this duration, because this limited timeframe reduced the chances of external factors influencing the respondents during the data collection phase. It was impossible to prevent respondents from discussing the survey, but the nature of the survey, which each individual completed voluntarily on his or her own computer, made it less likely that respondents would have discussed the topic during the data collection phase. I made additional attempts to mitigate discussion between respondents by providing the respondents with a request (presented before and after survey) to minimize discussion surrounding the topic with other respondents (see Appendix A). While designing the study's research methodology, I identified a significant delimitation that influenced the study.

Scope/Delimitations. The most significant study delimitation I faced was the selection of pilots from a single U.S air-carrier as the sole population sample source. Gay et al. (2012) defined delimitations as boundaries a researcher uses to establish the limits of a study. I imposed this boundary because the selection of a single air-carrier increased the chances of homogeneity (because all respondents shared the same training and

corporate culture) and reduced the timeline required for data collection. I rejected foreign air-carriers due to possibility that cultural influences could make some foreign air-carrier pilots behave in ways significantly different from U.S. pilots, thus potentially skewing the results (Ghemawat & Reiche, 2011). This difference in behavior introduces a potential lack of homogeneity within the population. Restricting data collection to a single U.S. air-carrier effectively eliminated skewing due to cultural differences between organizations. Next, I will conclude the discussion of the research methodology with an examination of the ethical issues associated with this study.

Ethical Assurances

Throughout the study, I strived to ensure that the data collection, processing, and study dissemination would (a) protect the respondents from harm; (b) support Northcentral University's informed consent policy; (c) protect the respondent's right to privacy; and (d) preserve professional integrity and maintain academic honesty with colleagues (Creswell, 2014). There is an ethical requirement to ensure study respondents understand who will have access to the information contained in their survey responses, how I used their information, and how I protected the respondent's privacy. I addressed this adding specific verbiage to the introduction to the survey (provided in Appendix A), which discusses the nature of the survey and provides an assurance of confidentiality. The survey did not place the respondents at risk of physical harm and the anonymous survey protected the respondents from any type of retribution within the air-carrier community. A statement at the beginning of the survey emphasized the voluntary nature of the activity, provided a statement of informed consent, gave the respondent the opportunity to withdraw from the project at any point prior to completing the survey, and

described who would have access to the survey responses and how the responses would be used. I protected the respondent's privacy by using an anonymous and voluntary survey as the data collection tool. In an effort to provide scholarly transparency and maintain intellectual honesty, I included the sanitized raw survey data in Appendix C, additional comments collected in the main study in Appendix D, and statistical formulas, calculations, and results in Appendix E. Additionally, I did not begin collecting data until after the Northcentral University Institutional Review Board approved the survey and made no additional changes after approval of the data collection instrument. The research methodology stands as a second method I used to ensure that I maintained intellectually honesty with colleagues. The transparency of my data makes it possible for other researchers to recreate the study's results by taking the existing data and conducting an analysis using the methodology presented within this chapter. This comparison of results would quickly highlight any intellectual dishonesty or manipulation of statistical results. In the final section, I review the research methods, sample survey, data collection and analysis process, and ethical assurances required for this study.

Summary

The goal of this quantitative, comparative study was to analyze air-carrier pilot SAFIRE risk-reduction training as related to the principles of adult learning theory. The quantitative method was suitable for gathering, storing, and analyzing the large amounts of data required for testing the theories presented in the research questions and hypotheses (Wiggins, 2011). In this section, I defined the methodology required to examine the perceived value line air-carrier pilots place on SAFIRE risk-reduction training and I compared this perception to that of nonline air-carrier pilots to determine if

formal military training results in influenced perceptions within either group. I also used the study to determine which training methods air-carrier pilots would prefer if an air-carrier implemented a SAFIRE risk-reduction training program. The sample included self-selected air-carrier pilots from a major U.S. air-carrier as the respondents for the electronic survey. I concluded by identifying assumptions, limitations, delimitations, and ethical assurances that affected the research. This study consists of five chapters. In Chapter 1, I provided an overview of the study. Chapter 2 contained the literature review, which I used to describe SAFIRE-related issues, uncover principles of adult learning theory, identify gaps in learning, and ensure this study was an original project. Chapter 3 contained a description of the issues related to data collection and analysis. Chapters 4 and 5 include a discussion of the results of the analysis, as well as the implications, recommendations, and conclusion.

Chapter 4: Findings

The purpose of Chapter 4 is to present the results identified in this quantitative, comparative study. The objective of the study was to analyze air-carrier pilot SAFIRE risk-reduction training as related to the principles of adult learning theory because air-carriers do not currently provide their pilots with the training required to mitigate the risk associated with SAFIRE threats. The quantitative analysis method was more suitable for addressing the four research questions than a qualitative or mixed approach (Wiggins, 2011). The study included descriptive statistics to address RQ1 and RQ2 and comparative statistics to address RQ3 and RQ4. For RQ1 and RQ2, data analysis involved comparing the medians of respondents to determine the validity of the null hypotheses. To address RQ3 and RQ4, a Kolomogorov-Smirnov test helped to determine normality and a Kruskal-Wallis test helped to conduct the statistical comparison between two pairs of sample groups. The study included the four research questions and eight hypotheses to guide the research and analysis.

Research Questions and Hypotheses

The current study involved examining the existing literature and defining the scope and limitations of the study using four research questions. The research questions were designed in accordance with guidance from *Educational Research: Competencies for Analysis and Applications* (Gay et al., 2012) and *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (Creswell, 2014). The following questions and hypotheses served as guides throughout the project:

RQ1: What value, if any, do air-carrier pilots place on SAFIRE risk-reduction training?

$H1_0$: The majority of air-carrier pilots sampled do not value SAFIRE risk-reduction training.

$H1_a$: The majority of air-carrier pilots sampled do value SAFIRE risk-reduction training.

RQ2: What difference in value, if any, do air-carrier pilots place on the potential SAFIRE risk-reduction training methods?

$H2_0$: There is no significant difference in the value air-carrier pilots place among the three potential SAFIRE risk-reduction training methods (computer-based, classroom, and simulator training).

$H2_a$: There is a significant difference in the value air-carrier pilots place among the three potential SAFIRE risk-reduction training methods (computer-based, classroom, and simulator training).

RQ3: What is the difference, if any, between air-carrier pilots with prior military flying experience and those without prior military flying experience in terms of the value placed on SAFIRE risk-reduction training?

$H3_0$: Prior military flying experience makes no difference in the level of importance that air-carrier pilots place on SAFIRE risk-reduction training.

$H3_a$: Prior military flying experience makes a difference in the level of importance that air-carrier pilots place on SAFIRE risk-reduction training.

RQ4: What is the difference, if any, between line air-carrier pilots and nonline air-carrier pilots in terms of the level of importance placed on SAFIRE risk-reduction training?

$H4_0$: There is no difference in the level of importance of SAFIRE risk-reduction training based on pilot type (air-carrier line pilots and air-carrier nonline pilots).

$H4_a$: There is a difference in the level of importance of SAFIRE risk-reduction training based on pilot type (air-carrier line pilots and air-carrier nonline pilots).

The data collection and analysis led to the results required to address each research question and hypothesis. The following sections of this chapter contain information describing the population, data, analysis methods, and results.

Results

This study involved using the SurveyMonkey website for data collection and gathering a sufficient amount of data to conduct the data analysis procedure outlined in Chapter 3. The data analysis methodology consisted of descriptive analysis for RQ1 and RQ2 and comparative analysis for RQ3 and RQ4; G*Power indicated a minimum required sample size of 73 for statistical sufficiency (Boslaugh, 2013). Respondents completed 132 surveys using the SurveyMonkey website, and 112 of the surveys were complete and suitable for use in data analysis. Of the 20 rejected surveys, 15 were incomplete, four of the respondents were not air-carrier employees at the time (but who were most likely previous employees), and one elected not to proceed after reading the informed consent statement. The statistical tools in Microsoft Excel 2010 were suitable to perform the required data analysis. Appendix E contains detailed information regarding the statistical formulas used in this study. The next paragraph contains a

detailed discussion of the survey respondents' demographic and background characteristics.

Demographic and background characteristics. Based on guidance from the expert panel, I identified a number of demographic categories that contributed to the legitimacy of the survey, helped prepare me to identify causes of potential statistical skewing, and may assist future researchers in conducting related research. I based the demographic categories on those used by Belanger (2008) and modified the categories to incorporate expert panel input from the pilot study. The demographic categories selected, including training background, types of military aircraft flown, actual experience in the presence of SAFIRE threats, hours flown as an air-carrier pilot, and airline duties, provided insight into the homogeneity of the two groups and facilitated the capture of information for the comparative analysis. The expert panel deemed typical demographic questions that often include race, gender, and age as unnecessary for the purposes of data collection. Instead, I substituted type of military aircraft flown and SAFIRE combat experience (see Table 1) civilian versus military training background (see Table 2), line versus nonline airline duties (see Table 2), and flying experience (see Table 3) in place of race, gender, and age. The information presented within Table 1 represented a preemptive effort to prepare for analysis to identify potential causes of data skewing and to provide researchers with information that may be relevant in future studies.

Although the data contained in Table 1 was not necessary for the study, the data provided insight into the sample. I used the information presented in Tables 3 through 5, illustrated in Appendix E, to perform hypothesis testing required to address each of the study's research questions.

Table 1

Demographics on Military Aircraft Flown and Combat Experience

	n	% of military experience group
Fighter/attack	30	48
Bomber	6	9
Tanker/variants	7	11
Transport	29	46
Fixed wing trainer instructor	25	40
Helicopter/tilt rotor	5	8
Helicopter/tilt rotor instructor	2	3
Unmanned aerial vehicle	3	5
Other	9	14
SAFIRE combat experience (Y/N)		
Yes	45	71
No	18	29

Note. Several of the 63 respondents had time logged in more than one type of military aircraft, resulting in a total exceeding 100%.

Table 2

RQ3 and RQ4 Descriptive Statistics of Respondent Demographics

	n	%
Research Question 3		
Civilian-only experience	49	44
Military background	63	56
Research Question 4		
Line pilot	102	91
Nonline pilot	10	9

Note. $n = 112$.

Table 3

Demographics on Total Flying Hours

Number of hours	*n*	% of total sample
3,000 or less	0	0
3,001 to 5,000	3	3
5,001 to 10,000	32	29
> 10,000	77	69

Hypothesis testing. The study contained four research questions, each supported with a null hypothesis and alternate hypothesis. The study included descriptive statistics

to examine RQ1 and RQ2 and comparative analysis to address RQ3 and RQ4 (Boslaugh, 2013). The descriptive analysis required for RQ1 and RQ2 involved determining the categorical response distribution for each question and comparing the medians to determine null hypothesis validity. Comparative statistics, specifically a Kruskal-Wallis test, served to address RQ3 and RQ4. Chapter 3 contained a description of two potential courses of action based on whether the distribution of data was normal. The ANOVA test was the appropriate analysis method for normally distributed data, and the Kruskal-Wallis test was for the nonparametric method of comparative analysis. To determine the appropriate comparative analysis tool, I used the Kolmogorov-Smirnov test determine normality or nonnormality of data distribution. The descriptive analysis using median values was highly effective when examining RQ1 and RQ2.

Research Question 1. Addressing RQ1 involved gathering responses to determine what value, if any, air-carrier pilots place on SAFIRE risk-reduction training. The associated hypotheses were as follows:

$H1_0$: The majority of air-carrier pilots sampled do not value SAFIRE risk-reduction training.

$H1_a$: The majority of air-carrier pilots sampled do value SAFIRE risk-reduction training.

The specific question from the survey was as follows: "I believe that SAFIRE risk-reduction training is necessary and should be included as part of my formal training as an air-carrier pilot." The responses to this question were categorical on a standard 5-point Likert-type scale of *strongly disagree*, *disagree*, *neutral*, *agree*, or *strongly agree*. The median response is an appropriate method of determining which hypothesis is correct

(Boslaugh, 2013). The median response to this question was *agree*. This was also the most frequent response (i.e., the mode), as 55 of the 112 respondents answered *agree* to this question, which indicated that, mathematically, the majority of air-carrier pilots sampled did believe that air-carrier pilots should receive SAFIRE risk-reduction training and that I must reject the null hypothesis. Twenty-four respondents answered *strongly agree* to this question, which made the total who responded *agree* or *strongly agree* a convincing 79 out of 112, or 70.5%. Next examined was what difference, if any, the respondents saw in the value of the three most common SAFIRE risk-reduction training methods.

Research Question 2. My approach to answering RQ2 involved the respondents answering three related questions to determine the following: What difference in value, if any, do air-carrier pilots place on the potential SAFIRE risk-reduction training methods? The respective hypotheses were as follows:

$H2_0$: There is no significant difference in the value air-carrier pilots place among the three potential SAFIRE risk-reduction training methods (computer-based, classroom, and simulator training).

$H2_a$: There is a significant difference in the value air-carrier pilots place among the three potential SAFIRE risk-reduction training methods (computer-based, classroom, and simulator training).

In the survey, the respondents used a standard 5-point Likert-type scale to respond to each of three questions asking to what level they valued CBT alone, CBT plus classroom training, or CBT plus classroom plus simulator-based training. These are three of the most common forms of training provided to air-carrier pilots, and if an air-carrier

established a SAFIRE risk-reduction training program, the air-carrier would most likely administer the program using one of these methods of training (Henley, 2003). As with RQ1, descriptive analysis using the median response to each of the three questions allowed me to determine if there was any significant difference in the responses between the three. The median response to the value ascribed to CBT-only training was *neutral*, to CBT plus classroom training was *agree*, and to CBT plus classroom training plus simulator training was *strongly agree*. This is highly significant in a 5-category Likert-type scale, as the median values span three of the five total categories. The respondents clearly favored the most intensive form of training that combines all three methods, and I rejected the null hypothesis to RQ2. This concluded the descriptive analysis of survey responses, as RQ3 and RQ4 required sample data analysis for normality and a follow-up with the appropriate type of comparative analysis.

Normality of data. To perform the proper method of comparative analysis for RQ3 and RQ4, it was first necessary to determine whether the survey response data followed a normal or nonnormal distribution. I determined the type of data distribution using the Kolmogorov-Smirnov test for normality (Boslaugh, 2013). Using the Kolmogorov-Smirnov test, I determined that three of the four sample groups had nonnormally distributed data, with only nonline pilots (by far the smallest sample group) showing a normal distribution. Appendix E contains the results of the Kolmogorov-Smirnov normal distribution test. Because the majority of the sample groups were nonnormal in distribution, a Kruskal-Wallis test was suitable for comparing nonparametric data for RQ3 and RQ4.

Research Question 3. RQ3 was as follows: What is the difference, if any, between air-carrier pilots with prior military flying experience and those without prior military flying experience in terms of the value placed on SAFIRE risk-reduction training? The respective hypotheses were as follows:

$H3_0$: Prior military flying experience makes no difference in the level of importance that air-carrier pilots place on SAFIRE risk-reduction training.

$H3_a$: Prior military flying experience makes a difference in the level of importance that air-carrier pilots place on SAFIRE risk-reduction training.

In addition to using a comparative analysis of the respective sample group medians, the study also involved comparing the distribution between the sample groups with a Kruskal-Wallis test. A Kruskal-Wallis test was the most suitable comparative analysis tool based on the need to compare four sample groups to address RQ3 and RQ4. The Kruskal-Wallis test allowed a single comparison between all four groups for the detailed analysis (Boslaugh, 2013).

The median response for both the civilian-only and prior military training experience groups was *agree*. In addition, the Kruskal-Wallis test for all four sample groups resulted in a *p* value of .46, which is significantly higher than the threshold α of .05, indicating no significant distribution differences between the four groups. Therefore, I did not reject the null hypothesis for RQ3. An examination of RQ4 results indicated if the same similarity of responses would hold true.

Research Question 4. For RQ4, I asked the following: What is the difference, if any, between line air-carrier pilots and nonline air-carrier pilots in terms of the level of

importance placed on SAFIRE risk-reduction training? For this final research question the hypotheses were as follows:

$H4_0$: There is no difference in the level of importance of SAFIRE risk-reduction training based on pilot type (air-carrier line pilots and air-carrier nonline pilots).

$H4_a$: There is a difference in the level of importance of SAFIRE risk-reduction training based on pilot type (air-carrier line pilots and air-carrier nonline pilots).

As with RQ3, the process involved a comparative analysis of the median responses and comparing the distribution between the sample groups with the multigroup-appropriate Kruskal-Wallis test (Boslaugh, 2013). The median response for the line pilot group was *agree*, whereas the median response for the nonline group fell between *neutral* and *agree*, which puts the two medians a half-category apart. Because this is statistically a gray area, the more refined Kruskal-Wallis test determined that the test result were above the 95% threshold; thus, I did not reject the null hypothesis. The overall results for all four research questions are in Table 4.

Table 4

Summary of Research Question Results

Research question	Null hypothesis	Result
1	Rejected	The majority of the overall sample group does see value in SAFIRE risk-reduction training
2	Rejected	The majority of the overall sample group does see a significant difference between the three proposed methods for SAFIRE risk-reduction training
3	Not Rejected	No difference between the civilian only and prior military training sample groups regarding significance of SAFIRE risk-reduction training
4	Not Rejected	No difference between the line and nonline groups regarding significance of SAFIRE risk-reduction training

Additional Findings

Conducting the survey and analyzing the results revealed several additional findings worth including in this chapter. I included questions specifically intended to collect framing and demographic data to identify the causes of any statistical discrepancies, skewing, or outliers (Boslaugh, 2013). The homogeneity of the data made additional analysis unnecessary; there were no significant discrepancies or outliers. I was, however, able to draw several additional conclusions from the data.

Survey Question 10 helped to determine if the sampled air-carrier pilots deemed SAFIRE threats to be credible. I placed Question 10 between the initial demographics questions and those that directly answered the four research questions, primarily to aid in recognizing any possible bias in the sample groups (Boslaugh, 2013). Survey Question 10 stated, "I believe that SAFIRE threats pose a credible risk to either domestic or international air-carrier operations." The median response to this question for the entire sample, and for each sample subgroup, was *agree*, which was in agreement with the later

survey questions that addressed the value of SAFIRE risk-reduction training and indicated that a majority of respondents viewed the SAFIRE threat as credible and saw a need for SAFIRE risk-reduction training. In addition to the formal responses, many of the respondents added comments that shed additional light on their perception of the topic.

The respondents provided numerous inputs into the additional comments portions of the survey, which helped me to confirm content validity (Boslaugh, 2013). A few recurring themes emerged throughout these responses. Several of the respondents considered the SAFIRE threat significantly higher for international air-carrier operations than for domestic operations. Respondents also mentioned the growing threat posed by laser illuminators in four separate comments (see Appendix D). Numerous respondents noted that CBT-only training was significantly less effective than other methods, which supported the descriptive conclusions of RQ2. Finally, several respondents indicated that their airline would not likely participate in a SAFIRE risk-reduction training program unless the FAA mandated the training requirement. Appendix D contains a full list of respondent comments with all references identifying a specific air-carrier masked. The statistical results discussed for RQ1 through RQ4, expanded and supported by the respondents' additional comments, provided the basis for the next section on evaluation of findings.

Evaluation of Findings

The purpose of this quantitative, comparative study was to analyze air-carrier pilot SAFIRE risk-reduction training and its value as related to the principles of adult learning theory. U.S. air-carrier pilots lack formal training in SAFIRE risk-reduction

techniques and are not able to mitigate the risk associated with most SAFIRE threats (T. Shackouls, personal communication, October 18, 2012). The research questions helped to identify the study's four objectives. The first objective was to investigate air-carrier pilots' perception of SAFIRE risk-reduction training value. The second objective was to determine if pilots with a military flying background perceived the value of the training different from pilots who did not have military flying experience. The third objective was to determine if line pilots, when compared to nonline pilots, perceived the value of SAFIRE risk-reduction training differently. The fourth objective was to quantify perceived differences in air-carrier pilot value between the three SAFIRE risk-reduction training methods. The remainder of this section includes a discussion of the relationship between the results and adult learning theory.

The theory of andragogy indicates that training is more successful if adult learners perceive the topic as relevant and applicable to their lives. Adult theory scholars state that adult learners need to see the relevance of the training program and understand its importance for a training program to be successful (Henley, 2003). The results of this study could help academics, researchers, and curriculum development experts tailor SAFIRE risk-reduction training programs to meet the preconceived notions of adult learners, thereby increasing the likelihood of developing successful SAFIRE risk-reduction training programs.

Research Question 1. Evaluating RQ1 involved determining that a majority of air-carrier pilots place value on SAFIRE risk-reduction training; the results of Survey Question 10 indicated that the overall perception among the respondents is that the SAFIRE threat is real and growing. These results indicate that air-carrier pilots see

SAFIRE risk-reduction training as relevant to their career field, and adult learning theory scholars believe that this relevance is necessary for success in adult learning programs according to andragogical principals (Henley, 2003; Knowles et al., 2012). These results indicate that the FAA, or the air-carriers themselves, would be able to build a SAFIRE risk-reduction training program that air-carrier pilots would receive well. The theory of andragogy states that adult training is more successful if the learners perceive the training topic is relevant and applicable to their lives and if the analysis of RQ1 indicates a properly designed SAFIRE risk-reduction training program would comply with this this concept. With relevance clearly established, I then examined RQ2 in terms of adult learning theory.

Research Question 2. The results for RQ2 clearly showed that air-carrier pilots do place a difference in value on the potential SAFIRE risk-reduction training methods. Air-carrier instructors use CBT, classroom training, and simulator training to conduct training that would be too expensive or too dangerous to conduct in an actual aircraft (Henley, 2003). The study leveraged the prior experience of adult learners to determine what training method or methods were most suitable for a potential SAFIRE risk-reduction training program. Both the statistical analysis and respondents' individual comments revealed that the majority of air-carrier pilots favored a combination of all three training methods when compared to CBT only or CBT in conjunction with classroom training. As with all air-carrier pilots, the life experience of the sample group included each of the three training methods at various times. Simulator training in conjunction with the other methods is widely recognized as the best approach, and the prior positive learning experience of these adult learners likely played a large role in their

choice of this method as best for SAFIRE risk-reduction training as well. RQ3 and RQ4 helped to determine if differing training backgrounds and professional responsibilities influenced individual attitudes toward the value of SAFIRE risk-reduction training.

Research Questions 3 and 4. RQ3 included an examination into whether air-carrier pilots with a military-training background versus those with a civilian-only-training background had different opinions on the value of SAFIRE risk-reduction training. In a similar fashion, RQ4 allowed me to determine whether line and nonline air-carrier pilots had different perceptions of the value of SAFIRE risk-reduction training (Creswell, 2014). The independent life experience variables selected for this study had little effect on an air-carrier pilot's perception of the value of SAFIRE risk-reduction training. The data analysis revealed prior military training experience did not influence the adult learners' perception of the topic compared to those with civilian-only experience, but job position (line or nonline pilot) did appear to influence the adult learners' perception very slightly. It may be that the nonline pilot's primary duties being more business and less operations related result in a greater consideration of cost versus benefit, resulting in that sample group's slightly lower perceived value of SAFIRE risk-reduction training. This chapter concludes with a summary of the research questions, a comparative analysis of RQ1 and RQ2, data distribution testing for RQ3 and RQ4, a comparative analysis of RQ3 and RQ4, a review of additional findings, and an analysis of findings.

Summary

Chapter 4 contained the results identified in this quantitative, comparative study. The objective of the study was to analyze air-carrier pilot SAFIRE risk-reduction training

as related to the principles of adult learning theory. The quantitative analysis method was well suited for gathering, storing, and analyzing the large amounts of data required to address the research questions and hypotheses (Boslaugh, 2013). The descriptive statistics used to address RQ1 and RQ2 indicated that the majority of the sample group did see value in SAFIRE risk-reduction training and that the preferred training method would be a combination of CBT, classroom, and simulator training. A Kolomogorov-Smirnoff test indicated that all but one of the sample group distributions were nonnormal, which in turn required a Kruskal-Wallis test for comparative analysis. The comparative analysis showed all four of the sample groups shared a similar distribution, even though the nonline sample group had a slightly different median value compared with the other three groups. Therefore, RQ3 and RQ4 showed that prior military training versus civilian-only training, and line vs nonline airline duty, did not result in different perceptions of the value of SAFIRE risk-reduction training. Next examined were additional findings resulting from other survey questions, along with individual comments from the respondents, which added support and personal interpretation to the overall study results. A majority of air-carrier pilots sampled believed in the value of SAFIRE risk-reduction training, which indicates that it is possible to develop a successful SAFIRE risk-reduction training program that aligns with the andragogical framework of adult learning theory. Chapter 1 contained an introduction to the topic and an overview to the study. Chapter 2 contained the literature review, which included a detailed exploration into the topic and an outline of the theoretical framework for the study. Chapter 3 contained an outline of the research methodology and demonstrated how I

executed that methodology in Chapter 4. The final chapter of this study, Chapter 5, contains the study's implications, recommendations, and conclusions.

Chapter 5: Implications, Recommendations, and Conclusions

The problem addressed in this study was that air-carriers do not provide pilots with formal risk-reduction training to prepare them to avoid, detect, defeat, and report SAFIRE attacks. The study further addressed the fact there is a significant lack of research to indicate if air-carrier pilots perceive SAFIRE risk-reduction training as valuable (J. Denton, personal communication, July 12, 2011). The purpose of this quantitative, comparative study was to analyze air-carrier pilot SAFIRE risk-reduction training and its value as related to the principles of adult learning theory. The study involved a quantitative methodology to examine (a) the perceived value of SAFIRE risk-reduction training among air-carrier pilots; (b) if air-carrier pilots perceive a difference in value among the potential SAFIRE risk-reduction training methods; and (c) whether prior military training experience or primary job duty differences had any effect on air-carrier pilots' perceived value of SAFIRE risk-reduction training. A number of limitations influenced study results. For example, one of the sample group sizes was significantly smaller than the other three, and I administered the survey to U.S. air-carrier pilots only. As a result, the results might not be generalizable to air-carriers of foreign nations, especially to air-carriers whose national culture differs significantly from that of U.S. air-carrier pilots. Another potential limitation was a lack of survey involvement with a population composed entirely of active U.S. military pilots, many of whom may have dealt with SAFIRE threats on a regular basis. Military involvement was not possible due to both time restraints and the classified nature of military operations in this area. The remainder of this chapter contains the implications, recommendations, and conclusions identified in the analysis of this study.

Implications

This study addressed an identified gap in research data regarding how air-carrier pilots perceive the value of SAFIRE risk-reduction training. A significant body of knowledge exists relating to the SAFIRE threat in general (Elias, 2010), but research on the value of training to counter the SAFIRE threat was lacking. This section contains a discussion of implications generated by the research when compared to the literature gaps. The consistency between the various sample groups simplified analysis and highlighted a number of implications. The discussion begins with an examination of the implications that arose from the results of RQ1.

Research Question 1. What value, if any, do air-carrier pilots place on SAFIRE risk-reduction training?

$H1_0$: The majority of air-carrier pilots sampled do not value SAFIRE risk-reduction training.

$H1_a$: The majority of air-carrier pilots sampled do value SAFIRE risk-reduction training.

Because I rejected the null hypothesis, and the respondents' additional comments provided added support, I can definitively state that the majority of the sample air-carrier pilots placed value on SAFIRE risk-reduction training. Because the air-carrier sample group is representative of all U.S. air-carrier pilots, the results indicated that the majority of all U.S. major air-carrier pilots do place value on SAFIRE risk-reduction training, which is a logical extension of Survey Question 10, which I put in place to identify potential skewing, in which the majority of respondents agreed that SAFIRE threats were

a risk to air-carrier operations. The fact that a majority of air-carrier pilots do perceive SAFIRE as a threat also leads to certain ethical implications.

The results from RQ1 and Survey Question 10 point to an ethical imperative for establishing SAFIRE risk-reduction training programs. Research has shown that air-carrier pilots have the ability to respond to contingencies, especially if training has exposed them to similar scenarios (Casner et al., 2013). This highlights the social responsibility to provide air-carrier pilots with specific SAFIRE risk-reduction training, because failing to provide such training may place the U.S. flying public at avoidable risk. Based on respondent additional comments, SAFIRE risk-reduction training would likely need to be FAA mandated, as several respondents felt this would be the only way their air-carrier would institute such a training program.

Research Question 2. What difference in value, if any, do air-carrier pilots place on the potential SAFIRE risk-reduction training methods?

$H2_0$: There is no significant difference in the value air-carrier pilots place among the three potential SAFIRE risk-reduction training methods (computer-based, classroom, and simulator training).

$H2_a$: There is a significant difference in the value air-carrier pilots place among the three potential SAFIRE risk-reduction training methods (computer-based, classroom, and simulator training).

I rejected the null hypothesis, as the air-carrier sample group clearly selected the combination of CBT, classroom training, and simulator training as the method of choice with a *strongly agree* response. Although more complex and expensive, the added capabilities of simulator training to provide pilots with the most realistic and intensive

form of training short of actual live-fly training in a real aircraft (Henley, 2003). In keeping with the principles of adult learning theory, the fact that simulators provide instant visual, aural, and tactile feedback makes them an excellent means of training pilots to execute the psychomotor skills necessary to respond to emergencies. Air-carriers use simulators for most other key phases of training, which indicates that the company leaders believe that the training value justifies the simulator training cost. The survey respondents' comments reinforced this idea, with several stating that SAFIRE risk-reduction simulator training should be FAA mandated due to the superior nature of this form of training. The implication is also that a lesser approach using only CBT or classroom training plus CBT would provide incomplete training that would put both air-carrier crew and passengers at risk.

Research Question 3. What is the difference, if any, between air-carrier pilots with prior military flying experience and those without prior military flying experience in terms of the value placed on SAFIRE risk-reduction training?

$H3_0$: Prior military flying experience makes no difference in the level of importance that air-carrier pilots place on SAFIRE risk-reduction training.

$H3_a$: Prior military flying experience makes a difference in the level of importance that air-carrier pilots place on SAFIRE risk-reduction training.

There was an extremely small variation in the distribution of responses for these two sample groups, and both had a median and mode response of *agree* to RQ3. In the social learning portion of adult learning theory, a researcher could surmise that less experienced learners will observe and adopt behaviors and attitudes from more experienced individuals within their environment (Henley, 2003). Regarding SAFIRE

threats, air-carrier pilots with a civilian-only background will not have the operational or training experience dealing with SAFIRE threats of their coworkers with prior military experience. Because individuals in the civilian-only sample responded the same positive way to the questions regarding perceived SAFIRE threat and the value of SAFIRE risk-reduction training, an implication is that they picked up, through informal discussion and other nonformal exchanges, a similar attitude regarding SAFIRE risk-reduction techniques.

Research Question 4. What is the difference, if any, between line air-carrier pilots and nonline air-carrier pilots in terms of the level of importance placed on SAFIRE risk-reduction training?

$H4_0$: There is no difference in the level of importance of SAFIRE risk-reduction training based on pilot type (air-carrier line pilots and air-carrier nonline pilots).

$H4_a$: There is a difference in the level of importance of SAFIRE risk-reduction training based on pilot type (air-carrier line pilots and air-carrier nonline pilots).

Although the responses for the line and nonline groups were similar, they were not as similar in distribution as were the civilian-only and prior-military-training sample groups examined in RQ3. The descriptive comparison using median response values for RQ4 showed a difference of one half of an ordinal category, with the line group responding *agree* and the nonline group having a median that fell in between *neutral* and *agree* due to an even number of respondents in that sample group (Creswell, 2014). One possible implication is that the members of the nonline sample group, who may focus on the business side of the air-carrier operations, may give a higher priority to training costs and a lower priority to operational requirements. Although some of the respondents'

additional comments tended to support this implication, there were not enough data to support this as a conclusion. The next section contains several recommendations based on the implications generated by the research.

Recommendations

Several clear recommendations emerged from the survey responses and data analysis used to examine RQ1 through RQ4. Based on the RQ1 response that the majority valued a SAFIRE risk-reduction training program, along with Survey Question 10's related result that the majority of air-carrier pilots see SAFIRE threats as credible, air-carriers should establish SAFIRE risk-reduction training programs (FAA, 2008). The response to RQ2 showed that a training program using CBT, classroom, and simulator training would be the most effective based on the perceptions and training experiences of the respondents in the sample group. Based on several of the respondents' additional comments, an FAA-mandated program may be the only way to get major air-carriers to expend the resources required to implement a SAFIRE risk-reduction program. A SAFIRE risk-reduction training program would likely be more effective if it applies lessons learned from pilots of international air-carriers and military operations, both of which have much more experience with the SAFIRE threat than domestic U.S. air-carriers. The respondents' comments also highlighted other recommendations beyond the establishment of a training program.

Assuming that domestic air-carriers implement a SAFIRE risk-reduction training program, the air-carriers can make efforts to implement SAFIRE risk-reduction effectively as part of daily operations. Because most of the activity in SAFIRE threat reduction to date has focused on counter-MANPADS technology, there has been no real

effort made to reduce the threat by using improved operational standards or techniques (Elias, 2010). Air-carriers need to develop operational protocols that lay out exactly what methods their pilots will execute if involved in a SAFIRE incident. Adult learning theory indicates that these should be the primary protocols practiced in the simulator portion of a training program. A common system for threat tracking and reporting by all air-carriers would standardize avoidance efforts and could provide faster reporting to all air-carriers when an incident occurs. Air traffic control could incorporate these protocols into the existing system, as suggested in several of the respondents' additional comments. Finally, the air-carrier industry should continue to pursue low-cost technological countermeasures, which would augment operational training programs and aircrew protocols. A review of the results of this study revealed several topics for future research.

Recommendations for Future Research

My analysis, along with additional comments from some of the respondents, indicated that further study could be productive in several areas. One area would be a comparison of cultural differences between U.S. air-carrier pilots and foreign air-carrier pilots to see if the differences predicted in the punishment–reward structure prevalent in other countries could make SAFIRE risk-reduction techniques less effective, which would be consistent with behaviorist learning theory (Henley, 2003). For example, some foreign air-carriers have a very rigid protocol structure between the captain and the first officer reflective of their cultural norms. In such a cockpit, the first officer is much less likely to act in response to an outside situation without a direct order to do so from the captain, which could slow the crew's response. Another study might involve looking into

the slight difference I noted between the line and nonline sample groups regarding RQ4, where the nonline sample group had a median response one half of a category less positive about the value of SAFIRE risk-reduction training. My supposition is that the business focus of the nonline group may have caused the members of that sample group to perceive the value of SAFIRE risk-reduction training programs as lower, especially if viewed through the lens of a cost–benefit analysis. A need exists for more research to verify or refute this possibility. Additionally, there is a requirement for technical research to define the parameters of specific countertactics and objectives for CBT, classroom training, and simulator training syllabi. With or without additional research, however, the data and analysis supported the main conclusions presented earlier in this chapter.

Conclusions

The majority of air-carrier pilots surveyed view SAFIRE as a legitimate threat and indicated they desired formal SAFIRE risk-reduction training to equip them to deal with IR MANPADS, manually aimed weapons, and laser illuminators. The problem addressed in this study was that air-carriers do not provide pilots with risk-reduction training designed to prepare them to deny, detect, defeat, and report SAFIRE attacks (J. Denton, personal communication, July 12, 2011). This study included an examination of this problem through the lens of adult learning theory and involved statistical analysis using a quantitative methodology. The analysis began with comparative statistics that indicated 70.5% of 112 valid survey respondents perceived SAFIRE risk-reduction training as valuable. There was little difference in the perception of training value when comparing line versus nonline pilots and military-trained versus nonmilitary-trained

pilots, as indicated in a Kruskal-Wallis comparison due to nonnormal data distribution. A review of these results indicated the sample group displayed a level of interest in a potential SAFIRE risk-reduction training program in accordance with the tenets of adult learning theory. Analysis using descriptive statistics revealed that 85.7% of air-carrier pilots believe that SAFIRE risk-reduction training should consist of a combination of CBT, classroom training, and simulator training methods, and some respondents indicated the FAA should make the simulator phase of SAFIRE risk-reduction training mandatory. Finally, the research uncovered several topics worthy of further study. There is value in conducting research to determine if the results of this study apply to non-U.S. air-carrier pilots, to identify parameters for specific countertactics, and to generate specific objectives for potential training programs.

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Appendixes

Appendix A: Text of Survey Used in the Main Study

The SAFIRE Risk-Reduction Survey

Introduction

Purpose of Study

Data is being collected to determine the level of interest air-carrier pilots have in receiving training to deny, detect, defeat and report surface-to-air threats. Specific tactics have been developed for air carrier pilots flying airline appropriate aircraft. These tactics are optimized for use by air carriers with specific attention paid to passenger comfort, crew familiarization and aircraft performance and limitations. The tactics generally focus on mission planning, lighting configurations, ground track, visual scanning and flying specific flight profiles.

Assurances

The identity of all participants we be kept completely confidential. I will be the sole individual with access to participant names and responses. All personal identification will be coded prior to analysis and distribution. To prevent any statistical skewing, please do not accomplish the survey more than once. Please do not discuss the topic of the survey with other pilots. Survey results will be posted after completion of the project.

This survey should take approximately fifteen minutes. Please select the correct answer and advance to the next question by selecting the "Next" key at the bottom of the page. Feel free to select the "Prev" key at the bottom of the page if you wish to change any answers. Please answer all questions.

Definitions

Surface-to-Air Fire (SAFIRE) threats: SAFIRE threats include rockets, rocket-propelled grenades, small arms, lasers, spotlights, anti-aircraft artillery and Man-Portable Air-Defense Systems that are employed to interfere with or destroy an aircraft in flight.

Air-carrier line pilot: An air-carrier line pilot is an air-carrier captain or first officer of an air-carrier aircraft whose only duty is to conduct scheduled passenger or cargo transportation flights.

Air-carrier nonline pilot: An air-carrier nonline pilot is an air-carrier pilot whose primary duties ARE OTHER THAN conducting scheduled passenger and cargo flights. Nonline pilots DO NOT execute day-to-day operations. This population includes pilots in management, training and evaluation positions.

Civilian-only flying experience: Civilian-only flying experience refers to an air-carrier pilot who HAS NOT completed training as a crewmember serving in the U.S. Air Force, U.S. Army, U.S. Marines, U.S. Navy, U.S. Coast Guard or foreign equivalent.

Prior military flying experience: The term refers to an air-carrier pilot who HAS completed training as a crewmember serving in the U.S. Air Force, U.S. Army, U.S. Marines, U.S. Navy, U.S. Coast Guard or foreign equivalent. An assumption is that pilots with prior military flying experience have, at some point during military service, had exposure to formal or informal training associated with SAFIRE threats.

SAFIRE risk reduction training: SAFIRE risk reduction training is a training syllabus designed to give air carrier pilots the tools to counter SAFIRE threats. This training would teach pilots techniques to "deny" hostiles the opportunity to fire on the air carrier aircraft, to "detect" enemy SAFIRE, to "defeat" the specific threats (using tactics, procedures, and maneuvers which are safe for the type of aircraft being flown) and to "report" the incident to authorities following a SAFIRE incident.

Informed Consent Form

By selecting the link, you have volunteered to participate in an anonymous study designed to quantify the perceived value of Surface-to-Air Fire (SAFIRE) risk-reduction training and to identify the desired training method or methods for a Northcentral University (NCU) PhD dissertation being accomplished by Doctoral Student Earl W. Burress, Jr. The information from the completed study will be provided to academia, the airline industry and the federal government as a foundation for future SAFIRE risk-reduction related research. Please read this form before providing your name and selecting the block to indicate that you wish to participate or that you wish to withdraw.

Your participation will help the researcher determine the level of value air-carrier pilots place on SAFIRE risk-reduction training. The researcher will also determine if air-carrier pilots believe that SAFIRE-risk reduction training is valuable, because adult learning theory indicates that a lack of perceived value can greatly reduce or eliminate the effectiveness of training. The results will help determine if air-carrier pilots believe there is a legitimate requirement for SAFIRE risk-reduction training. If you agree to participate in this study, you will be requested to type your name in this form, select the block indicating that you wish to participate and complete the survey. Your total participation time should be under 15 minutes.

Your participation is voluntary and you can opt out at any time. Also, please feel free to provide written or verbal feedback to the researcher or the university at any point during the study.

The participants will not be provided with compensation but digital copies of the completed study will be available upon request. An executive summary of the research will be posted on [redacted] after the dissertation is completed.

There are no physical risks to this study. There are no direct benefits for participation, although the participants in this study may benefit from study if it serves as a foundation for additional research resulting in changes in policy, procedures or training programs. Risk mitigation for confidentiality issues is discussed in the following paragraph.

The names of the participants will be known only to the researcher. These names will be coded with pseudonyms prior to data analysis and all personally identifiable information (either electronic or hardcopy) with be stored in the researcher's personal files for five years in a locked safe that only the researcher can access. After five years the information will be destroyed. All findings will be presented in aggregate form with no personal identifiers attached.

Please feel free to contact Doctoral Student Earl W. Burress, Jr. with any comments or concerns associated with the study via email at earlburress@hotmail.com. You can also contact the dissertation chair, Dr. Walter McCollum via email at WMcCollum@ncu.edu. If you have questions about your rights as a research participant, any complaints about your participation in the research study, or any problems that occurred in the study, please contact the researcher at earlburress@hotmail.com or if you prefer to talk to someone outside the study team, you can contact NCU's Institutional Review Board at irb@ncu.edu or call them at 1-888-327-2877 ext. 8014.

The participant understands the purpose and risks of the study and has no additional questions. Typing your name on this form and selecting the appropriate statement indicates that you have decided to voluntarily participate in the study and that the researcher is authorized to analyze the information collected during data collection. Refusal to participate in this study will involve no penalty and participants have the right to withdraw at any time.

1. Please select the appropriate answer to either provide informed consent or to exit the survey.

__ YES, I have read and understand the informed consent form and WISH to participate in the survey.

__ NO, I do NOT wish to participate in the survey.

2. Please type your name to indicate that you have read the informed consent statement and agree to participate in this study.

Your name will be coded with a personal identifier and your participation will be anonymous. Your non-coded responses will be stored in a safe that only the researcher has access to for a period of five years. After five years the data will be destroyed.

3. The following anonymous survey is a voluntary and intended for current [redacted] pilots. Please select ONE response to either continue or exit the survey.

__ I AM currently employed by [redacted] as an air-carrier pilot.
__ I am NOT currently employed as a [redacted] air-carrier pilot.

Demographics (Training Background)

4. Training Background:
__ I have a civilian-only flying experience
__ I have prior military flying experience

5. Please identify the types of aircraft you were qualified to fly as a military pilot:
__ Fighter and Attack Type Aircraft
__ Bomber Type Aircraft
__ Tanker Type Aircraft (To include non-tanker variants of tanker airframes)
__ Transport Type Aircraft
__ Fixed Wing Military Trainer Aircraft as an Instructor
__ Helicopter and Tilt Rotor Aircraft
__ Helicopter and Tilt Rotor Aircraft as an Instructor
__ Unmanned Aerial Vehicles
__ Other Types of Aircraft

Please feel to elaborate if you have selected “Other Types of Aircraft”.

6. I have logged combat flying hours in the presence of potential surface-to-air threats:
__ True
__ False

Demographics (Flying Time)

7. Please select your approximate total flying time logged while flying times while flying in the positions of Captain, First Officer, pilot and copilot:
__ Below 3,000 hours.
__ 3,001 to 5,000 hours.
__ 5,001 to 10,000 hours.
__ More than 10,000 hours.

Demographics (Duties within the Company)

8. Airline Duties:
__ I am a line pilot
__ I am a nonline pilot

Demographics (Comments)

9. Please feel free to list any other unique experiences (flying as a navigator, weapon system operator, as a foreign airline, or as a ground SAFIRE operator) which may influence your perception of the topic. Do not include any information that could be used to personally identify you to include precise flying time, specific years of service, or specific aircraft types flown:

Perceptions of Topic Importance

10. I believe that SAFIRE threats pose a credible risk to either domestic or international U.S. air carrier operations.
__ Strongly Disagree
__ Disagree
__ Neutral
__ Agree
__ Strongly Agree

11. I believe that SAFIRE risk reduction training is useful and should be included as part of my formal training as an air carrier pilot.
__ Strongly Disagree
__ Disagree
__ Neutral
__ Agree
__ Strongly Agree

12. Please feel free to provide any additional comments as necessary. Please do not include any information that could be used to personally identify you to include precise flying time, specific years of service, and specific aircraft types flown:

Perceived Value of Training

In the following section, you will be asked for your opinion of combinations of training options to include Computer Based Training, Classroom Training and Simulator Training. Please read all four questions and then provide the appropriate combination of responses.

13. Computer Based Training is an effective method of providing SAFIRE risk-reduction training to air-carrier pilots.
__ Strongly Disagree
__ Disagree
__ Neutral
__ Agree
__ Strongly Agree

14. A combination of Computer Based Training and Classroom Training is an effective method of providing SAFIRE risk-reduction training to air-carrier pilots.
__ Strongly Disagree
__ Disagree
__ Neutral
__ Agree
__ Strongly Agree

15. A combination of Computer Based Training, Classroom Training and Simulator Training is an effective method of providing SAFIRE risk-reduction training to air-carrier pilots.
__ Strongly Disagree
__ Disagree
__ Neutral
__ Agree
__ Strongly Agree

16. Please feel free to provide any additional comments as necessary. Please do not include any information that could be used to personally identify you to include precise flying time, specific years of service and specific aircraft types flown:

Survey Complete

Thank you for your participation. An executive report of the dissertation findings will be made available for your review on the [redacted] website after the study is complete.

As a reminder, please do not accomplish this survey more than once and please do not discuss the details of the survey with other potential participants. Results will be made available on the pilot message board upon completion of the study.

Appendix B: Letter of Permission to Post Survey Link

[redacted]

Earl W. Burress, Jr.
[redacted]

December 14, 2013

Dear Mr. Burress,

As webmaster of the [redacted] website, I authorize you to post your PhD survey announcement and link for the website for up to 45 days (beginning on the date of the initial message posting). I understand that you desire a minimum of 73 participants and may periodically "bump" the posting to encourage participation.

I also authorize you to post this statement, or variations of this statement, with the link to the survey, "To all [redacted], I am requesting your assistance and hope you are willing to accomplish the voluntary survey posted at the link below. The survey will take approximately five minutes. Your participation is completely voluntary, confidential, greatly appreciated, and essential to this project. Please invest a brief period of your time to make a lasting impact on aviation safety. The link to the survey is at the bottom of the page. Thank you."

I have reviewed draft versions of the anonymous survey and understand that it will take each volunteer approximately five minutes to complete. I am aware that the data collected will be used in a Northcentral University PhD Dissertation titled "Analyzing Air-Carrier Pilot Interest in Surface-to-Air Fire (SAFIRE) Risk-Reduction Training". I also understand that this dissertation will address the objectives outlined in the following section from the dissertation proposal abstract: The purpose of this quantitative, comparative study is to analyze air-carrier pilot perceptions of SAFIRE risk-reduction training as related to the principles of adult learning theory. The study will include descriptive statistics and an analysis of variance to determine (a) whether participants believe a need exists for training to develop the skills necessary to avoid, detect, defeat, and report SAFIRE threats; (b) whether the proposed training's perceived level of value differs between the active air-carrier community and within the air-carrier professional instructor corps; (c) whether air-carrier pilots with military experience perceive the importance of the training is different from pilots without military experience; and (d) if air-carrier pilots believe that a particular method of training is most suitable for SAFIRE risk-reduction training.

If you have any questions, please feel free to contact me at [redacted].

[redacted]
Webmaster/Owner
[redacted]

Appendix C: Survey Question Responses Collected in the Main Study

Table C1 breaks out all of the survey questions responses for the entire respondent sample group, which totaled 112. Under some categories, such as military aircraft type flown, the total of the sub-category responses exceeds 112 due to some respondents having experience in multiple sub-categories.

Table C1

Summary of All Survey Responses

Survey Question	**Total Responses**
I have civilian-only flying experience	49
I have prior military flying experience	63
Please identify the types of aircraft you were qualified to fly as a military pilot:	
-- Fighter and Attack type aircraft	30
-- Bomber type aircraft	6
-- Tanker type aircraft (to include non-tanker variants of tanker airframes)	7
-- Transport type aircraft	29
-- Fixed wing military trainer aircraft as an instructor	25
-- Helicopter and tilt-rotor type aircraft	5
-- Helicopter and tilt-rotor type aircraft as an instructor	2
-- Unmanned aerial vehicles	3
-- Other types aircraft	9
I have logged combat flying hours in the presence of potential surface-to-air threats:	
-- True	45
-- False	18
Please select your approximate total flying time logged while flying in the positions of Captain, First Officer, pilot and copilot:	
-- Below 3,000 hours	0

-- 3,001 to 5,000 hours	3
-- 5,001 to 10,000 hours	32
-- More than 10,000 hours	77
Airline Duties:	
-- I am a line pilot	102
-- I am a nonline pilot	10
I believe that SAFIRE threats pose a credible risk to either domestic or international U.S. air carrier operations:	
-- Strongly Disagree	3
-- Disagree	3
-- Neutral	8
-- Agree	72
-- Strongly Agree	26
I believe that SAFIRE risk reduction training is useful and should be included as part of my formal training as an air carrier pilot.	
-- Strongly Disagree	1
-- Disagree	6
-- Neutral	26
-- Agree	55
-- Strongly Agree	24
Computer Based Training is an effective method of providing SAFIRE risk-reduction training to air-carrier pilots:	
-- Strongly Disagree	10

-- Disagree	33
-- Neutral	28
-- Agree	36
-- Strongly Agree	5
A combination of Computer Based Training and Classroom Training is an effective method of providing SAFIRE risk-reduction training to air-carrier pilots:	
-- Strongly Disagree	3
-- Disagree	23
-- Neutral	30
-- Agree	52
-- Strongly Agree	4
A combination of Computer Based Training, Classroom Training and Simulator Training is an effective method of providing SAFIRE risk-reduction training to air-carrier pilots:	
-- Strongly Disagree	1
-- Disagree	7
-- Neutral	8
-- Agree	39
-- Strongly Agree	57

Appendix D: Additional Comments Collected in the Main Study

I gave the respondents an opportunity to add open-ended comments regarding that portion of the survey in three places. Table D1 identifies these three locations in the survey, followed by all of the open-ended additional remarks made by the survey respondents. I asked the respondents to provide additional comments after the demographics section, after the question on the value of SAFIRE risk-reduction training, and after the final question on the value of various SAFIRE risk-reduction training methods.

I replaced all references to a particular employer with "[redacted]".

Table D1

Additional Remarks by Survey Respondents

DEMOGRAPHICS SECTION: Please feel free to list any other unique experiences (flying as a navigator, weapon system operator, as a foreign airline, or as a ground SAFIRE operator) which may influence your perception of the topic. Do not include any information that could be used to personally identify you to include precise flying time, specific years of service, or specific aircraft types flown.
Attended Combat Air Tactics Military Airlift Command School, Red Flag/Green Flag as a transport pilot
AF TENCAP
21 years AF, F16 F117.
Flew first night of Desert Storm and 30+ combat missions. Many SAM s spotted and defense maneuvers performed.
I flew 43 combat/combat support flights over Iraq/Kuwait in Gulf war 1
Electronic warfare officer
I spent 3 years flying overseas from 2009-2012. 1 year in China and almost 2 years at Korean Airlines.
Participant in USAF Red Flag Exercises and was a F-4G Wild Weasel Pilot
F-111 WSO, Air Liason Officer
ISR Battle Captain in Iraq - managed operational control and scheduling of manned and unmanned aircraft for special ops.
I recently returned to [redacted] after a five year furlough. During this time, I worked at a defense contractor on counter MANPADS programs for the military. There were also associated hostile fire indication programs. This may skew my opinion. I can see value in this type of training for air carrier pilots.

WSO prior to being a Pilot
VALUE OF SAFIRE TRAINING SECTION: Please feel free to provide any additional comments as necessary. Please do not include any information that could be used to personally identify you to include precise flying time, specific years of service, and specific aircraft types flown.
Always am interested in safety measures that airlines are taking in military charter ops. Procedures are in manuals yet, diversions are rare, but happen into hostile countries.
I believe lasing to be the biggest threat as airline pilots but we would certainly be an easy and effective target publicity-wise if someone was motivated and had access to the right weapon.
I have experienced several laser events in Brazil and Kuwait with Kuwait being the more intense events. Training on how to avoid eye damage and on what types of lasers are out there would be helpful.
Providing only a small amount of information (CBT only) training may be more harmful than no training for many pilots. Sim time would be needed.
Difficult to get a pilot to a proficient level of training in alloted time
The questions seem to be very limited in scope so I'm not sure what data you are trying to get. I don't feel there is a significant domestic threat that would justify the required training for SAFIRE. Internationally is a different story and depending on which routes pilots fly, then that type of training could be of some benefit.
Training airline pilots to counter "SAFIRE" threats is not a good use of assets. The best prevention is securing approach corridors.
In my 35+ year aviation career I have flown in multiple locales where the presence of SAFIRE would be nearly impossible to detect or defend against.
Do not know benefits of training on aircraft with no countermeasures available.
Global operations are probably at higher risk and therefore more in need of procedural training.
I believe that SAFIRE training would be beneficial for international flight operations.
A third party trainer such as the military would be great.
One civilian transport was fired upon and hit overseas, it's just a matter of time until another is shot at.
Knowledge of specific threat capabilities would allow pilots to mitigate risk, further protecting the traveling public.
It's highly unlikely that the company would provide this training unless mandated by the FAA. This is a cost issue to management.
The training to defeat is beyond the scope what air carrier training could provide. Active on board systems would be much more effective.
Threat possibility is as strong domestically around large cities/hubs as it is internationally.
Specific intelligence training causes me to believe this subject matter is relevant and widely ignored. I have discussed this issue with a former U.S. Secretary of Defense in the last 12 months. The issue is relevant. The topic is timely.

While this topic is not foremost in a pilot's mind, it is never the less a real possibility in our current world. Many of us would be interested in more information on how to recognize and defeat such potential threats.
Training would be especially useful for international destinations where the threat is a greater possibility.
The surface to air threats at this time have been more theater specific. I took I volunteer furlough from [redacted] and flew for a DOD contract cargo operator into higher threat areas with active combat, and the risk level there would warrant such measures and training although none were provided. [redacted] has a network over reduced risk areas, although some military charters do operate in increased risk areas. Giving every line pilot training may not be as valuable or effective as more focused and specific training to 747 and 777 crews flying these charters.
International, Middle East, destinations on wide-body aircraft here at UCH present the greatest threat today in our operations.
IMO it is a credible threat in several parts of the world.
Where do we fly normally that would require training to avoid missile shots? What do you think an air carrier to do to defeat a missile threat/
With the continual reduction in allotted time and increase in training criteria, we are running out of any possible time that could be allotted to extra training for rare, but possible threat traing.
detecting threat training without aircraft borne equipment to help will probably not be useful
To date I've seen no info on SAFIRE to be able to make a reasonable assessment of the potential risk.
DHL and a C-5 both got hit by SAMs at Baghdad/BaladAB.
We fly worldwide and as such are subject to threats which may be far greater than those found operating in a purely domestic theatre. The world is a dangerous place and there are weapons out there possessed by all types of lunatics and we are an easy and visible target.
VALUE OF POTENTIAL SAFIRE RISK-REDUCTION TRAINING METHODS SECTION: Please feel free to provide any additional comments as necessary. Please do not include any information that could be used to personally identify you to include precise flying time, specific years of service and specific aircraft types flown.
Simulator topics are time restricted as is. Adding this would only be more time consuming and it does not happen often. CBT is sufficient.
Please don't advocate any CBT training to [redacted]. They think CBT is the answer to their dreams. I hate it. Very difficult for me to absorb training from a computer monitor.
All these types of truing are effective methods to reduce risk. I personally feel the risk is very low and that most airlines would not feel or approve this additional training. Training = cost, and most company's would only do it if required by the FAA.
Ongoing updates on where the current laser threats are, and any other type of threats that are occurring on at least a quarterly report basis would be helpful, plus and alerts on any immediate or escalated threat.

CBT would be the only method that I would approve of for the air carrier pilot. More and more instruction is being cut from the syllabi and there are bigger threats that need the time. My experience with the civilian pilots as students is that they lack the capacity to identify threats outside of their normal realm of experience.
CBT is of limited value in a dynamic environment. Supplementing CBT with live classroom training is helpful, but there is no substitute for actually flying the maneuvers.
Have had actual LASER encounter BOS
Knowledge of threat capabilities such as manpad seeker micron ranges vs airline engine signature would be helpful, however with the limited maneuvering capability of airliners and the limited visibility from the cockpit, I'm not convinced providing simulator would increase safety. If anything, it might encourage maneuvering that might have more devastating results than the threat itself.
Again, it comes down to cost! Management will do a cost benefit analysis of this and will not move forward with it. Ask yourself, how many US civilian airliners have been attacked by these weapons? Unless mandated by the FAA nothing will happen!
For me, sim training would be the gold standard for learning techniques to minimize the SAFIRE threat.
Training must include any on-board countermeasure equipment companies may purchase for their fleets. Simulators must have visual capabilities.
The topic and survey are well stated. Thank you for the interest.
Simulator training would be the most effective way to prepare for these types of events.
Video demonstrations and graphics with general information on performance parameters of threats would be a good start followed by the required geometry to defeat such threats. Simulator training is always valuable regardless of the topic. Simulator time, however, will be limited due to the high volume of training in the coming years.
If CBT and class rooms could fully prepare pilots to deal with threats we would have no need for simulators. Simulators reinforce procedures introduced in class and greatly increase the chances of getting it right when actually flying the aircraft.
Procedural simulation will always provide the greatest benefit in learning and becoming familiar with SAFIRE techniques and their application.
Without some type of simulator training it is all worthless
It's difficult to objectively evaluate question 11 without being exposed to an example of CBT on this subject. The quality of a CBT can vary widely, and a high quality CBT could be at least as effective as a classroom lecture.
Computer based training is ineffective. Classroom and simulator training is most effective for actual learning.
Classroom and Sim would be the most effective. CBT's if used at all should be kept to a minimum. They are boring and in most cases a waste of everyone's time
Lack of counter measures on airliners limits what you can do. Expecting a airline crew to do spiral ups/spiral downs to a field is a non starter. Would have to be trained, certified, and currency tracked. Too much money for the greedy bastards who run my airline.

Practical application including the visual indications are necessary to ingrain the academic instruction.
[redacted] has reverted to a LOT of computer based training and it is, in many cases INEFFECTIVE and poorly designed. ANY computer based training produced by [redacted] Airlines would be highly suspect.

Appendix E: Statistical Formulas, Calculations, and Results

I computed all spreadsheet calculations referenced here using the Microsoft Office 2010 Excel calculation and statistics tools.

Descriptive analysis for RQ1 and RQ2, calculation of MEDIAN response:

- Each sample group contains n total responses
- The Likert-type Scale responses were each assigned a corresponding integer value (1 = "Strongly Disagree," 2 = "Disagree," etc.)
- Survey responses were ordered using the Excel "sort data" function
- I selected the response value at n/2 as the MEDIAN value.
- In one case where n was an even number, the MEDIAN value fell at a break point between two values ("Agree" and "Neutral"). Rather than round up or down, I described the statistical significance of this value as falling halfway between two response values, as this was a potentially significant finding.

Kolmogorov-Smirnov normality test for RQ3 and RQ4:

- I used The NORMQUANT Excel package developed by Professor Scott Guth at Mt. San Antonio College for these calculations. The test calculates a correlation value r for the actual sample and the related normal distribution for that sample size, then compares the two values.
- The critical value for $\alpha = 0.05$ and a sample group size n was calculated using: 1.0063 - 0.1288/SQRT(n) - 0.6118/D3 + 1.3505/n^2
- A z-score for each sample group value was computed using the Excel NORMSINV function
- The correlation value r was computed using the Excel CORREL function, comparing the sample group and corresponding z-score distributions
- The results of this test are displayed in Table E1 and Figure E1

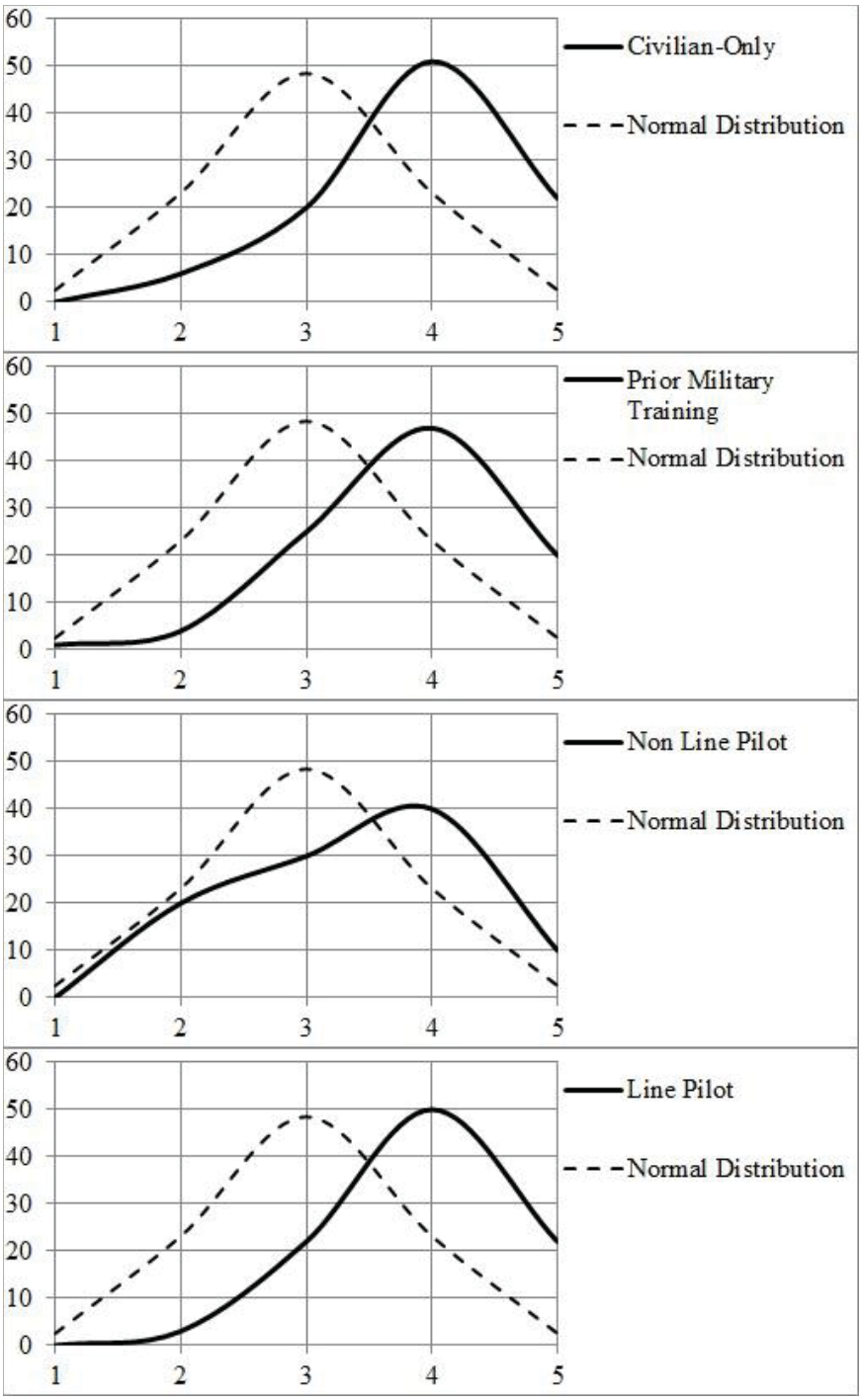

Figure E1. Individual sample group distribution versus normal distribution.

Table E1
Kolmogorov-Smirnov Normality of Distribution Test Results

Sample groups	Sample *r* value	Minimum *r* value for normality	Distribution result
Civilian-only	0.924095236	0.975976760	Nonnormal data
Prior military	0.927200133	0.980701876	Nonnormal data
Line	0.909578975	0.987678666	Nonnormal data
Nonline	0.953475230	0.917894864	Normal data

Note. $\alpha = .05$.

Kruskal-Wallis Test for RQ3 and RQ4

- Since the Kolmogorov-Smirnov test showed most of the sample group distributions could not be assumed normal with at least 95% confidence, a Kruskal-Wallis test for nonnormal data was used to compare the four sample group distributions (Civilian-Only Training, Military Training Experience, Line Pilot, Non Line Pilot)
- The first step was to sort each of the sample groups based on ordinal representations of the Likert-type scale responses.
- Next an Excel array was defined containing the sorted ordinal responses for all four sample groups
- Step three was to use the Excel RANK.AVG function to create a rank-averaged value for each response of each sample group, relative to the total set of responses for all four groups.
- Step four was to add all the RANK.AVG values in each sample group for a rank sum R value, and from that to calculate a value for R^2 / n for each of the four sample groups (where n = the total respondents within each respective group)
- Step five was to calculate an H value using: H = [12(R^2/n)]/(n(n+1)) - 3(n+1).
    - H = 1.430441612
- Step six was to calculate a p-value using the Excel CHIDIST function and a value of 3 for degrees of freedom (based on DF = #sample groups -1)
    - p = 0.698414818
- Finally, since H > p the result of the Kruskal-Wallis test is that no significant distribution difference exists between any of the four sample groups