SCENARIO-BASED TRAINING IN TECHNICALLY ADVANCED AIRCRAFT AS A METHOD TO IMPROVE RISK MANAGEMENT

by

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ABSTRACT

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The purpose of this research is to measure pilot attitudes toward scenario-based training as an effective training strategy in technically advanced aircraft. Two groups of pilots participated in a scenario-based, pilot proficiency training seminar sponsored by the Cirrus Owners and Pilots Association and by the Federal Aviation Administration Industry Training Standards research team. The author prepared a survey that was administered to these groups of pilots. The survey results demonstrated the effectiveness of scenario-based training as a method of teaching and group interaction. The results indicated that scenario-based training appears to be an effective method of improving pilot decision making skills and consequently may reduce the general aviation accident rate in technically advanced aircraft.

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ACRONYMS AND ABREVIATIONS

ADM	Aeronautical Decision Making
ATC	Air Traffic Control
CFIT	Controlled Flight Into Terrain
COPA	Cirrus Owners and Pilots Association
CRM	Crew Resource Management
ERAU	Embry-Riddle Aeronautical University
FAA	Federal Aviation Administration
FITS	FAA Industry Training Standards
GA	General Aviation
GAMA	General Aviation Manufacturers Association
GPS	Global Positioning System
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
LOFT	Line Oriented Flight Training
MFD	Multi-Function Display
PFD	Primary Flight Display
PTS	Practical Test Standards
SBT	Scenario-Based Training
SPSS	Statistical Package Software System
SRM	Single Pilot Resource Management
UND	University of North Dakota
VFR	Visual Flight Rules

CHAPTER I

INTRODUCTION

Background

The Federal Aviation Administration (FAA) has developed a new training program titled, “FAA Industry Training Standards” (FITS). This program is designed to reduce the general aviation (GA) accident rate in a new classification of aircraft called technically advanced aircraft (TAA). The FITS program began in late 2001. By mid June 2002, the FAA had awarded two grants to Embry-Riddle Aeronautical University (ERAU) and to the University of North Dakota (UND) to develop pilot training syllabi. (Grant # 5495-0526) The designed program combines a scenario-based training (SBT) curriculum with the current standards found in the FAA’s practical test standards (PTS).

The FITS program challenges the GA community to develop an adaptable flight training system that will improve the safety and utility of increasingly complex flight operations. (Wright, 2002). “The TAA will require new skills, a new decision-making matrix, and new maneuvers to ensure it provides the increased safety requirements desired by the FITS initiative” F. H. Ayers (personal communication, November 16, 2003) The FITS program is leading an effort to change the current flight training process, to embrace technology, and to target the pilot’s decision-making skills with each curriculum. The FITS research team has developed the concept of single pilot resource management (SRM) to formalize the process used by GA pilots to manage risk. FITS teaches the pilot how to monitor, manage, and integrate information from many sources while flying a TAA (Connolly, 2003).

Statement of the Problem

The problem in GA is that current training methods do not appear to be impacting the TAA accident rate (Wright, 2002). Can SBT be used to teach SRM and have an effect on the way GA pilots transition into TAA? Is SBT a training method that will improve pilots' risk management skills? The FAA has challenged a team of industry experts and universities with the task of developing new training syllabi that addresses training for GA pilots transitioning to a TAA. The FAA hopes that SBT along with SRM in the FITS training program, it will achieve its goal to reduce the GA accident rate in TAA.

Delimitations

The purpose of this study is to assess pilots' reactions to SBT and the concept of SRM. This paper will concentrate on SBT and its effects on GA pilot training in TAA. It primarily focuses on single pilot operations in a TAA. This paper will discuss some findings the FITS research team has had thus far concerning SBT and the concept of SRM.

Definition of Terms

Aeronautical Decision-Making (ADM) – A systematic approach to the mental processes used by pilots to consistently determine the best course of action in response to a given set of circumstances. Aircraft flying requires a continuous stream of decisions pertaining to the pilot, the aircraft, and the environment. The Pilot, aircraft, environment, operation, and situation are five subject areas that combine to define ADM.

Approach – This paper uses the term "an approach" as a noun, meaning a procedure a pilot follows in order to obtain landing guidance. It can be utilized in both visual conditions or in instrument meteorological conditions.

Federal Aviation Administration (FAA) – The governing body of all civil flight operations within the United States.

General Aviation (GA) - All aviation other than scheduled commercial airlines and military aviation. It accounts for carrying 166 million passengers annually including helicopters, single-engine piston airplanes, mid-size turboprops, and large business jets capable of flying non-stop international flights. General aviation is relied upon exclusively by more than 5,000 communities for their air transportation needs (scheduled airlines serve about 500). Nearly 70 percent of the hours flown by general aviation are for business purposes.

Glass Cockpit – An electronic display of flight instrumentation that includes aircraft navigation, communication, and systems information.

Global Positioning System (GPS) – A space based radio positioning, navigation, and time transfer system. The system provides highly accurate position, velocity information and precise time on a continuous global basis to an unlimited number of equipped users. The system is unaffected by weather and provides a worldwide common grid reference system.

Instrument Flight Rules (IFR) – A set of rules governing the conduct of flight under instrument meteorological conditions.

Instrument Meteorological Conditions (IMC) – Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling less than the minima specified for visual flight conditions.

Light Turbine TAA - A jet or turboprop TAA certified for single-pilot operations, weighing 12,500 lbs or less, that may be equipped with cabin pressurization, and may be capable of operating in Class A airspace on normal mission profiles.

Multi-Function Display (MFD) - A device that combines primary navigation, aircraft systems, and situational awareness information into a single electronic display.

Non-Parametric – Not involving the estimation of parameters of a statistical function.

Primary Flight Display (PFD) – A device that combines the primary six flight instruments plus other related navigation and situational awareness information into a single electronic display.

Scenario-Based Training (SBT) – A training system that uses a highly structured script of real-world experiences to address flight training objectives in an operational environment. Such training can include initial training, transition training, upgrade training, recurrent training, and special training.

Simulation - Any use of animation and/or actual representations of aircraft systems to simulate the flight environment.

Single Pilot Resource Management (SRM) – The “art and science” of managing all resources (both on-board the aircraft and from outside sources) available to a single-pilot (prior and during flight) to ensure the successful outcome of the flight is never in doubt.

Technically Advanced Aircraft (TAA) – A general aviation aircraft that contains a GPS navigator with a moving map display, plus any additional systems. Traditional systems such as autopilots when combined with GPS navigators are included. It includes aircraft used in both VFR and IFR operations, with systems certified to either VFR or IFR standards.

Visual Flight Rules – Rules that govern the procedures for conducting flight under visual meteorological conditions. The term “VFR” is also used in the United States to indicate weather conditions that are equal to or greater than minimum VFR requirements.

CHAPTER II

REVIEW OF RELEVANT LITERATURE AND RESEARCH

Technically Advanced Aircraft

Technically advanced aircraft (TAA) entered the GA market in the mid to late 1990s, and today are becoming increasingly popular. Aircraft sales statistics from the General Aviation Manufacturers Association (GAMA) report that out of 541 total GA aircraft delivered in the first quarter of 2004, 105 were Cirrus Aircraft and 57 were Diamond Aircraft (GAMA, 2004). These were the only two aircraft manufacturers producing TAA at the time. These are “aircraft in which the pilot interfaces with one or more computers in order to aviate, navigate, or communicate” (FAA, August, 2003, p. 4). A TAA is a general aviation aircraft that contains a GPS navigator with a moving map display, plus any additional systems. Traditional systems such as autopilots when combined with GPS navigators are included. It includes aircraft used in both VFR and IFR operations, with systems certified to either VFR or IFR standards. This list describes the minimum equipment for an aircraft to be considered a TAA.

Most of the new production TAA in GA also have Primary Flight Displays (PFD). In fact, all of the Cirrus SR-20 and SR-22 aircraft have PFDs as part of its minimum avionics package (Cirrus, 2004). This electronic instrument combines the traditional analog flight instruments and displays them all onto a flat computer screen in front of the pilot. These electronic displays are part of what is referred to as a glass cockpit. “The introduction of the glass cockpit, as well as a whole new generation of high performance aircraft into the GA community, demands not only a thorough review but also a comprehensive overhaul of the traditional approach to training pilots” (Connolly, 2003, p. 10).

Manufacturers have responded to a demand for technically equipped and computer-advanced GA aircraft. To meet these demands, aircraft such as the Cirrus SR20 and SR22, Diamond Aircraft DA40, Eclipse Jet, and the Cessna Mustang were designed and developed in the last decade. All of the aforementioned aircraft fall into the category of TAA. Additionally, existing aircraft have been converted to TAA, such as the Cessna 172 and 182 with a glass cockpit. These aircraft were designed for the single pilot to fly in instrument meteorological conditions (IMC). Although similar to single pilot IFR operations, SRM goes further to incorporate technical aircraft systems training early on with decision-making skills. SRM training in a TAA is designed to give the single pilot a more thorough understanding not only of the automated aircraft systems, but also of the proper methods of utilizing available resources to make the best decisions.

Safety Study

The accident rate of TAA is much higher than the average GA accident rate. To use as an example, “according to figures published by Aviation Consumer, Cirrus has an overall accident rate of about 10 per 100,000 flight hours or three times that of the typical GA fleet” (Cessna, 2004, p. 6). Figure 1, on the following page, was taken from an article that compared the Cessna 182T glass cockpit to that of the Cirrus SR-20 aircraft. Both of these aircraft are considered TAA. The blue (left) column displays the GA accident rate while the red (right) column displays the Cirrus accident rate (Cessna, 2004, p. 6).

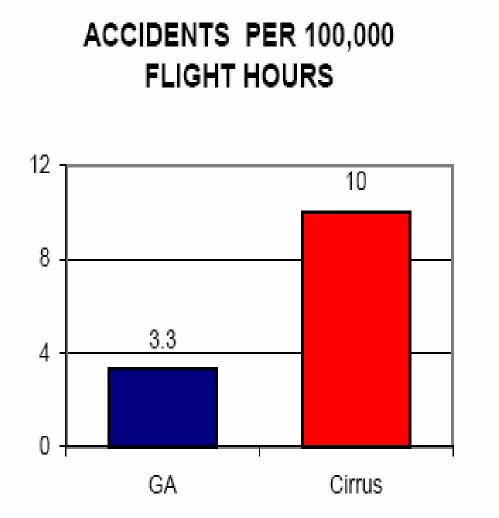

Figure 1. *Cirrus Accident Rate*

In an effort to reduce the high accident rate of TAA, the FAA, along with TAA manufacturers, insurance companies, ERAU and UND, and several GA safety organizations, spearheaded a recent TAA safety study. This published study identified several findings relating to the TAA accident rate. Some of these are:

1. The steps required to call up information and program an approach in IFR certified GPS navigators are numerous, and during high workload situations they can distract from the primary pilot duty of flying the aircraft. MFD's and PFD's did not present a complexity problem.

2. TAA's provide a potential for increased safety. However, to actually obtain this increased safety, pilots must receive additional training in the specific TAA systems and operate within the limitations inherent in the particular TAA system.

3. Typical GA pilot judgment errors found in non-TAA accidents were also found in TAA accidents.

4. Effective and feasible interventions have been identified, mostly recommending improvements in training, and effective implementation mechanisms exist. Therefore, TAA safety problems can be addressed. (FAA, August, 2003, p. 18)

By reviewing these findings and understanding the typical causes of TAA accidents, the GA industry safety analysts can develop training programs that address the aforementioned findings.

Challenge of Flying TAA

TAA are equipped with the latest avionics packages that were previously only in military aircraft, commercial airlines, and a few corporate aircraft (Wright, 2002). Today, there are several fast, complex, long-distance, and single-pilot aircraft on the GA market. These aircraft are notable for the ability to travel long distances in comfort, and with the potential to achieve air carrier and corporate levels of safety. As the demand for utilizing TAA for the business category increases, so does the responsibility of the single pilot, and the pilot is a significant limitation in TAA. The single pilot workload in a business jet is immense. Utilizing all available resources will help alleviate some of the workload and aid in decision-making concerning a flight. It is not enough to possess aircraft systems knowledge.

The TAA pilot needs to incorporate aeronautical decision-making (ADM) and risk management into his/her thought process along with possessing a comprehensive knowledge of all systems. In today's aviation industry, airspace complexity and air traffic density are increasing dramatically. The single pilot of a business jet needs to be situationally aware at all times, understand risk assessment, and have a complete understanding of automation management. A new concept called SRM training will enhance all of these attributes (FAA, June, 2003).

In order to fly a TAA at an increased level of safety, a different approach to training may be necessary than in the average GA aircraft. The single pilot of a TAA must fully comprehend all of the aircraft systems with emphasis on the navigation systems. The GPS is important to the single pilot for improving situational awareness. Not only is the GPS used as an approach aid, but also it can also be coupled to the autopilot. This combination can take the place of a second pilot in the cockpit. While this can reduce pilot workload, it can also be dangerous if the single pilot loses situational awareness. The single pilot needs to know the sequence of the steps in GPS programming and ensure the data is double-checked in order to avoid a possible mishap. This type of flying requires prior and proper planning during all aspects of flight (Wright, 2002)

Crew Resource Management (CRM)

Crew Resource Management (CRM) is the utilization of all potential resources that are available to the flight crew in decision-making. In the commercial airline industry, these resources can include but are not limited to pilots, flight attendants, dispatchers, mechanics, Air Traffic Control (ATC), and jump-seaters (Jump-seaters are often off-duty line pilots that have access to an extra seat available in the cockpit). Components of a CRM program include interpersonal communication, information exchange techniques, human behavior, and decision-making. CRM emphasizes effective communication skills and teaches pilots how to improve communication, prioritize tasks, delegate authority, and monitor automated equipment (Baron, 2003).

CRM was introduced more than two decades ago in an effort to reduce airline aircraft accidents and to promote safety (Baron, 2003). With CRM came a new training mentality for flight crew that was previously void in the training process. Today, every major commercial airline operator in the United States has a FAA mandated CRM program (Weiner et al., 1993). Over the years, airlines have integrated CRM into their individual corporate cultures. CRM instruction has many forms, however, the basis of all CRM programs is to promote safety. The manner in which the training is conducted is not as important as the end result of reducing aircraft accidents caused by human factors.

History of Crew Resource Management

CRM was developed out of a need to increase aviation safety and to decrease the rate of airline accidents. In 1979, the National Aeronautics and Space Administration (NASA) held a CRM workshop to analyze commercial and military aviation accidents. This workshop focused on three areas; interpersonal communications, decision-making, and leadership roles. The goal of the NASA workshop was to decrease pilot errors by increasing human factors awareness among flight crews (Weiner, Kanki, & Helmreich, 1993).

In 1980, United Airlines began the first CRM program at a commercial airline in the United States. This program was established to concentrate on the human factor issue in aviation. Airlines noticed that pilots were technically competent but their people skills were deficient (Baron, 2003). Accident statistics made the airlines realize that flight crews were lacking effective communication skills, although their flight skills were highly efficient. In modern aviation, most accidents are not caused by aircraft failure, but by the way the situation is handled (Weiner et al., 1993). Prior to CRM, the decision of a flight crew Captain was rarely questioned. The initial CRM courses were about raising awareness of the problem of human factors and encouraging attitude change (Benison, 2000). Due to CRM programs, today's Captain is statistically more likely to use all available cockpit resources (Weiner et al., 1993).

By the end of the 1980s, most of the major and medium sized commercial air carriers incorporated CRM programs into their flight crew training. "The justification being the inevitable accident statistics showing how human error was and still is the major cause of aircraft accidents" (Benison, 2000, p. 5). Due to the enormous success of past CRM programs, the FAA legislated that all commercial airlines in the United States have some version of a CRM program incorporated into their training regime. Internationally, CRM has impacted the aviation industry as well. In 2000, legislation was introduced making CRM training compulsory both in Europe and in the United Kingdom (Benison, 2000).

Since its induction into the aviation industry more than 20 years ago, CRM has been adapted to many different corporate cultures. When United Airlines initially began their program, CRM meant cockpit resource management (Weiner et al., 1993). In 1986, the acronym's meaning changed to crew resource management to include the flight attendants as well as the pilots. As a way of incorporating all employees, other airlines use the CRM acronym to mean company resource management. Regardless of its specific interpretation, CRM is a crucial segment of flight training that encompasses an entire company's corporate culture. CRM is constantly being updated and continually incorporating new ideas and strategies to improve aviation safety.

Today, United uses the acronym of CLR, which translates to Command/Leadership/Resource Management (Weiner et al., 1993). Included in United's CLR program is Line Oriented Flight Training (LOFT). This is a form of SBT that teaches pilots to fly normal and abnormal situations utilizing the basic principles of CRM. Most airlines today incorporate LOFT in their training curriculum. However, LOFT flights can also be designed as high workload, single-pilot IFR flights. The decisions made in a LOFT scenario compound to affect the safety and outcome of a simulated flight.

Single Pilot CRM

As stated earlier, CRM plays an integral role in airline pilot training. But, if CRM deals with crew, more than one, how is it able to help the single pilot? Pilots of smaller, non-airline planes "are faced with virtually the same decision-making tasks as are captains of jumbo jets. The only difference is that they are scaled down in altitude, payload, speed, and distance"

(Fowler, 2003, p. 1). There are many ways that the principles of CRM can be used for single pilots. CRM examples include pre-flighting and flight planning to the way charts are organized in the cockpit, the way a pilot interacts with other aircraft traffic on the ground and in the air. CRM also includes the use of ground support agencies such as ATC, Flight Service Stations including Flight Watch, the fuelers of the aircraft, ramp control personnel, etc. (Flight Watch is a FAA radio service that provides pilots with up-to-date weather information). Utilizing your passengers as a resource to help look for traffic, to help monitor gauges or to even serve themselves a beverage is practicing the principles of CRM. “Professionally minded pilots, no matter the size of the plane they fly, use every tool at their command and CRM becomes a natural part of their lives aloft” (Fowler, 2003, p. 4).

According to FAA statistics (1999), the air carrier accident rate has steadily decreased over the last 20 years. It is this author’s opinion that CRM, is a contributing factor to the decreasing airline accident rate. With a future longitudinal study, the FITS research team hopes to prove a correlation between the concept of SRM and the training method of SBT in GA to a decrease in the GA accident rate.

Single Pilot Resource Management

The term Single Pilot Resource Management (SRM) is a relatively new acronym in the aviation world and was developed by the FITS research team. SRM applies to the GA single pilot that flies for business and/or pleasure. SRM can help the pilot of these TAA (and any other single pilot aircraft for that matter) in much the same way that crew resource management (CRM) helped the airlines. Today, CRM is an integral part of the airline industry’s safety and training programs (Weiner et al., 1993).

Using SRM in TAA

SRM is very similar to the concept of CRM. However, SRM deals with the dynamics of flying a TAA as a single pilot. To better understand this new concept, the FITS research team defined SRM in their newest FITS flight training syllabi as, “The art and science of managing all the resources (both on-board the aircraft and from outside sources) available to a single pilot (prior and during flight) to ensure that the successful outcome of the flight is never in doubt” (FAA, June, 2003, p. 6). In other words, utilize all available resources in order to optimize safety.

Components of SRM

To further develop the concept of SRM, one must include the categories of task management, automation management, situational awareness, risk management, and controlled flight into terrain (CFIT) awareness. Each of these categories is described in the following paragraphs.

Task Management

In task management it is critical for the single pilot to prioritize tasks and avoid distractions during critical phases of flight. Organizing needed information in the aircraft before engine start will help to reduce pilot workload during busy situations. Pre-programming the GPS and using the electronic aids such as the autopilot, PFD and the MFD will all help the single pilot. The single pilot in busy airspace is saturated with a multiplicity of tasks. The computers in the cockpit have reduced the pilot’s scan from many instruments to just two or three screens of information. Although this instrumentation helps, it could cause the pilot to have tunnel vision and a reduced sense of situational awareness. However, good task management skills will help keep the single pilot focused on the task at hand and will enforce a priority system that keeps tasks in check (Preusser, 2004).

Automation Management

Today's GA aircraft are more technically complicated than ever. Systems training is crucial for the single pilot to develop a detailed knowledge of the systems particular to his/her aircraft. Typically, the more complex the machinery, the less workload for the pilot. The intent of automation is to reduce pilot workload. The advantages of having automated equipment are numerous but automation management is necessary when flying a TAA. Not knowing all of the functions of the GPS, MFD, or PFD, or misinterpreting information could prove fatal for the single pilot. Automation can give pilots a false sense of security and lead them into situations beyond their experience and control. Automation decreases the role of flight experience by giving the single pilot a wealth of knowledge at his/her fingertips. Implementing SRM can help the single pilot manage automation systems in order to be efficient and safe in the cockpit (Preusser, 2004).

Situational Awareness

Situational awareness is one of the most important aspects of flying. "Situational awareness is the accurate perception of factors and conditions affecting the airplane and crew during a specific period in time" (Hawaiian Airlines, 1986, p. 16). In other words, pilots need to be constantly aware of what has happened in the past in relation to the present situation and how it might affect the future of a particular flight. For the single pilot, "much of the information from which situational awareness is derived comes from the flight instruments and the navigational equipment on board" (Royal Aeronautical Society, 1999, p. 5). Constant monitoring and cross checking of aircraft systems helps to keep the single pilot aware of his/her situation.

Reduced situational awareness is most likely to occur during times of boredom, preoccupation or distractions, or if the pilot becomes fatigued. These symptoms become even more dangerous for the single pilot. Proper training, knowledge of aircraft systems, and proper use of navigational systems help to keep the single pilot situationally aware (FAA, June, 2003).

Risk Management and CFIT Awareness

Risk management is important to the single pilot because he/she must be honestly aware of their limitations and experience. Self-assessment becomes even more important to the single pilot of a TAA. Risk management combined with decision-making skills forms the basis of the SRM concept. Risk management in a TAA means decisions are based on a variety of factors including passengers, pilot temperament, as well as the capabilities and limitations of the aircraft. Also included in the risks for pilots is CFIT awareness. The single pilot of a TAA can utilize the terrain overlay feature of a GPS to stay aware of the terrain. To avoid CFIT accidents, pilots need to be positionally aware at all times. This could be difficult for the single pilot over unfamiliar terrain. Most MFD's have a terrain display to help the pilot avoid CFIT. The organization skills implemented in SRM can help the single pilot cope with risk management and CFIT awareness.

Scenario-Based Training (SBT)

SBT is not a new teaching method; its concept has been used for more than 50 years in the military as well as in other government agencies and corporate business environments (Schuetz, 2003). For the past 1 1/2 years, the FITS research team has been developing generic FAA accepted pilot training syllabi for TAA in an effort to reduce the GA accident rate. The basis of these syllabi is a group of training scenarios that challenges and increases his/her knowledge with each lesson. Appendix A is an example of the standard for flight planning in a

SBT lesson from the FITS Private/Instrument Generic Syllabus for TAA. It lists the different tasks to be completed and well as the standards for which each task should be performed. This example of SBT incorporates a typical flight planning lesson with the concepts of SRM. This teaches the pilot much earlier in training to develop decision-making skills that are practiced with each SBT lesson (FAA, June, 2003).

Line Oriented Flight Training (LOFT)

As mentioned earlier, LOFT is an example of SBT. It has been used by the airlines for many years as a way to practice scenarios and improve pilot decision-making skills utilizing CRM. During a LOFT scenario, the pilots are typically in a flight simulator flying a previously briefed flight scenario. The LOFT instructor video records the scenario and does not interrupt while the LOFT is being flown. After the LOFT is finished, the instructor debriefs the pilots. "This is when the pilots and instructors review and discuss the performance during the scenario" (Funk, 1998, p. 24).

FITS Training Scenarios

"SBT is especially effective for the automated aircraft because of the complexities of automated systems and the many ways in which they may be used" (Funk, 1998, p. 24). In the single pilot GA world, SRM plays a crucial role in decision-making skills. One way the FITS team teaches this concept is through SBT seminars. While in a classroom environment, the FITS instructor becomes more of a facilitator by guiding the pilot group through a discussion. Through these discussions, the pilot group realizes that there are many ways or alternatives to arrive at the same conclusion. The facilitator's job is to ensure the discussion always pertains to safety and improves the decision-making skills of the group.

Scenario-Based Training in TAA

The FITS SBT training seminars are based on real world scenarios taken from pilots' experiences. These SBT seminars help the single pilot of a TAA to make better decisions pertaining to a particular flight because the student benefits from the instructor's experiences, and also those experiences from other TAA pilots who happen to be attending the group SBT course. This training approach, when coupled with state-of-the-art training devices and SBT curricula, is ideally suited in preparing GA pilots for operation in a TAA as well as providing an effective bridge between the training environment and the actual environment pilots will experience (Connolly, 2003).

The author is a member of the FITS research team and helped to create its SBT seminars. Appendix B is taken from a slide presentation that the FITS team presented to the Cirrus Owners and Pilots Association (COPA). The facilitator asks questions during a scenario presentation using PowerPoint slides. Appendix B is an example of the questions that were asked during the seminar to the pilot group. The seminars were designed to accomplish the following objectives:

1. Introduce pilots of TAA to the concept of SRM.
2. Evaluate the effectiveness and applicability of SRM training for GA pilots.
3. Evaluate the effectiveness of SBT in teaching pilot judgment and decision-making.
4. Evaluate effective and ineffective strategies and methods for designing, developing, and delivering scenarios in a classroom setting. **(**Ayers, 2004, p. 1)

Statement of The Research Question

Will using SBT as a method to teach SRM have an effect on pilots transitioning into TAA? Will these pilots use SRM in their future flying? How effective is SBT and the concept of SRM in improving pilots' risk management skills? This paper will address these questions with survey results and recommendations.

CHAPTER III

RESEARCH METHODOLOGY

Research Design

The research in this paper was completed by using two different but similar surveys. The first survey was given to a COPA group at the end of a SBT seminar conducted in St. Augustine, Florida in January, 2004. The first survey served as a pilot study. The pilot survey was revised and administered to two different groups of COPA pilots after they attended a similar SBT seminar. The first seminar was conducted in Las Vegas, Nevada in March, 2004, and the second seminar was conducted in Madison, Wisconsin in June, 2004. The two seminars had a combined total of 38 participants.

Research Model

The type of research that was conducted was descriptive. The research results were of the opinion type and are presented as ordinal data. Non-parametric statistics are used to show the data.

Survey Population

The COPA group is comprised of pilots and owner-pilots that fly the Cirrus SR-20 and SR-22 aircraft. These aircraft are TAA and highly sophisticated. When a pilot purchases this aircraft, for insurance purposes, he/she must attend a mandatory Cirrus training program. The surveyed pilots all attended the FITS optional SBT seminars after the mandatory Cirrus required training.

A total of 38 participants attended the two COPA SBT seminars; 27 from the first seminar, and 11 from the second. The pilots total flight hours ranged from a few hundred hours to several thousand hours of total flight time. Pilot certificates held ranged from the beginning private pilot certificate to the airline transport pilot certificate.

Pretest

The first survey was given as a pilot study to the COPA members that attended a Cirrus training seminar in St. Augustine, Florida in January, 2004. This survey was changed to more specifically address the effectiveness of SBT as a method for teaching SRM. The survey grading scale was changed but still remained a Likert Scale. Both the pilot study and the author's survey are shown in Appendix C and D, respectively.

Distribution Method

Both of the instruments used for this research were administered during the Cirrus training seminars. The instructor/facilitator handed out the surveys at the end of a 3-day training seminar. Both of the surveys had the option for the participants to give personal information for a follow up study/survey to be conducted by the FITS research team.

Treatment of Data and Procedures

There were a total of ten survey questions. The answers given were represented by a numeric value in order to compute the resulting data. The survey results contain ordinal data; therefore, the researcher used non-parametric statistical analysis to describe the data. For the statistical analysis, the researcher entered the numerical data for each survey participant into a Microsoft Excel spreadsheet. The data was then transported into the statistical software package of Statistical Package Software System (SPSS) in order to produce non-parametric statistics.

CHAPTER IV

RESULTS

The author's survey is shown below in Figure 2. Each question had the same Likert grading scale ranging from 1-5. The grading scale is shown in black, while the number of participants that chose an answer, the frequency, is shown in bold (red) type. The 1 represents a survey answer of not at all, the 2 represents a survey answer of a little, the 3 represents a survey answer of some, the 4 represents a survey answer of a lot, and the 5 represents a survey answer of a great deal.

Please circle your answer	Not At All 1	A little 2	Some 3	A lot 4	A Great Deal 5
1. Have you ever attended scenario-based training presentations?	**15**	**10**	**10**	**2**	**1**
2. Prior to this seminar, did you know anything about SRM?	**14**	**13**	**10**	**1**	**0**
3. Do you feel you understand the basic principles of SRM?	**0**	**1**	**5**	**22**	**10**
4. Do you think you will implement SRM into your flying habits?	**0**	**0**	**2**	**21**	**15**
5. Did you think the scenarios were realistic?	**0**	**0**	**2**	**19**	**17**
6. Did you learn anything useful from the scenarios?	**0**	**0**	**7**	**14**	**17**
7. Do you think scenario discussion is an effective teaching tool?	**0**	**0**	**1**	**17**	**20**
8. Could you mentally visualize yourself acting out the scenarios?	**0**	**0**	**5**	**19**	**14**
9. Will you continue to use mental imagery to rehearse flight scenarios?	**0**	**0**	**2**	**23**	**13**
10. Will you practice SRM after this course?	**0**	**0**	**4**	**19**	**15**

Figure 2. *Numerical Values for Survey Questions 1-10*

Questions # 2, 3, 4, and 10 pertain to SRM while the remaining questions pertain to SBT. In order to show a correlation between the SRM and the SBT questions, a Sprearman's rho correlation chart was used. This type of correlation chart is specifically used for non-parametric statistics. The researcher chose to edit the mirror figures on the bottom half of the chart. Please refer to Table 1on the following page.

Table 1

Nonparametric Correlations – Spearman's Rho

		Ques 1	Ques 2	Ques 3	Ques 4	Ques 5	Ques 6	Ques 7	Ques 8	Ques 9	Ques 10
QUES1	Correlation Coefficient	1.000	.621(**)	.300	.256	.549(**)	.250	.373(*)	.327(*)	.487(**)	.392(*)
	Sig. (2-tailed)	.	.000	.067	.121	.000	.130	.021	.045	.002	.015
	N	38	38	38	38	38	38	38	38	38	38
QUES2	Correlation Coefficient		1.000	.376(*)	.506(**)	.507(**)	.315	.455(**)	.533(**)	.573(**)	.518(**)
	Sig. (2-tailed)		.	.020	.001	.001	.054	.004	.001	.000	.001
	N		38	38	38	38	38	38	38	38	38
QUES3	Correlation Coefficient			1.000	.487(**)	.329(*)	.407(*)	.446(**)	.512(**)	.510(**)	.421(**)
	Sig. (2-tailed)			.	.002	.044	.011	.005	.001	.001	.008
	N			38	38	38	38	38	38	38	38
QUES4	Correlation Coefficient				1.000	.365(*)	.552(**)	.322(*)	.455(**)	.685(**)	.642(**)
	Sig. (2-tailed)				.	.024	.000	.049	.004	.000	.000
	N				38	38	38	38	38	38	38
QUES5	Correlation Coefficient					1.000	.425(**)	.358(*)	.572(**)	.495(**)	.421(**)
	Sig. (2-tailed)					.	.008	.027	.000	.002	.008
	N					38	38	38	38	38	38
QUES6	Correlation Coefficient						1.000	.415(**)	.454(**)	.372(*)	.457(**)
	Sig. (2-tailed)						.	.010	.004	.021	.004
	N						38	38	38	38	38
QUES7	Correlation Coefficient							1.000	.580(**)	.391(*)	.229
	Sig. (2-tailed)							.	.000	.015	.167
	N							38	38	38	38
QUES8	Correlation Coefficient								1.000	.554(**)	.465(**)
	Sig. (2-tailed)								.	.000	.003
	N								38	38	38
QUES9	Correlation Coefficient									1.000	.744(**)

	Sig. (2-tailed)									.	.000
	N									38	38
QUES10	Correlation Coefficient										1.000
	Sig. (2-tailed)										.
	N										38

**** Correlation is significant at the 0.01 level (2-tailed).**

*   Correlation is significant at the 0.05 level (2-tailed).

The following 10 bar charts represent the quantity of participants that chose the answers for each question.

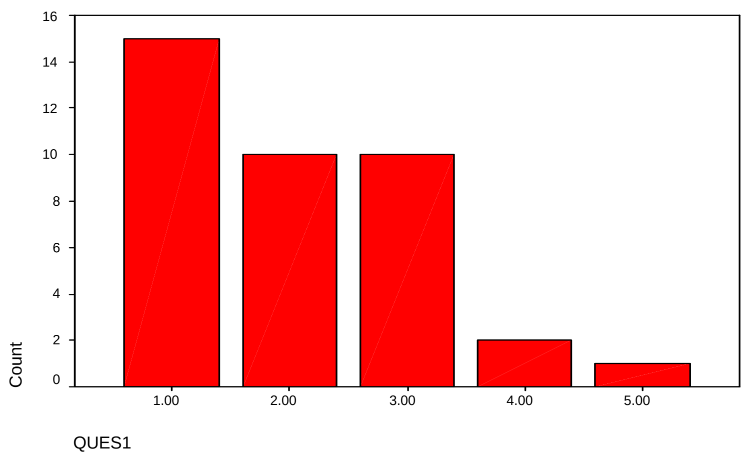

Figure 3. *Bar Chart for Question 1*

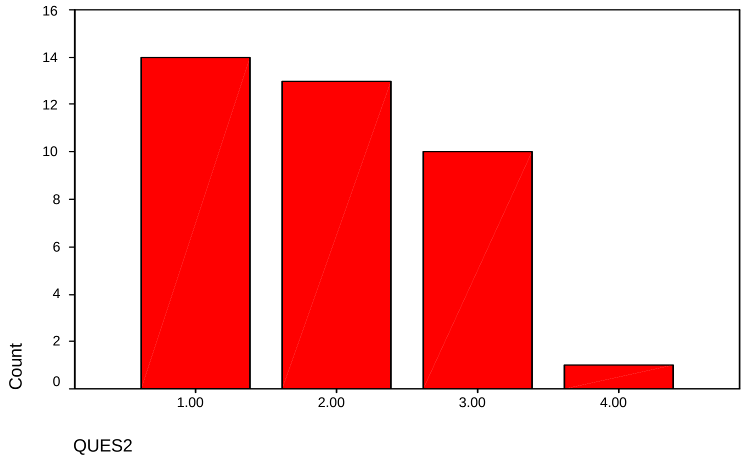

Figure 4. *Bar Chart for Question 2*

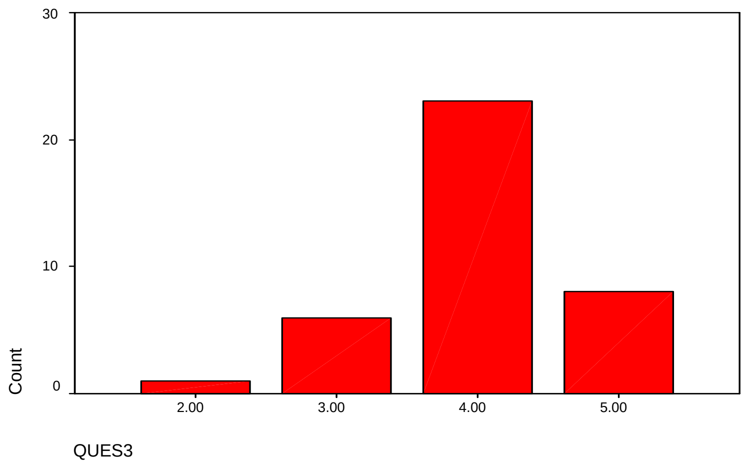

Figure 5. *Bar Chart for Question 3*

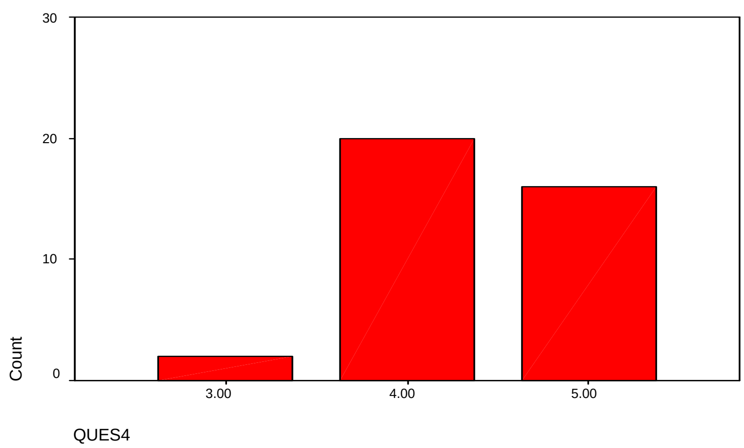

Figure 6. *Bar Chart for Question 4*

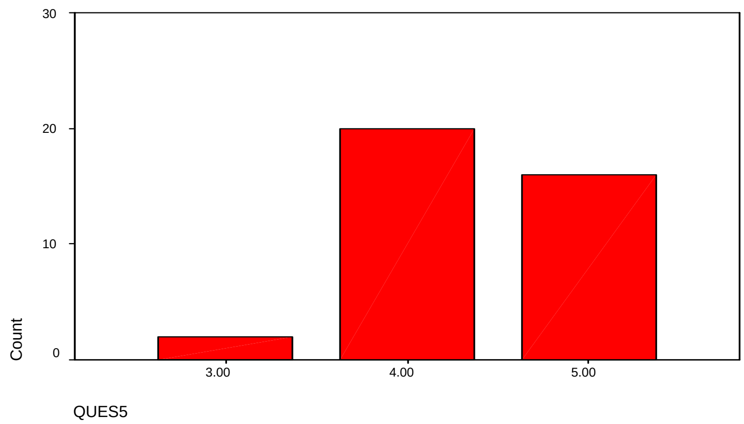

Figure 7. *Bar Chart for Question 5*

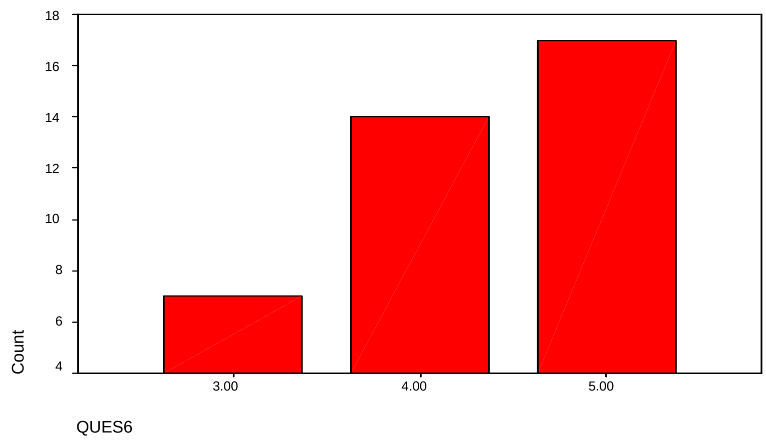

Figure 8. *Bar Chart for Question 6*

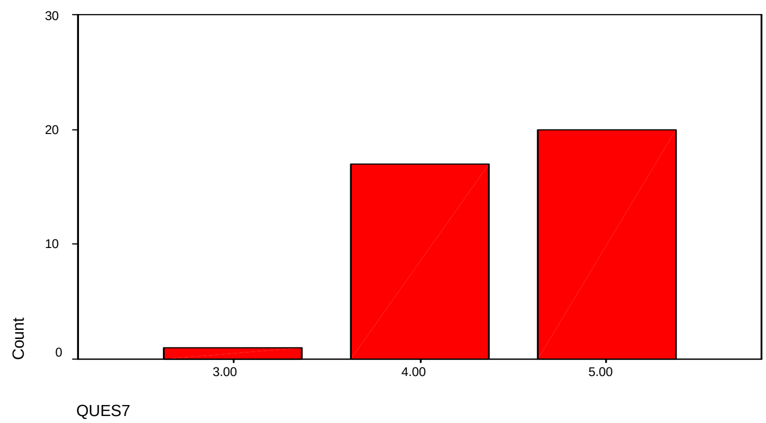

Figure 9. *Bar Chart for Question 7*

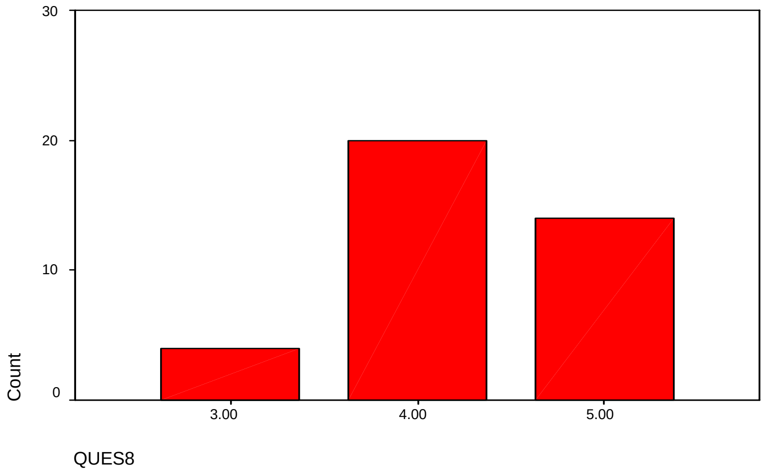

Figure 10. *Bar Chart for Question 8*

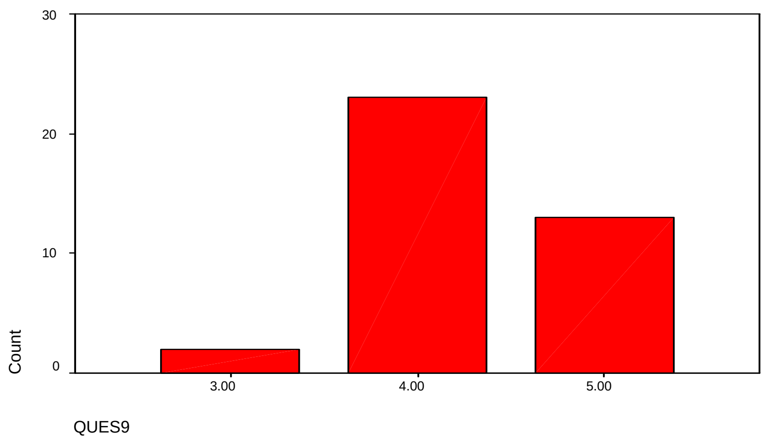

Figure 11. *Bar Chart for Question 9*

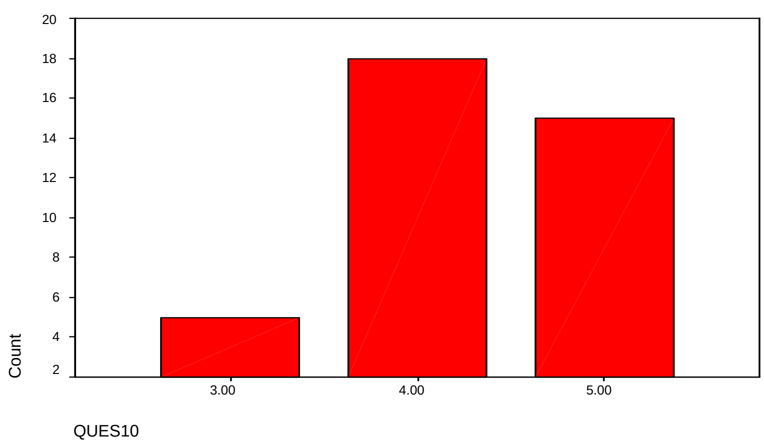

Figure 12. *Bar Chart for Question 10*

For each of the 10 survey questions, frequency statistics were measured in Table 2. The measures of central tendency; mean, median, and mode are shown in this table. This research data produced non-parametric data and it depicts an irregular bell curve, therefore, the standard deviation and the variance are skewed. The table also depicts the skew value and the error of the skew.

Table 2

Frequency Statistics

		QUES1	QUES2	QUES3	QUES4	QUES5	QUES6	QUES7	QUES8	QUES9	QUES10
N	**Valid**	38	38	38	38	38	38	38	38	38	38
	Missing	0	0	0	0	0	0	0	0	0	0
Mean		2.0526	1.9474	4.0000	4.3684	4.3684	4.2632	4.5000	4.2632	4.2895	4.2632
Std. Error of Mean		.17262	.14085	.11315	.09557	.09557	.12328	.09044	.10455	.09167	.11114
Median		2.0000	2.0000	4.0000	4.0000	4.0000	4.0000	5.0000	4.0000	4.0000	4.0000
Mode		1.00	1.00	4.00	4.00	4.00	5.00	5.00	4.00	4.00	4.00
Std. Deviation		1.06409	.86828	.69749	.58914	.58914	.75995	.55750	.64449	.56511	.68514
Variance		1.13229	.75391	.48649	.34708	.34708	.57752	.31081	.41536	.31935	.46942
Skewness		.743	.367	-.504	-.292	-.292	-.492	-.494	-.301	-.029	-.391
Std. Error of Skewness		.383	.383	.383	.383	.383	.383	.383	.383	.383	.383
Range		4.00	3.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Minimum		1.00	1.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Maximum		5.00	4.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Sum		78.00	74.00	152.00	166.00	166.00	162.00	171.00	162.00	163.00	162.00
Percentiles	**25**	1.0000	1.0000	4.0000	4.0000	4.0000	4.0000	4.0000	4.0000	4.0000	4.0000
	50	2.0000	2.0000	4.0000	4.0000	4.0000	4.0000	5.0000	4.0000	4.0000	4.0000
	75	3.0000	3.0000	4.0000	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000

The Mann-Whitney U and Wilcoxon W statistical measures are compared in Table 3 for each of the 10 questions.

Table 3

Mann-Whitney U and Wilcoxon W

	QUES1	QUES2	QUES3	QUES4	QUES5	QUES6	QUES7	QUES8	QUES9	QUES10
Mann-Whitney U	127.000	82.000	145.000	85.500	146.500	139.500	127.500	120.500	99.000	103.500
Wilcoxon W	193.000	148.000	211.000	151.500	524.500	205.500	193.500	186.500	165.000	169.500
Z	-.728	-2.266	-.129	-2.296	-.073	-.313	-.773	-1.005	-1.854	-1.589
Asymp. Sig. (2-tailed)	.466	.023	.898	.022	.942	.754	.440	.315	.064	.112
Exact Sig. [2*(1-tailed Sig.)]	.505(a)	.032(a)	.924(a)	.041(a)	.949(a)	.775(a)	.505(a)	.373(a)	.116(a)	.149(a)
a Not corrected for ties.										
b Grouping Variable: SEMINAR										

In Table 4, the Mann-Whitney U test compares the ranks of the given answers between the two different SBT seminars.

Table 4

Mann-Whitney U Test

Ranks

Question #	SEMINAR	N	Mean Rank	Sum of Ranks
QUES1	1	27	20.30	548.00
	2	11	17.55	193.00
	Total	38		
QUES2	1	27	21.96	593.00
	2	11	13.45	148.00
	Total	38		
QUES3	1	27	19.63	530.00
	2	11	19.18	211.00
	Total	38		
QUES4	1	27	21.83	589.50
	2	11	13.77	151.50
	Total	38		
QUES5	1	27	19.43	524.50
	2	11	19.68	216.50
	Total	38		
QUES6	1	27	19.83	535.50
	2	11	18.68	205.50
	Total	38		
QUES7	1	27	20.28	547.50
	2	11	17.59	193.50
	Total	38		
QUES8	1	27	20.54	554.50
	2	11	16.95	186.50
	Total	38		
QUES9	1	27	21.33	576.00
	2	11	15.00	165.00
	Total	38		
QUES10	1	27	21.17	571.50
	2	11	15.41	169.50
	Total	38		

CHAPTER V

DISCUSSION

In Figure 2, the survey results show the frequency of answers per question. Questions 1 and 2 both refer to the participant's prior knowledge of SBT and SRM. This would explain why these questions scored low compared to the rest of the answers.

Questions 1 and 5-9 pertain to SBT while the remaining four deals with the concept of SRM. In Table 1, the researcher showed the correlation rankings with the Spearman's Rho test. This test was chosen due to the ordinal data of the survey results. This type of correlation is based on the ranks of the answers rather than the actual values. In Table 1, the significance is shown for each question. A significance level or p-value of .05 or less shows a significant correlation between two questions. For example, questions 2, 3, 4 and 10 all ask about SRM. The p-value between these answers ranges between .020 - .001, therefore, showing a strong relationship. The same is true of the SBT questions, 1 and 5-9.

It is interesting to note, that questions 1 and 2 show a p-value of .000, resulting in a very strong correlation. Although question 1 pertains to SBT and question 2 pertains to SRM, both of these questions ask about the participant's prior knowledge to the subjects. The same positive correlation is shown for questions 9 (SBT) and 10 (SRM), both of these questions ask if the participants will incorporate their new knowledge in their flying habits.

Figures 3 – 12 display bar charts of each of the 10 questions. In each bar chart, the bottom (horizontal) number represents the numerical value given to each answer. The numbers on the left (vertical) represents how many of the participants that chose answers 1-5. For example, in Figure 3, question 1, column 1.00 depicts that 15 participants answered one, which on the survey means, not at all. Referring to the same chart, 10 participants each chose answers 2 and 3. The remaining bar charts are translated in the same manner.

In Table 2, the frequency statistics were calculated for each of the 10 survey questions. N represents the number of cases. The scores of 38 participants with no missing values were calculated. The measures of central tendency; mean, median, and mode are shown in this table. The mean, or average score, for question 5 is 4.3684. The median, or the 50% value, for the same question is 4.0. The mode for question 5 is also 4.0, this means that the most popular answer for this question was 4.

This research data produced non-parametric data and it depicts an irregular bell curve for each question. Non-parametric data can produce an uneven distribution causing non-applicable confidence intervals. The confidence intervals do not apply because the standard deviation and the variance are skewed. In Table 2, the percentiles show a numerical representation of the skewed shape of the distribution. The skew value and the error of the skew for each question are shown. Table 2 also depicts the range of scores for all questions. Only questions 1 and 2 have answer 1 scores while the remaining 8 questions have the majority of answers being 4 and 5.

Table 3 compares the Mann-Whitney U and Wilcoxon W statistical measures. The Mann-Whitney U test analyzes two independent variables of non-parametric data. The Wilcoxon W test is the non-parametric statistical substitution for the T-test. The researcher chose to compare the two SBT seminars to show no significant difference of answers between the two groups. The first SBT seminar was given in Las Vegas, NV in March, 2004 while the second was given in Madison, WI in June, 2004. Both seminars had different SBT facilitators/instructors. In comparing the Mann-Whitney U and the Wilcoxon W statistics, a significance of .05 or less indicate that the two seminars differ with respect to the test variable. Questions 2 and 4 are the only two that have a high significance value. This would assume an outlier for each of these questions. Referring back to Figure 2, in question 2 the outlier is the single answer of 4. For question 4, the outlier is the answer of 3 that was chosen twice.

Table 4 shows the rankings of the Mann-Whitney U test. The highest difference between the mean ranks is shown in questions 2 and 4. In comparing the two seminars, all of the answers were similar, however, questions 2 and 4 show that same significant difference as in Table 3. It is the researcher's conclusion that an overall comparison between the two seminars shows that future SBT seminars would share similar results.

The research results appear to validate the concepts of SBT and SRM. Professor Frank Ayers was an instructor/facilitator during the St. Augustine and Las Vegas seminars. He stated (2004) that the participants of the COPA training scenarios were enthusiastic and quite animated during the seminars. During the seminars, it appeared that learning occurred on several different levels based on the exchanges between the students and the instructor, but more importantly by observing the exchanges between students. "The participants found the scenarios and the discussion they generated very useful." (Ayers, 2004, p. 2). The survey results appear to support this idea. Survey results also appear to indicate that the participants, will not only utilize SRM in their daily flying, but also that they enjoyed the learning style of SBT.

As previously discussed in detail, there were a total of 10 survey questions that asked the participants to select a score of 1-5 for each question. In addition to these 10 questions, there were also two written questions and an area where the participants can fill out personal information for a follow-up survey for a longitudinal study conducted by the FITS research team. The following two written questions were on the survey: (Please see Appendix D)

1. What are the top three best parts of the scenario presentations?
2. If you could improve three things about this seminar, what would it be?

With reference to the first question, the majority of the participants answered that the best parts of the SBT seminars were the discussions of the group led by the instructor, the realistic scenarios, and the sharing of ideas from all levels of flight experience. The numerical data shown in the statistical analysis also support this thought. With reference to the second written question, the majority of the participants overwhelmingly answered that they would improve nothing, followed by requests for longer SBT seminars, and several requests for visual flight rules (VFR) scenarios as the FITS SBT seminars only involved IFR scenarios. It appears that the seminar participants not only enjoyed SBT but also that they will incorporate SRM into their current flying regime.

The feedback the FITS research team received regarding the SBT seminars was very positive. Most of the survey participants stated that the scenario-based exercises were more than just a fun way to address serious problems, but that the scenarios used were a unique way to gain insight and to explore new ideas. The instructor guided group discussions made a positive impact on all of the seminar participants regardless of their flight hours and experience.

CHAPTER VI

CONCLUSIONS

SBT is a training system that uses a highly structured script of real world experiences to address learning objectives in an operational environment. SBT is not a new teaching method; its concept has been used for more than 50 years in the military as well as in other government agencies and corporate business environments (Schuetz, 2003). As technology increases, SBT is becoming more popular. SBT allows hands on experience in a controlled environment that allows learners to take advantage of others' experiences.

Successful SBT include realistic scenarios that are written with specific learning objectives in mind. Some of these scenarios could be ill-structured scenarios that require a dynamic, decision-based resolution. Another method of SBT is using role-players that follow a specific script in order to achieve the outlined objectives.

To address the problem of a high GA accident rate in TAA, the FAA developed the FITS program in an effort to decrease the human errors in the cockpit that result in accidents. The FITS program is leading an effort to change the current flight training process to embrace technology and to target the pilot's decision-making skills with each training module. By utilizing the concepts of SRM and the SBT methodology, the FAA is succeeding in its goal.

The survey results conclude that SBT is a very effective method to instruct SRM. While the reader cannot automatically assume that development of quality instruction reduces accident rates, one can conclude that higher quality instruction focused on SRM should improve pilots' risk management skills and therefore produce safer pilots.

CHAPTER VII

RECOMMENDATIONS

In order to create successful SBT seminars, the participants should be representative of those found in typical real-life settings. Also, the student /instructor ratio should be relatively small. Typically, the smaller the group, the more participation received from all of the learners. It is also suggested to properly design and equip training sites that simulate real-life locations, such as a flight simulator to train pilots. The more interactive the training, the better the lessons learned (Schuetz, 2003).

SBT by nature is a slower and more methodical training process. Because of this, it can be costly in time and material. The instructors/facilitators should be highly trained which also adds to the expense. The FITS research team developed and presented well-received training scenarios that appeared to be very effective for the participants. After developing and training the scenarios used in the COPA seminars, it is recommended that the instructor/facilitator guide the discussion in such a manner that all pilots with various levels of experience can benefit from the discussion. Both the scenario developers and participants agreed that the training scenarios be as realistic as possible. In a classroom environment, this is crucial as there was not a simulator to act as a hands on learning tool.

The FITS research team is in the process of conducting a long-term longitudinal study utilizing its SBT curriculum and seminars. The team has gathered personal information from the 38 survey participants that have agreed to answer additional surveys and/or questionnaires.

Currently, the COPA organization is conducting its own FITS SBT seminars to its pilots. The COPA instructors are administering the surveys at the end of each seminar. As future data is collected, more statistical analysis can be made. As with most studies, more research is recommended in the area of SBT and aviation training.

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APPENDIXES

APPENDIX A

FITS Private/Instrument Generic Syllabus for TAA

TAA 01	**Flight Planning**	
Unit Objective – Develop thorough and successful preflight habit patterns for flight planning, performance, weight and balance, and normal and emergency single pilot resource management		
Performance	Conditions	Standards
The training task is:	The training is conducted during:	The pilot in training will:
1. Flight Training Scenario Planning	Preflight planning	a. Review the required elements of the appropriate flight training scenario b. Decide on the optimum route and sequence of events to accomplish all required tasks c. Obtain all required charts and documents d. Obtain and analyze an FAA approved weather briefing appropriate to the scenario to be flown File a flight plan (VFR/IFR) for the scenario to be flown
2. Weight and Balance and Aircraft Performance Computation	a. Classroom training b. Preflight planning	Perform weight and balance and performance computations for the specific training scenario to be flown without error.
3. Preflight SRM Briefing	Preflight planning	a. Orally review in specific terms all aspects of the flight scenario. b. Identify possible emergency and abnormal procedures relevant to the scenario and describe successful SRM strategies to deal with them.
4. Decision Making and Risk Management	a. Pre-Arrival e Learning b. Classroom Training c. All phases of flight planning and flight	a. Make sound decisions based on a logical analysis of factual information, aircraft capability, and pilot experience and skill. b. Continuously critique the success of the flight scenario. c. Adjust the training scenario to maintain flight safety at all times.

APPENDIX B

COPA Seminar Presentation

- **The “5P” Check**
  - **The Plan?**
  - **The Plane?**
  - **The Pilot?**
  - **The Passengers?**
  - **The Programming?**

- **What is the situation?**
- **What are the tasks?**
- **How can automation help?**
- **What is the risk involved?**
  - **How can risk be reduced?**
  - **Are there terrain issues?**
- **What is my decision?**

Failure to make a decision, is a decision!!

APPENDIX C

Single Pilot Resource Management Survey

Scenario-Based Training in TAA

Single Pilot Resource Management Survey

	Yes	Some	Maybe	A Little	No
1. Did you enjoy the presentation and discussion of SRM?	5	4	3	2	1
2. Did you feel the subject is worthy of discussion?	5	4	3	2	1
3. Do you feel you understand the basic philosophy of SRM?	5	4	3	2	1
4. Do you feel SRM might be of use in your daily flying?	5	4	3	2	1
5. Do you feel you were given practical ways to implement SRM?	5	4	3	2	1
6. Did you find the scenario(s) enjoyable?	5	4	3	2	1
7. Did you learn something useful during the scenario(s)?	5	4	3	2	1
8. During the flight scenario(s) who did you learn the most useful information from:					
The instructor	5	4	3	2	1
The entire discussion group:	5	4	3	2	1
Your own reflection on the material:	5	4	3	2	1
9. Based on this experience will you consider using SRM?	5	4	3	2	1
10. Would you like to know more detailed information about SRM?	5	4	3	2	1

WRITTEN QUESTIONS:

What is the best single part of the presentation?

If you could improve one thing about this presentation, what would it be?

If you would be willing to participate in a single follow up mail (or E-Mail) survey several months from now by the FITS research team. If so, please place your name and address below (or E-mail Address if appropriate). No one will call you!!!

Name:

Address:

E-mail:

APPENDIX D

Single Pilot Resource Management Survey II

Scenario-Based Training in TAA

Single Pilot Resource Management Survey II

Please circle your answer

	A Great Deal	A lot	Some	A Little	Not At All
1. Have you ever attended scenario based training presentations?	5	4	3	2	1
2. Prior to this seminar, did you know anything about SRM?	5	4	3	2	1
3. Do you feel you understand the basic principles of SRM?	5	4	3	2	1
4. Do you think you will implement SRM into your flying habits?	5	4	3	2	1
5. Did you think the scenarios were realistic?	5	4	3	2	1
6. Did you learn anything useful from the scenarios?	5	4	3	2	1
7. Do you think scenario discussion is an effective teaching tool?	5	4	3	2	1
8. Could you mentally visualize yourself acting out the scenarios?	5	4	3	2	1
9. Will you continue to use mental imagery to rehearse flight scenarios?	5	4	3	2	1
10. Will you practice SRM after this course?	5	4	3	2	1

WRITTEN QUESTIONS:

What are the top three best parts of the scenario presentations?

If you could improve three things about this seminar, what would it be?

Would you be willing to participate in a very brief follow-up mail (or email) survey conducted by the FITS research team? If so, please complete the below information. You will not be called. This list will be used for research purposes only and will not be solicited. You will be contributing to the improvement of our training methodologies. Thank you for your time.

Name:

Address:

Email: