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The Effectiveness of Behavior-based Safety in the Flight Training Environment

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THE EFFECTIVENESS OF BEHAVIOR-BASED SAFETY IN THE FLIGHT TRAINING ENVIRONMENT

A Dissertation
Submitted to the Faculty
of
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by
Ronda Elaine Cassens

In Partial Fulfillment of the
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of
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ABSTRACT

Cassens, Ronda E. Ph.D., Purdue University, August 2015. The Effectiveness of Behavior-Based Safety in the Flight Training Environment. Major Professor: James P. Greenan.

Although flight training accounts for an eighth of the total flying in general aviation, nearly one-third of midair collisions occur during instructional flights. Initiating clearing turns prior to training maneuvers is an important means of preventing a midair collision. Therefore, the purpose of this study was to determine (a) Which human factors are causing the discrepancies between procedures and practice with respect to clearing turns, and are those discrepancies reduced through the implementation of behavior-based safety (BBS)? and (b) Is there a significant increase in the utilization of clearing turns prior to the initiation of training maneuvers by students in the flight program after BBS implementation? The participants in this study were college students and instructors in a 4-year professional pilot program operated under Part 141 regulations. The results of the study indicated there were several human factors that inhibited clearing turn use by the students, and that BBS did not have a significant benefit on these factors or the percentage of clearing turns that were performed by the students. However, due to several limitations of this study, further research is recommended to determine the true effect of BBS on safe behaviors in the flight training environment.

CHAPTER 1: INTRODUCTION

Nature of the Problem

Aviation is a high-risk industry. It involves ever changing weather conditions, hazards, and high stress environments that when combined, can lead to disastrous consequences. While these risks cannot be eliminated entirely, it is the responsibility of the pilot to minimize risk as much as possible to complete the flight safely. Yet, the pilot's actions or inactions in response to risks encountered in flight were responsible for 74% of non-fatal accidents and 70% of fatal accidents in 2010 (Aircraft Owners and Pilots Association, 2012). Unfortunately, this number has remained fairly stable over the years despite the pilot training and safety initiatives of organizations such as the Federal Aviation Administration (FAA) and the Aircraft Owners and Pilots Association (AOPA). As stated in the 22nd Annual Joseph T. Nall Report (Aircraft Owners and Pilots Association, 2012), "One thing that just doesn't seem to change annually is the excess risk that some pilots are willing to take on for personal flights" (p. 3). It stands to reason that if the risk-taking behavior of pilots could be reduced, the number of accidents would also likely decline.

The nature of the risk that is experienced by pilots has changed over time. Strauch (2004) stated that "human, organizational and systematic factors, rather than technical or operational issues, now dominate the risks to most hazardous industries" (p.

xi). The increase over time in accidents caused by human error may be attributed to increasingly complex systems being managed by humans who have not advanced as quickly. Human beings are not perfect, and are subject to different types of errors. These errors cannot be eliminated, but it is possible to reduce the opportunities for errors to occur. It is important to note; however, that as more safety features or people are added to an operation, there is a potential to increase the chance of error through increased complexity (Strauch, 2004). It is assumed that errors are unintentional, and there are characteristics within the system that have caused these errors called precursors or antecedents. Examples of antecedents include equipment, equipment operators, organization, maintenance, multi-operator systems, and culture of the organization. These antecedents are often hidden, but they can be exposed by investigating the action, situation, or factor that caused the person to commit the error (Strauch, 2004). There are three main categories of pilot error: procedural, perceptual-motor, and decisional (Diehl, Hwoschinsky, Livack, & Lawton, 1987; Jensen, 1995). Procedural errors occur due to insufficient knowledge of aircraft systems. Perceptual-motor errors stem from the pilot misjudging sensory cues and aircraft control inputs. Decisional errors are the most deadly, and account for 71% of the fatal accidents caused by pilot error (Aircraft Owners and Pilots Association, 2009).

Many companies employ some form of safety program to make employees aware of workplace hazards and correct safety procedures; however, they are often unsuccessful at reducing accidents because they focus on the attitudes of the employees rather than the behaviors that are causing the accidents (Loafmann, 1998; Reynolds, 1998). Simply telling people how to be safe does not always result in them actually behaving safely.

Also, typical safety programs are reactionary in that once an accident occurs, methods are implemented to prevent its future occurrence. Behavior-based safety (BBS) addresses these shortcomings by focusing on the employee's behavior. This is accomplished through monitoring accident trends, pinpointing safe behaviors, collecting data on the frequency of safe behaviors, and providing feedback to employees on a regular basis. BBS has been shown to be highly effective in reducing accidents in industrial settings (Krause, 2001; Sulzer-Azaroff & Austin, 2000; Wilson, 2004), and has the potential to reduce the number of accidents in the aviation industry as well.

Statement of the Problem

Accidents involving midair collisions are rare, but when they do occur, nearly half of them result in fatalities. A search of the National Transportation Safety Board's aviation accident database resulted in 116 reports including the terms midair collision (MAC) resulting in an accident in the United States between 2000-2012. The NTSB files one report for each registered aircraft involved in a midair accident, and upon further analysis of the data, there were a total of 60 midair accidents during that timeframe involving 120 aircraft resulting in 72 deaths. There were two reports that did not have a corresponding report filed for the other aircraft involved in the incident. This was due to the type of aircraft and one report where a witness claimed there were two aircraft involved, but radar imagery indicated only a single aircraft. Sixteen of the reports involved aircraft on training flights, totaling 13 MAC incidents, eight of which were fatal resulting in 20 deaths. Midair collisions were ranked as the 9th highest cause of fatal general aviation accidents from 2001 to 2011 (Federal Aviation Administration, 2012).

Many of the accident reports cited the pilot's failure to "see and avoid" the other traffic as the cause of the midair collision. According to the Federal Aviation Regulations, 91.113(b): "When weather conditions permit, regardless of whether an operation is conducted under instrument flight rules or visual flight rules, vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft." According to The FAA's Advisory Circular 90-48C, "The Pilots' Role in Collision Avoidance": "Pilots should…execute appropriate clearing procedures before all turns, abnormal maneuvers, or acrobatics" (1983, p. 3). The Aeronautical Information Manual (Federal Aviation Administration, 2014) more specifically states that "appropriate clearing procedures should precede the execution of all turns including chandelles, lazy eights, stalls, slow flight, climbs, straight and level, spins, and other combination maneuvers" (section 4-4-15). It is also noted in the *Airplane Flying Handbook* that "proper clearing procedures, combined with proper visual scanning techniques, are the most effective strategy for collision avoidance" (Federal Aviation Administration, 2004, p. 1.5). The collegiate flight training program in this study also specifies clearing turns in the procedures for each maneuver in the materials distributed to students. The purpose of a clearing turn is to ensure that the maneuver being performed will not result in a collision with another aircraft, and consists of turns to allow the pilot to completely scan the area around the aircraft, typically consisting of 180° of heading change. Despite these recommendations and explicit procedures, some pilots in the collegiate training program fail to execute clearing turns.

Purpose and Objectives of the Study

The purpose of this study was to determine if BBS could effectively motivate students to complete a clearing turn prior to every training maneuver. The objectives of this study, therefore, included:

1. Identify those human factors that cause the discrepancies between procedures and practice with respect to clearing turns, and assess whether or not those discrepancies are reduced through the implementation of BBS.
2. Determine if there is a significant increase in the frequency of clearing turns completed by students in the flight program when BBS is implemented into flight training.

Research Questions

To determine the effectiveness of BBS in the flight training environment, the following research questions were posited:

1. Which human factors are causing the discrepancies between procedures and practice with respect to clearing turns, and are those discrepancies reduced through the implementation of BBS?
2. Is there a significant increase in the utilization of clearing turns prior to the initiation of training maneuvers by students in the flight program after BBS implementation?

Significance of the Study

Over the years, various aviation organizations have attempted to reduce the frequency of accidents caused by pilot error. The FAA recently announced its initiative to reduce the number of accidents caused by pilot error by 10% by 2018 (Federal Aviation Administration, 2012). Behavior-based safety has been used in a wide variety of industry, including building construction, shipyards, paper mills, and chemical companies. Although most BBS applications have been in non-aviation industries, its fundamental concepts can be applied to the flight training environment (Olson & Austin, 2006). Olson and Austin's study, however, was not a full implementation of BBS and focused primarily on determining areas where unsafe operations were occurring. It was intended to contribute to the body of knowledge concerning the effectiveness of BBS in flight training and provide a means of assisting pilots in becoming safer in all aspects of flight. Additionally, the human factors analysis and classification system, or HFACS, was used in this study as a means of determining where errors were occurring and to allow for a more focused approach to training and accident prevention. The HFACS model has been used traditionally as a method to aid in accident analysis; however, this study used it in a proactive manner to help prevent accidents. This application of HFACS has not been used widely in research. Perhaps, it can be useful to those personnel who supervise safety programs; thereby, it may assist in reducing the number of accidents caused by human error.

Delimitations of the Study

This study was limited to examining the effectiveness of BBS on students in a Midwestern, Part 141 collegiate aviation program. It did not include student training outside of a collegiate setting. The professional pilot program enrolls only undergraduate students; therefore, no graduate students were involved in the study. The study addressed one-on-one instruction in the aircraft as well as solo flights; it did not include the evaluation of BBS in classroom instruction. The study did not involve any of the investigator's students in order to minimize researcher bias. Additionally, it did not address flight instructor training. Further, the population and sample in the study was relatively small due to the number of students enrolled in the professional pilot program; accordingly, the results have limited generalizability.

Assumptions of the Study

Some of the data collected for this study were based on self-reporting. Therefore, it was assumed that the students and instructors were frank and honest in their responses. There is, however, the possibility that the participants may have provided socially acceptable responses. It was also assumed that the students were not consistently performing clearing turns based on the researcher's observations during stage checks and instructional flights. The researcher was aware of this potential bias and did not conduct any behavioral observations during the study.

Definition of Terms

Behavior-based Safety (BBS): A proactive approach to accident prevention through targeting errors by identifying safe behaviors, observing behaviors to collect data, using feedback to encourage desired behaviors, and using the data collected to facilitate improvements in safety (U.S. Department of Transportation, 2000).

Certified Flight Instructor (CFI): A person who is authorized within the limitations of that person's flight instructor certificate and ratings to give training and endorsements toward a pilot certificate and/or rating (Federal Aviation Administration, 2011).

Clearing Turns: A series of turns completed prior to initiating a maneuver that allows a pilot to visually scan the area for other aircraft to ensure that the maneuver being performed will not result in a collision with another aircraft (Federal Aviation Administration, 2004).

General Aviation (GA): Flights that do not involve a commercial airline or the military. It includes flights for personal purposes, such as aircraft used by corporations or for pleasure flights (Aircraft Owners and Pilots Association, 2010).

Human Error: When a person commits or intends to commit an act that results in a consequence that is different from what he or she expected or intended. It is commonly caused by latent characteristics embedded within complex systems that have the potential to cause an error (Strauch, 2004).

Maneuver: An intended variation from straight and level flight. It includes stalls, spins, slow flight, steep turns, chandelles, lazy eights, and any other procedure required by the FAA practical test standards (Federal Aviation Administration, 2014).

Midair Collision: An occurrence where at least two aircraft unintentionally collide while airborne (de Voogt & van Doorn, 2006) due to the failure of one or both pilots seeing and avoiding the other aircraft.

CHAPTER 2: REVIEW OF THE LITERATURE

In most organizations, behavior contributes to 86% to 96% of all injuries (McSween, 2003). It follows that targeting unsafe behavior and the environment that causes it will help to decrease the amount of injuries in the workplace. This is the premise of behavior-based safety (BBS). BBS is defined as “a set of methods to improve safety performance in the workplace by engaging workers in the improvement process, identifying critical safety behaviors, performing observations to gather data, providing feedback to encourage improvement, and using gathered data to target system factors for positive change” (U.S. Department of Transportation, 2000, p. 1). Although BBS is primarily used in manufacturing, its fundamental concepts can also be applied to improving safety in flight training. The literature review examines the concept of human error and its causes and prevention. It also provides an overview of BBS as an approach to error prevention through targeting unsafe behavior, its development and implementation, and potential applications of BBS in the flight training environment.

Nature of Human Error

It is easy to blame pilots when an accident occurs; they are closest to the actual event. However, in most cases, there is a series of factors that lead to an accident, making the concept of human error more complicated than it seems at first glance. According to Reason (1997):

> "…human error is a consequence not a cause. Errors…are shaped and provoked by upstream workplace and organizational factors. Identifying an error is merely the beginning of the search for causes, not the end. The error, just as much as the disaster that may follow it, is something that requires an explanation. Only by understanding the context that provoked the error can we hope to limit its recurrence" (p. 126).

In a similar vein, Cooper (2000) stated, "to greater or lesser degrees, accident causation models recognize the presence of an interactive or reciprocal relationship between psychological, situational, and behavioural factors" (p. 117). For example, an organization may say that they put safety first, but safety first can vary depending on situational factors such as the technologies available, the type of organization, and external market pressures (Atak & Kingma, 2011). These factors can combine to create a safety culture that is susceptible to risk-taking and ultimately accidents. A poor safety culture was stated as a major factor in many of the well- known organizational accidents such as the Challenger Space Shuttle explosion, the King's Cross Underground fire, the Chernobyl nuclear disaster (Reason, 1998), and most recently the Deepwater Horizon oil rig explosion in 2010 (Bureau of Ocean Energy Management Regulation and Enforcement, 2011). Organizations typically have many defenses in place to prevent major disasters such as these, which suggests that several failures within the system must align to result in an accident. This concept is called the "Swiss cheese model" (see Figure 1), which is an accident causation theory developed by Reason (1998). According to Reason (1998), each slice of cheese represents the organization's defenses. These cheese slices have holes in them, which represent active failures (violations caused by the human-system interface) and latent failures (failure of those in charge of the system to plan for all possible scenarios). By themselves, active and latent failures do not result in an accident, but when the conditions are right, the holes can align and lead to an accident. A poor safety culture can be a prime instigator of holes within the defense system since safety culture is something that permeates throughout the entire organization. Reason (1998) stated that "only culture can affect all the 'cheese slices' and their associated holes" (p. 297).

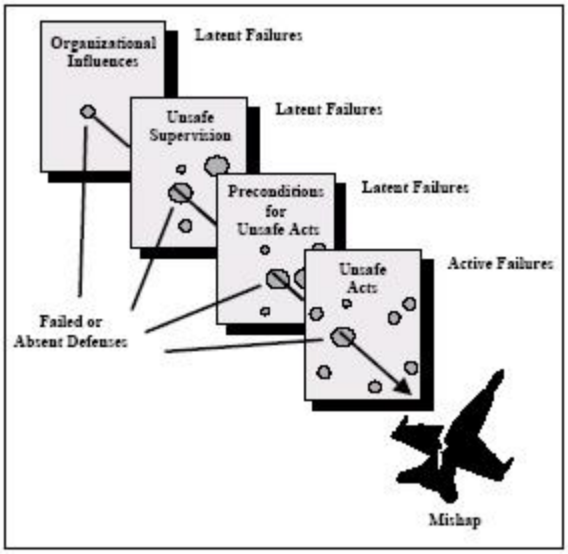

Figure 1. Reason's Swiss Cheese Model

According to Reason (1998), there are three ways that a poor safety culture can weaken an organization's defenses against accidents. First, it increases the number of active failures within the system through non-compliance with established safety procedures, allowing more opportunities for an accident to penetrate the defenses. Second, it creates complacency towards safety in its members by failing to emphasize the dangers of the particular operation. Lastly, and most critically, a poor safety culture will allow deficiencies in its defenses to perpetuate, and even encourage members to bypass the defenses in the name of profit and production.

Accidents are rarely random; there are typically certain aspects common to each reoccurring accident. Reason (1998) called these common aspects universals, local traps, and drivers. Universals are hazards that are always present in an activity. An example of a type of aviation universal would be weather such as thunderstorms or high winds. Local traps are ones that, when combined with human error, cause a person to be drawn into unsafe actions (e.g. pressure to complete a flight to make it to a meeting). Drivers are what compel a person to fall into a local trap. Reason (1998) considers the driver in this case to be the safety culture of an organization, since conflicts can arise between the goals of the safety program and production when a poor safety culture exists. For example, in a study conducted by Atak and Kingma (2011), there was an extreme amount of pressure on an aircraft mechanic to get aircraft repaired and flying as quickly as possible, yet also do a quality job. These conflicting pressures often resulted in the mechanic taking shortcuts to satisfy both demands even though he knew that this did not conform to established safety standards. Early in the oil drilling industry (1966-1980), the culture was a fast work pace that resulted in high amounts of risk and a high accident rate (Haukelid, 2008). Richter and Koch (2004) determined that a packaging company’s high accident rates, where 25% of the workers had been injured over a five-year period, may have been attributed to a focus on economy and productivity, as well as the company’s valuing an employee’s ability to minimize production issues, leading to increased risk taking. Reason (1998) concluded:

> “The same cultural drivers - time pressure, cost-cutting, indifference to hazards and the blinkered pursuit of commercial advantage - act to propel different people down the same error-provoking pathways to suffer the same kinds of accidents. Each organization gets the repeated accidents it deserves. Unless these drivers are changed and the local traps removed, the same accidents will continue to happen” (p. 302).

An organization that is proactive in seeking the holes in its defenses that could promote errors can prevent an accident before it happens.

One of the limitations of Reason’s model, however, is that it does not give any indication regarding what these holes may be, as noted by Wiegmann and Shappell (2003), “After all, as a safety officer or accident investigator, wouldn’t you like to know what the holes in the ‘cheese’ are? Wouldn’t you like to know the types of organizational and supervisory failures that ‘trickle down’ to produce failed defenses at the preconditions or unsafe acts level?” (p.49). Through extensive accident analysis, Shappell and Wiegmann (1997) developed the Human Factors Analysis and Classification System (HFACS, see Figure 2), which incorporated accident causal categories into Reason’s four levels of failure: unsafe acts, preconditions for unsafe acts, unsafe supervision, and organizational influences.

Unsafe acts are comprised of errors and violations (Wiegmann & Shappell, 2003). Errors can be mental or physical and are further divided into skill-based, decision, and perceptual errors. Skill-based errors are those that result from a behavior that has become automated. These automated behaviors can be disrupted by distractions, lapses in memory, or poor technique. When an action is carried out as planned, but the plan is faulty, it is considered a decision error (Wiegmann & Shappell, 2003). There are three types of decision errors: procedural errors, poor choices, and problem solving errors. In aviation, there are many procedures in place to help keep pilots safe, but when a pilot applies a procedure that is not appropriate for the situation, it is considered a procedural error. A poor choice error occurs when a pilot selects the wrong action when dealing with a situation for which there is no procedure. There are times when a pilot is faced with a situation that he or she has never encountered and for which there is no known procedure for handling the specific situation. The pilot then must determine what to do, often in a very limited timeframe. Perceptual errors occur when the pilot makes an incorrect response to limited and possibly faulty sensory input.

Violations, in contrast to errors, are the purposeful violation of the rules, and occur in two forms: routine and exceptional (Wiegmann & Shappell, 2003). Routine violations are generally tolerated by those in charge, which encourages more and more people to violate the rules as commonplace behavior. Exceptional violations, however, are neither part of a person’s normal behavior nor are they tolerated.

The next area of the HFACS model includes preconditions for unsafe acts (Wiegmann & Shappell, 2003). These preconditions include the condition of the operators, personnel factors, and environmental factors. The operator’s ability to perform can be affected by conditions such as adverse mental and/or physiological states, as well as physical and/or mental limitations. Interactions between crew members and how they prepare themselves for a flight can contribute to personnel factors in an accident. Environmental factors consist of the physical and technological environment. The physical environment can be the temperature and noise in the cockpit, weather, or terrain;

whereas, the technological environment consists of how the operator interacts with the technology.

The categories of unsafe operations are inadequate supervision, planned inappropriate operations, failure to correct problem, and supervisory violations (Wiegmann & Shappell, 2003). Poor training and guidance can lead to errors and violations. Planned inappropriate actions involve management making poor decisions, such as overloading workers with tasks or not providing adequate rest periods. When there are known deficiencies in areas such as training or the work environment, but management fails to correct them, it lies in the category of failure to correct a known problem. Lastly, supervisory violations occur when supervisors purposely ignore rules or regulations.

The final area is organizational influences. Organizational influences are resource management, organizational climate, and organizational process (Wiegmann & Shappell, 2003). When allocating resources, management often has to make decisions based on the potentially conflicting goals of safety and production. Sometimes the less expensive, riskier alternative is chosen due to cost-saving. Organizational climate consists of the atmosphere in which the employees work. Climate is influenced by culture, which includes the unspoken rules, values, attitudes, and beliefs of the organization. The organizational process refers to the procedures created by management that provide guidance to the workers. It can also include items such as quotas, time pressure, and operational tempo.

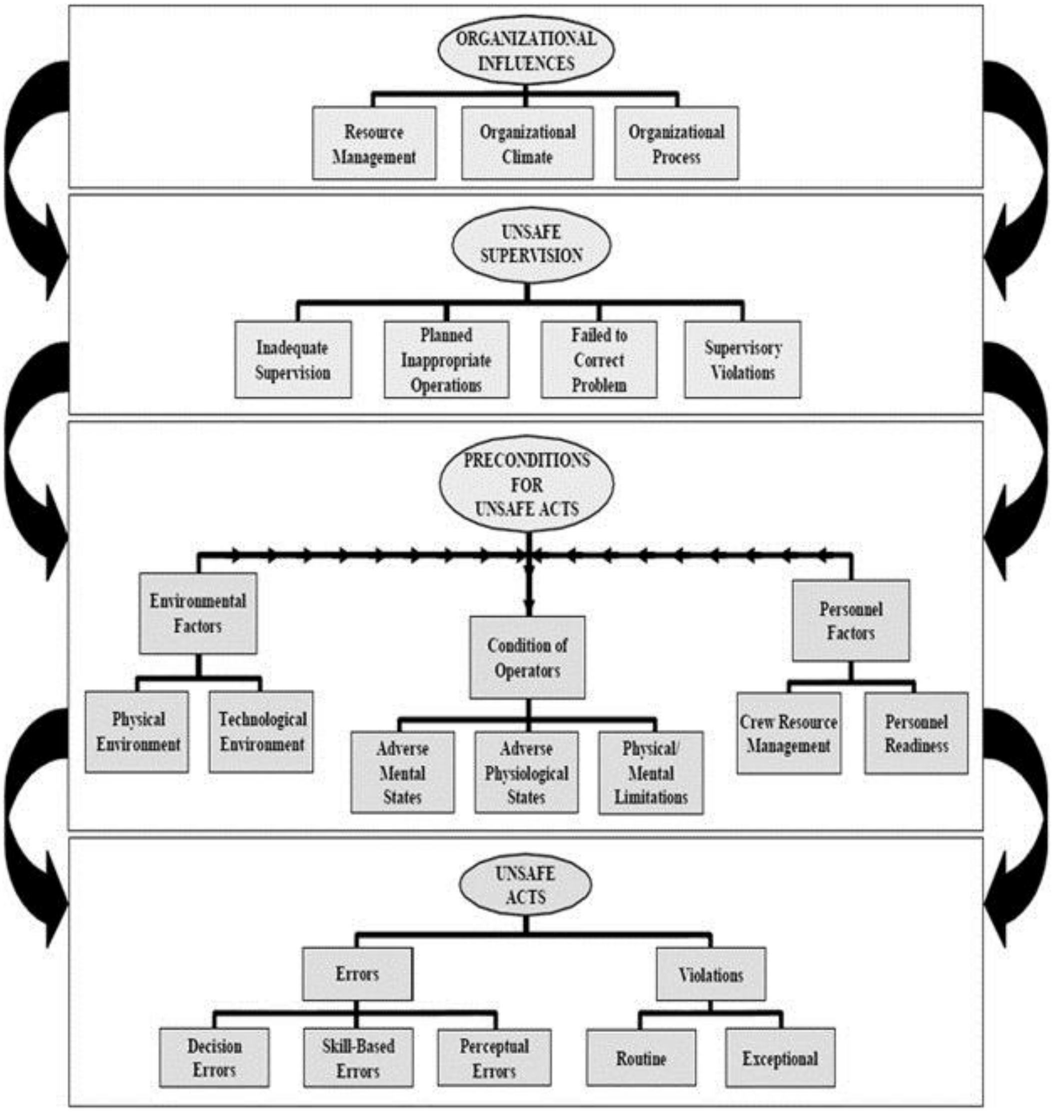

Figure 2. Wiegmann and Shappell's HFACS Model

In contrast to the human error theories created by Reason (1998) and Wiegmann and Shappell (2003), Dekker (2005) proposed ignoring errors, wrongdoing, and violations. He states, “to understand safety, an organization needs to capture the dynamics in the banality of its organizational life and begin to see how the emergent collective moves toward the boundaries of safe performance” (p. 31). An organization does not instantaneously develop unsafe tendencies. Instead, it tends to drift into failure, often unknown to those within the organization and even sometimes undetected by those who are on the outside (Dekker, 2005). Organizations learn and adapt over time, and when there are conflicting goals, such as safety and production, people have to find ways to adapt. Every time the adaptation is successful (i.e., no accident), it encourages further deviations that make it difficult for those within the organization to notice that they are incrementally moving away from what was originally considered safe until an accident happens. Then "the holes found in the layers of defense …are easy to discover once the rubble is strewn before one's feet" (Dekker, 2005, p. 29). To take a proactive approach, an organization has to closely examine its everyday, mundane activities to detect evidence of the drift away from safe performance. When an organization makes a conscious effort to discover and understand the gap between procedures and practice, they can improve their level of safety. It is also important for organizations to teach their employees when it is acceptable to adapt and how to adapt instead of simply telling them to follow procedures. This will develop their ability to deal with novel situations.

> "Work, especially that in complex, dynamic workplaces, often requires subtle, local judgments with regard to timing of subtasks, relevance, importance, prioritization and so forth…. Safety, then, is not the result of rote rule following; it is the result of people's insight into features of situations that demand certain actions, and people being skillful at finding and using a variety of resources (including written guidance) to accomplish their goals" (Dekker, 2005, pp. 138-139).

By examining the gaps between desired and actual behavior, an organization can detect the gradual drift into failure before it is too late.

Behavior-based Safety

Behavior-based safety was designed to target errors through identifying safe behaviors, observing behaviors to collect data, using feedback to encourage desired behaviors, and using the data collected to facilitate improvements in safety. This process is a proactive approach to preventing accidents, which in turn reduces injury and production-related costs to the company. Many companies employ some form of safety program to make employees aware of workplace hazards and correct safety procedures. They are, however, often unsuccessful at reducing accidents because they focus on the attitudes of the employees rather than the behaviors that are causing the accidents (Loafmann, 1998; Reynolds, 1998). These programs usually educate employees on how to be safe, but this does not always result in them actually behaving safely when they are on the work floor. According to Loafmann (1998), "behavior-based safety is an effective way to close the gap between what people know they should do and what they actually do" (p. 21). Also, typical safety programs are reactionary in that once an accident occurs, methods are implemented to prevent its future occurrence; whereas, BBS takes a proactive approach through frequent measurement of behavior and problem solving. Accordingly, injury and production related costs to the company are reduced (Komaki, Barwick, & Scott, 1978; Krause, Hidley, & Hodson, 1990; McSween, 2003; Olson & Austin, 2006). It has been shown that within 3 to 5 years after companies implement BBS, injury rates are reduced by 60% to 90% (Wilson, 2004).

The concept of BBS originated in the behavioral sciences, which focus on an individual's behavior and how the environment affects that behavior (Krause et al., 1990). Behavioral science includes the field of study called applied behavioral analysis

(ABA), and from this field emerged various methods of behavior modification, which use scientific research methodology to create a change in behavior. The first inception of BBS relied on supervisors to apply behavior modification methods to improve safety. Supervisors would observe the employees, give them feedback, and then provide either positive or negative reinforcement (Cooper, 2009). This method was not entirely effective, since removing the reinforcement usually resulted in a return of the undesired behavior. In the 1980s, the BBS model became more centered on the worker as a change agent, with the supervisors providing a support function (Krause, 2001). This was largely due to the fact that total quality management (TQM) had become very popular during this time, which promoted the concept of employee involvement.

The basis of BBS are the ABCs: antecedent, behavior, and consequence, where antecedent is the stimulus that prompts behavior, and the consequence is what reinforces or discourages the repetition of the behavior (Krause et al., 1990). A change in behavior can only be achieved by changing the consequences (Krause et al., 1990; McSween, 2003; Reynolds, 1998). Krause and Sloat (1993) explained the importance of consequences through the analogy of a ringing telephone. Many people believe that the ringing of a telephone causes people to respond to the phone, when in fact the ringing is actually an antecedent to the behavior of answering the phone. The consequence is having someone to talk to on the other end. If there is a telephone that rings constantly, but no one is there to talk to when the phone is picked up, people will stop responding to the phone when it rings. Safety meetings can provide employees with encouragement and information (antecedents) to perform their job safely; however, without consequences, they can be ineffective in changing behavior.

Not only must there be consequences, they must be soon, certain, and positive (Geller, 2000; Krause & Sloat, 1993; Loafmann, 1998; McSween, 2003; Reynolds, 1998). According to Reynolds (1998), “people respond more predictably to small, immediate, certain consequences than to large, future, uncertain ones” and “rewards not tied to specific behaviors do little to promote performance improvement” (p. 25). The consequences in the workplace do not need to be complicated or expensive, but should include incentive/reward programs and interpersonal recognition such as verbal praise (Geller, 2000).

Another important aspect of behavior change is feedback, and like consequences, it also must be soon, certain, and positive to change behavior effectively. According to Loafmann (1997), “when people receive feedback daily, they can see how that day’s attempts to use safe behaviors compare with attempts the day before. Then, improvement feels like a game in which winning is an exciting possibility” (p. 38). Daily feedback also aids in identifying obstacles to safe behaviors and helps develop and reinforce safe behaviors.

When implemented correctly, BBS “represents one of the few safety improvement methods to have solid, scientifically-based data to support its effectiveness” (Krause, 2001, p. 28). Sulzer-Azaroff and Austin (2000) conducted a meta-analysis of 33 data-based evaluations of behavioral safety programs that were implemented in a wide variety of work settings in several countries, and with various numbers of employees and facilities. They found that 32 of the articles reviewed revealed reductions in the occurrence of accidents and incidents. However, they caution that there may be some bias in the results since the research presenting poor results may have not been submitted or rejected for publication (Sulzer-Azaroff & Austin, 2000).

An overview of several other studies involving BBS effectiveness follows, each involving petroleum refining (Medina, McSween, Rost, & Alvero, 2009), bus transportation (Olson & Austin, 2001), food manufacturing (Komaki et al., 1978), and three involving flight training (Olson & Austin, 2006; Rantz, Dickinson, Sinclair, & Van Houten, 2009; Rantz & Van Houten, 2011). The study involving petroleum refining reported a 30% increase in safe behavior over the course of the study (Medina et al., 2009). The bus transportation study found a 12.5% overall increase in safe behavior over several behavioral areas, with individual areas ranging from 6% to 22% (Olson & Austin, 2001). In the food manufacturing study, two separate work shifts achieved a 21% to 26% increase in safe behaviors (Komaki et al., 1978). The research study conducted by Olson and Austin (2006) involving flight training primarily focused on the first step of BBS, identifying safety concerns through error tracking during the landing phase to determine where students were having the most problems. On dual flights, the highest number of errors occurred during flare, follow-through after touchdown, turn from base to final approach, and overall final approach. On solo flights, the highest number of errors were turn from base to final approach, angle of descent, flare, and touchdown centerline (Olson & Austin, 2006). In the two studies on checklist use by pilots enrolled in a collegiate flight program, the main focus was the effectiveness of the feedback portion of BBS (Rantz et al., 2009; Rantz & Van Houten, 2011). These studies reported that when the pilots received feedback on their checklist performance after each session in the form of verbal praise and visual indicators (charted data), their correct use of checklists increased from a mean of 53% to 91% in one study and 39% to nearly 100% in the other study. The results were maintained even after the intervention was withdrawn.

Techniques for Implementing Behavior-based Safety

There are several benefits to implementing BBS. The first is that it focuses on changing the cause of the behavior instead of simply blaming the employee. Creating a change in behavior is a systematic process that continues over time. Another benefit is that the employees are involved in the process, which increases their motivation to participate. Lastly, it provides quantifiable data that can be used for progress updates and further improvements in safety (Krause, 2001).

There has also been some criticism of BBS, especially the earlier versions where the supervisors directed behavior without employee input. Smith (1999) lists several shortcomings of early BBS models, such as ignoring the internal reasons for behavior, ignoring the working environment as a cause of accidents, and excluding the worker from the process, which promotes the concept of command-and-control management. He states that BBS does not fit well with the concept of quality management that had also become popular during the 1980s, because it eliminates internal motivation through the use of positive and negative reinforcement and top-down processes. Smith believed that "quality management systems—not BBS—will drive the safety management model that will be used in the 21st century and beyond" (p. 40). Proper use of BBS addresses the majority of these issues, and even closely coincides with the core concepts of quality management (Krause et al., 1990), precisely as Smith (1999) asserted. Additional criticisms of BBS are that it places blame on the employees, takes away management's responsibility for safety, and is manipulative (Blair, 1999). However, the aforementioned problems often arise from the misuse of behavior modification concepts, resulting in unsuccessful implementation. Therefore, it is important to understand the most effective ways to use BBS concepts to ensure the success of the program.

Over time, BBS has evolved to become more effective at modifying behaviors. The first attempts at BBS involved training supervisors in the academic concepts of behavior modification and expecting them to apply those lessons to the real world without guidance on how to do so (Krause et al., 1990). This resulted in supervisors incorrectly applying what they learned or reverting to more familiar safety management techniques. This led to the need to create a process that involved the concepts of organizational development, which focuses on both training and implementation (Krause et al., 1990). The successful implementation of BBS relies on seven principles described by Geller (2005, p. 540) that can be used effectively in real world applications: (a) focus on observable behavior, (b) look for external factors to understand and improve behavior, (c) direct with antecedents and motivate with consequences, (d) focus on positive consequences to motivate behavior, (e) apply the scientific method to improve intervention, (f) use theory to integrate information, not to limit possibilities, and (g) design interventions with consideration of internal feelings and attitudes.

The first key principle, focus on observable behavior, involves simply observing what people do and then targeting unsafe behaviors. Once an unsafe behavior is identified, it is important to look for external factors to understand and improve behavior. The external factors that are causing the unsafe behavior can then be modified to elicit a change in behavior. The third principle is to direct behavior with antecedents and motivate with consequences. This principle is based on the ABC concept, where A is the antecedent (or activator), B is the behavior, and C is the consequence. Antecedents are signals that elicit a certain behavior, and they can be internal or external (Geller, 1999). People are more likely to respond to an antecedent if they know that it will produce a pleasant consequence or allow them to avoid an unpleasant consequence (Geller, 2005). It is important to understand the two types of rewards or feedback to be successful in changing behavior (Geller, 1999). When a reward is offered as an antecedent, it motivates a behavior. When a reward is used as a consequence (given after the desired behavior), it supports the behavior. The appropriate method of reward or feedback depends on the type of behavior that is being changed.

Geller (1999) defines three types of behavioral transitions: (a) changing a risky habit (unconscious incompetence) into a self-directed behavior (conscious competence), (b) changing a risky self-directed behavior (consciously incompetent) into a safe self-directed behavior (consciously competent), and (c) changing a safe self-directed behavior (consciously competent) into a safe habit (unconsciously competent). There are three types of interventions to facilitate the three behavior transitions: instructional, supportive, and motivational. Instructional intervention, which consists of antecedents such as training and education, is used to facilitate changing unconscious incompetence to conscious competence. Supportive intervention, or the use of positive consequences, is used to change conscious competence into unconscious competence. There are usually no antecedents associated with supportive intervention since the person is already motivated to do the right thing and an incentive/reward would be considered demeaning. When a person is willfully unsafe, even after they are trained in safe procedures, motivational interventions must be used which require the use of both antecedents and consequences. Incentives and rewards are effective motivational interventions (Geller, 1999). Pairing the appropriate intervention with the desired change in behavior will insure that employees are properly motivated towards safety.

The fourth principle involves focusing on positive consequences to motivate behavior (Geller, 2005). Negative consequences are often ineffective because the probability of punishment seems remote, and may even trigger "more calculated risk taking, even sabotage, theft, or interpersonal aggression" (Geller, 1999, p. 48) due to a sense of loss of individual freedom. The next principle is to use the scientific method to improve the intervention, which provides feedback for further improvement (Geller, 2005). This involves the application of DO IT, which stands for Define behavior(s) to target, Observe to collect baseline data, Intervene to influence target behaviors, and Test to measure the impact of the intervention. This process is performed in a continuous loop, and each time it is completed, the employees learn more about improving safety within their organizations. It is important that the information gathered during DO IT is not used for punishment purposes, and that the findings are expressed in terms of safe operations rather than unsafe operations. The sixth key principle is to use theory to integrate information, not to limit possibilities. The DO IT process will allow employees to develop theories regarding which interventions work in certain situations and with which individuals. These theories can then be applied to the development of new types of interventions to increase their effectiveness. The final key principle is to design interventions with a consideration towards internal feelings and attitudes. It is important to consider the impact that an intervention has on individuals since an intervention can "increase or decrease feelings of empowerment, build or destroy trust, or cultivate or inhibit a sense of teamwork or belonging" (Geller, 2005, p. 551). When these key principles are adhered to, BBS is more likely to be effective in the workplace.

An important aspect of BBS is safety coaching. Behavior-based Safety Coaching involves one-on-one observation and feedback (Geller, Perdue, & French, 2004). The role of the safety coach is to encourage safe behaviors while providing useful feedback on at-risk behaviors. The observational data, collected through observation checklists, is then compiled and shared with employees. Behaviors that need attention are identified, and employees form teams to create ways to remove barriers to safe behaviors. The following list of 10 guidelines is key to implementing a successful BBS coaching system (Geller et al., 2004).

1. *Teach procedures with principles*, which consist of motivating people to learn safe behavior through teaching them the basic premise of BBS. Once they understand the process and the reasoning behind BBS, they will be more willing to change.
2. *Empower employees to own the process* through involving them with designing, implementing, evaluating, and refining the system. This sense of ownership will more likely result in behavior change because the employees hold themselves responsible.
3. *Provide opportunities for choice* in whether or not to participate, but it is important to avoid completely voluntary programs since they will usually lack sufficient support to be effective. Everyone should be expected to get involved to some degree.

4. *Facilitate supportive involvement from management*, which involves showing employees that what they are doing is being appreciated by their supervisors. Employees at all levels need to have specific roles in this process.
5. *Ensure that the process is non-punitive*, since punishment “stifles feelings of trust, empowerment, ownership, and commitment” (p. 44). It is important that employees believe that the data collected are anonymous and will not be used against them in any way. The discovery of at-risk behaviors should only be used to determine areas in need of improvement.
6. *Ensure that the coach is non-directive,* which means that they should not correct at-risk behavior. Their role is to simply encourage the safe behaviors that they observe.
7. *Progress from announced to unannounced observations* should be made at an appropriate time. Although unannounced observations will provide more realistic data, it can be seen by employees as a means to observe them in the act of doing something unsafe, which can breed distrust. Once employees recognize that BBS is for their benefit, observations can become unannounced with the permission of the workers.
8. *Focus on interaction, not just numbers* gleaned from the data. While the numbers provide valuable information as to progress towards safety, conducting the observations themselves lead to even greater benefits. The process of caring interaction and feedback by the observer should lead to informal peer coaching, where employees interact with each other and give feedback in the interest of a safe and accident free workplace.

9. *Continuously evaluate and refine the process* using a combination of the data gathered through observations, perception surveys, interviews, and focus groups. This information should be used to make adjustments and improvements to further target at-risk behaviors.
10. *Make the process part of a larger effort* by incorporating BBS throughout all aspects of the organization from training, recognition, and ergonomics.

While peer observations are important to a successful BBS program, BBS concepts can be applied by a single worker through self-observation (Geller & Clarke, 1999; Krause et al., 1990; McSween, 2003). With the assistance of management and peers, the worker targets the behaviors he or she wishes to improve and tracks them to monitor progress. Since the aviation workplace—the cockpit— consists of one or two pilots, self-observation techniques can be used to improve behavioral safety.

According to McSween (2003), the self-observation process involves answering three questions: What's my job, how am I doing, and what's in it for me? To answer the question of "what's my job?", each worker lists the actions that are needed to complete the job safely. Then these actions are included in a checklist, and the worker selects yes, no, or not applicable in reference to whether or not the action was performed. A percentage safe number is then calculated to see "how I am doing". This process makes the employee more aware of his or her safe and unsafe actions. To answer the question, "what's in it for me?", individuals need to feel that they can take control of their own safety. The worker must be motivated to conduct self-observations, and this motivation usually emerges from the desire to avoid injury. However, if motivation is low, training in the benefits of self-observation can help get him or her started, and motivation will build as the worker begins to internalize the concepts (Krause et al., 1990). It is also important to publicly congratulate individuals on their safety progress to keep them involved. The worker then uses the observation data to develop a plan to improve behaviors that do not meet his or her safety standards (Geller & Clarke, 1999). If possible, safety antecedents such as posters or notes should be posted in the work area to serve as reminders. Self-observations can be just as effective as peer observations. In a study conducted by Krause et al (1990), a safety self-observation program was implemented into a metropolitan transit authority. The drivers created an inventory of safe behaviors, which they completed twice a day. Four months after implementation, accident frequency decreased 66%.

Olson and Austin (2006) applied self-management BBS concepts to a highly accident prone element in student flight training: landings. Many of these accidents are the result of human error; tracking the causes of errors through behavioral processes can help prevent an accident. It also has the added benefit of providing the means to investigate patterns in errors and improve training through the evaluation of policies and programs. Additionally, self-evaluation can help students develop safe habits and attitudes. The instrument that was developed for this study collected information on student pilot landings that included personal variables, environmental conditions, and a rating scale of the landing quality. It was completed by both the instructor and student, and provided valuable information that can be used to assist students and instructors target errors, allow for the evaluation of teaching effectiveness, benchmark students against peers, and help standardize the timing of solo and check rides (Olson & Austin, 2006). This type of methodology can be applied to any area of flight training with the goal of improving safety and instruction.

Summary

Human error has been cited in many aviation accidents, and while it may seem natural to blame the pilot, there are many factors that were at work in the background. Reason (1998) developed the Swiss Cheese model of accident causation that defines these factors as organizational influences, unsafe supervision, precondition for unsafe acts, and unsafe acts. Holes in these defenses can potentially align to lead to an accident. Wiegmann and Shappell (2003) expanded this concept to help accident investigators and those in charge of safety programs determine exactly what those holes were. Their HFACS model was developed from extensive analysis of accidents and can be used by accident investigators to better define the causes of an accident; it can also inform industry practice and identify hazards before an accident can occur (Shappell & Wiegmann, 1997).

In most organizations, behavior contributes between 86% and 96% of all injuries (McSween, 2003). It follows that targeting unsafe behavior and the environment that causes it will help to decrease the amount of injuries in the workplace. This is the premise of behavior-based safety (BBS). The BBS model is a proactive approach that uses frequent measurement of behavior and problem solving (Olson & Austin, 2006). It has been proven to be effective through scientifically-based studies, and in the majority of cases, accident rates have been reduced by 60% to 90%.

There are many potential benefits to BBS if it is implemented correctly, most importantly, significant reductions in the occurrence of accidents. There are seven key principles for successful implementation of BBS. These principles will help supervisors develop a BBS program that will facilitate monitoring and changing behavior and environmental influences while involving employees in the process. Although most applications of BBS are in an environment that involves multiple employees, safety self-management concepts can be implemented in the cockpit. Using safety self-evaluations has the potential to increase safe behaviors through enhanced awareness of one’s actions. Additionally, safety self-management can assist personnel in flight schools in identifying common errors and improving instructional practices, which has the potential to address latent hazards leading to proactive accident prevention.

CHAPTER 3: METHODOLOGY

Rationale

There are many factors related to an accident, making it an oversimplification of the problem to just label the cause as pilot error, especially in an organizational setting such as flight training. Latent and active failures can develop within an organization (James T Reason, 1998), allowing it to gradually drift away from safety and closer to an accident (Dekker, 2005). In general aviation, the pilot's actions or inactions in response to risks encountered in flight were responsible for 74% of non-fatal accidents and 70% of fatal accidents in 2010 (Aircraft Owners and Pilots Association, 2012). Midair collisions were ranked as the ninth leading cause of fatalities in general aviation between 2001 and 2011 (Federal Aviation Administration, 2012). A search of the NTSB aviation accident database using the terms "midair collision" and accident revealed that there were 116 reports of midair collisions (MAC) between 2000 and 2012. These accidents resulted in substantial aircraft damage and/or death in the United States. Each report represented one of the aircraft involved, and further analysis yielded 60 instances of MACs involving 120 aircraft. Twenty-nine of these instances were fatal, resulting in 72 deaths (see Figure 3). Sixteen of the reports were aircraft on training flights, totaling 13 MAC incidents, eight of which were fatal resulting in 20 deaths (see Figure 4).

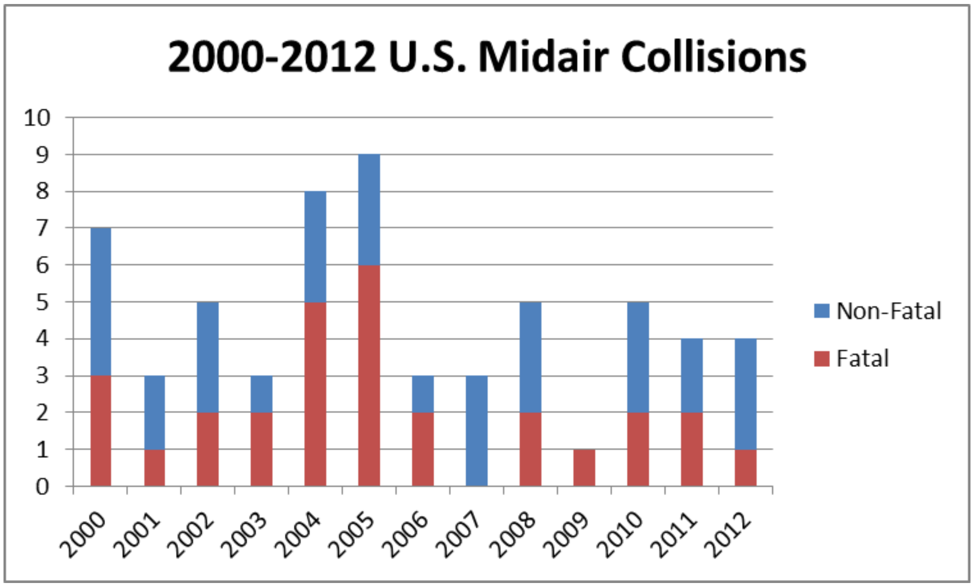

Figure 3. 2000-2012 U.S. Midair Collisions

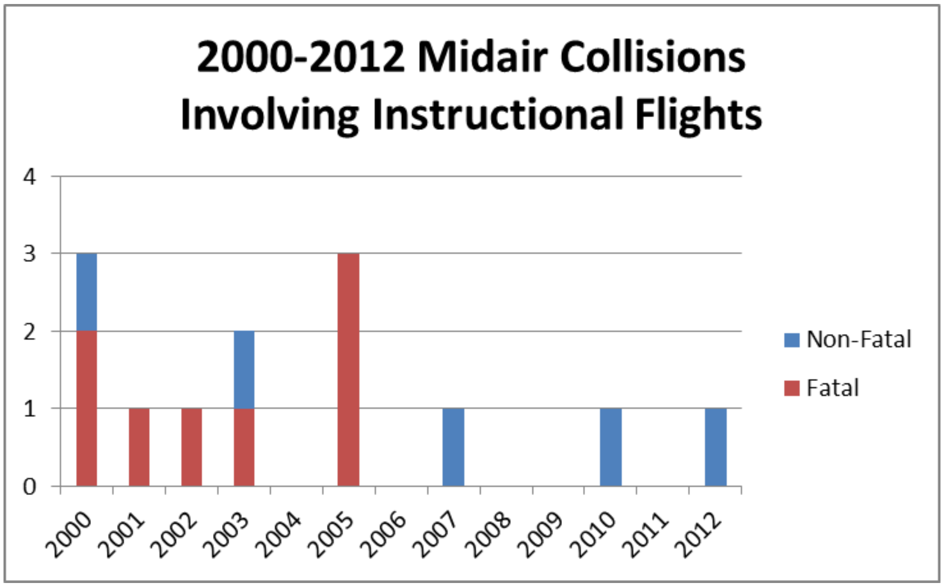

Figure 4. 2000-2012 Midair Collisions Involving Instructional Flights

It is the responsibility of the pilot to see and avoid, which requires the pilot to be vigilant during all phases of flight. During flight training, flight instructors should encourage their students to use collision avoidance techniques and set a good example by complying with all regulations and accepted safety practices (Federal Aviation Administration, 1983).

The purpose of this study, therefore, was to determine if the implementation of behavior-based safety (BBS) into the flight training environment could effectively improve the use of clearing turns prior to training maneuvers. In manufacturing, BBS is a system that has been used to encourage safe behavior in employees, resulting in significantly lower accident rates. It has been shown that within 3 to 5 years after companies implement BBS, injury rates are reduced from 60% to 90% (Wilson, 2004). Since BBS has been proven to be effective in a wide range of industries and settings, it is possible that it may be used as a tool for encouraging safe behaviors in the flight training environment.

Theoretical Framework

The overall goal of this research was to determine the effectiveness of BBS in a flight training environment. The experimental design used was a pre-test, post-test control group design. This research design would allow the effects of BBS to be more clearly defined as the cause of the change in the number of clearing turns that were performed. Additionally, the design offers several benefits according to Gall, Gall, and Borg, (2007). The use of a pre-test with both the experimental and control groups allows the researcher to establish that the two groups were approximately equal prior to administering the treatment to the experimental group. Accordingly, the administration of a post-test to both groups would suggest that any significant changes between the experimental and the control groups could be attributed to BBS (Gall et al., 2007). In this study, the dependent variables were human factors areas and the utilization of clearing turns; the independent variable was the BBS process, including observations and feedback.

The participants in this study were flight instructors and students. The instructors who volunteered to participate through completion of the pre-survey were assigned randomly to either the control or experimental group. Since one instructor may have several students, the group that the students were assigned was the same as the instructor so that an instructor would not have students divided between the groups. This minimized experimental treatment diffusion in which the instructor could unintentionally give the treatment to students in the control group. The experimental group completed training and treatment, several measurements of the treatment condition, and a post-survey, while the control group completed several measurements of the untreated condition, and a post-survey (see Table 1).

Table 1

Experimental Design

O_1	R	X	O_{cf}	O_{cf}	O_{cf}	O_{cf}	O_2
O_1	R		O_c	O_c	O_c	O_c	O_2

O_1 = HFACS pre-survey
R = Random assignment
X = Training in BBS procedures and treatment for clearing turn use
O_{cf} = Observation checklist with feedback
O_c = Observation checklist with no feedback
O_2 = HFACS post-survey

Gall et al. (2007) suggested several procedures to achieve control when using experimental designs: frequent checks on the reliability of the experimenter’s observations, frequent observation of the behaviors that have been targeted for change, and a detailed description of the procedures used to facilitate replication. For this study, both the students and instructors in each group performed the role of experimenter. The instructors in the experimental group administered the treatment of feedback on the student's performance of clearing turns as well as collecting data using the observation checklist, while the instructors in the control group only collected data using the observation checklist without providing feedback. The students in both groups had a dual role, that of participant and experimenter. When the students were flying solo, they conducted observations on themselves using the checklist at the completion of the flight to collect data on their performance. Frequent checks of the experimenters' observations consisted of both the student and the instructor completing the observation checklist for the same flight. Their observations were compared and checked for level of agreement. Every flight, dual and solo, was encouraged to complete the observation checklist to ensure frequent observations of the target behavior, consistently performing clearing turns. The details of the procedures are described to allow for other researchers to perform a similar experiment. Complying with all of these procedures helped maintain treatment fidelity, which ensured that improvement in the use of clearing turns could be attributed to the treatment and not differences in implementation (Gall et al., 2007).

The procedure used in BBS research has been outlined in several studies (Komaki et al., 1978; Medina et al., 2009; Olson & Austin, 2001, 2006). The first step in conducting BBS research is to identify the areas of safety concern through analysis of incident reports, interviews, observations, and reviews of procedures manuals. Then, training in BBS and desired safe behavior is provided to the employees; the observation checklist is distributed afterwards. The data are analyzed and graphs are created on a regular basis using the observation data. They are displayed in a prominent place to provide feedback on the participants' progress before and after BBS.

In this study, clearing turn use was used as the area of safety concern based on observations of the researcher. Then, the antecedents, or causes of the behavior, were determined through a pre-survey created by the researcher using the Human Factors Analysis Classification System (HFACS) Survey, which was administered to all participants prior to beginning the study. Once the barriers to completing clearing turns were identified, an intervention in the form of training was administered to the experimental group. The instructors and students in the experimental group received training to become effective observers as well as provide motivation for consistently performing clearing turns. This training occurred through a recorded presentation. Krause et al. (1990) identified 5 basic skills that the observers should gain from this training:

1. How to see safe and unsafe behaviors
2. How to record what they observe – the scoring procedures
3. How to calculate % Safe
4. How to chart % Safe
5. How to provide feedback on what they observe (p. 168)

These basic skills provided the guidelines for the training session. The participants were also briefed as to what constitutes correct execution of clearing turns. The students in the program work one-on-one with their instructors in the aircraft. They are accustomed to being observed and critiqued; therefore, the use of a checklist during flight lessons was a concrete method to measure their improvement. In previous studies, the fact that the participants were being observed had some effect on the increase in safe behaviors; however, over time, there was still a significant increase in safe behaviors.

After the training was completed, the observation checklist was distributed to the participants, which focused on the target behavior of clearing turns. The observers were students and instructors who used the checklist to record safe and unsafe behaviors exhibited by the participants. Those data were compiled into a percent safe for the group and this information was distributed to the participants in the experimental group as feedback. One study created a safety newsletter and a website devoted to the plant's safety progress (Medina et al., 2009). This study incorporated a newsletter delivered by e-mail to inform students as to how they are doing in relation to the group, which had the potential to motivate under-performing students to improve (Matsui, Kakuyama, & Onglatco, 1987). A study conducted by Erez (1977) found that when students were given feedback on their past performance and used it to set future goals, they performed better than students who did not receive feedback and set random goals. Another study found that college students who received feedback on their performance as well as the group's performance tended to work harder if their performance fell short of the groups' overall performance (Matsui et al., 1987). Additionally, the goals set by each group member were higher than the goals set by the individual, and while the group members exceeded their personal goals, individuals were satisfied with simply achieving their goals. In addition to the newsletter, feedback was also provided by the instructors after every flight to reinforce safe behaviors in the form of rewards or verbal congratulations.

A survey was developed by the researcher using the HFACS framework to address the first research question concerning the factors that were causing the differences between procedures and practices related to clearing turns (see Appendices A and B). Prior to beginning the study, all participants were asked to complete the HFACS survey. This assisted to determine those areas that need to be addressed during the study. At the conclusion of the study, all the participants completed the same survey to determine if there was improvement in these areas. The independent variable was the implementation of BBS procedures, and the dependent variable was human factors areas.

Data were collected for the second question related to changes in the quantity of clearing turns using a BBS checklist that was completed by instructors and students. The BBS checklists (see Appendix C) were used to provide daily individual feedback to the students to ensure that they could be apprised of progress towards improving their use of clearing turns, an important aspect of successful BBS programs. These data were collected on every dual and solo flight for six weeks. The independent variable was the implementation of BBS processes, and the dependent variable was the number of clearing turns completed as determined by the observer checklist. The percent safe, which is calculated by taking the number of safe observations divided by the total number of observations, was evaluated over time to determine if BBS had a positive effect on the use of clearing turns.

Population and Sample

The target population for this study was students enrolled in a four year, collegiate Part 141 professional flight training program. The graduates of this type of program typically pursue a career as an airline or corporate pilot, and normally earn their private and commercial certificates during the first two years of instruction. Many also earn their flight instructor certificate. The typical age range of the students was 18-22. The sample for this study was students enrolled in a Midwestern collegiate professional flight program. All students were invited to participate in the study as it had a direct impact on their overall safety, and resulted in the maximum number of participants. The number of students enrolled in the first two years of the flight program was approximately149, and consisted of freshmen and sophomores. Invitations to participate in the research study were distributed to 43 part-time and 3 full-time instructors. The participants were then assigned randomly to either the control or experimental group using a random number generator, resulting in seven instructors in the control group and six instructors in the experimental group. See Table 2 for the details. The minimum requirement to take the survey was to possess a certified flight instructor certificate (CFI), which was satisfied by all the participants. Both groups had fairly equal numbers of instructors who possessed a certified flight instructor instrument rating (CFII), multi-engine instructor rating (MEI), and advanced ground instructor certificate (AGI). There was a slightly higher number of instructors who possessed an instrument ground instructor certificate (IGI) in the experimental group than the control group. As far as total flight time, the experimental group had more flight experience than the control group participants with the majority of the instructors having a total flight time of 501-1000 hours; whereas, the control group was distributed more evenly among the lower flight times. The number of hours of instruction given was fairly similar in distribution between the two groups, with the control group having a slightly higher average. The demographics of the groups were not changed significantly from the pre-survey.

Table 2

Instructor Demographics

	Pre-Survey				Post-Survey			
	Cont. (n = 7)		Exp. (n = 6)		Cont. (n = 7)		Exp. (n = 5)	
Demographic	N	%	N	%	N	%	N	%
Flight instructor certificates held								
CFI	7	100.0	6	100.0	7	100.0	5	100.0
CFII	3	42.9	4	66.7	3	42.9	4	80.0
MEI	2	28.6	1	16.7	2	28.6	1	20.0
AGI	1	14.3	1	16.7	1	14.3	1	20.0
IGI	1	14.3	3	50.0	1	14.3	2	40.0
Total flight time (hours)								
200-250	1	14.3	0	0.0	1	14.3		
251-500	2	28.6	1	16.7	2	28.6	1	20.0
501-1000	2	28.6	5	83.3	2	28.6	3	60.0
1000+	1	14.3	0	0.0	1	14.3	1	20.0
Flight instruction given (Hours)								
0-40	1	14.3	1	16.7	1	14.3	1	20.0
41-100	2	28.6	0	0.0	2	28.6	0	0.0
101-200	0	0	2	33.3	0	0	1	20.0
201-500	2	28.6	2	33.3	2	28.6	2	40.0
501-1000	1	14.3	1	16.7	1	14.3	1	20.0
1000+	1	14.3	0	0.0	1	14.3	0	0.0
Employment								
Part-time	5	71.4	5	83.3	5	71.4	4	80.0
Full-time	2	28.6	1	16.7	2	28.6	1	20.0
Age								
18-21	2	28.6	2	33.3	2	28.6	1	20.0
22-25	4	57.1	4	66.7	4	57.1	4	80.0
26 +	1	14.3	0	0.0	1	14.3	0	0.0
Gender								
Male	6	85.7	5	83.3	6	85.7	4	80.0
Female	1	14.3	1	16.7	1	14.3	1	20.0

For the student portion of the study, invitations to participate in the research study were distributed to 149 students who were enrolled in the Private Pilot, Commercial Pilot I, Commercial Pilot II, and Instrument and Commercial flight courses. The participants who agreed to participate in the study were then assigned to either the control or experimental group based on the group that their instructor was assigned, resulting in 10 students in the control group and 16 in the experimental group. The control group had generally fewer hours of flight experience than the experimental group. The demographics and number of student participants in the control and experimental groups are presented in Table 3, which includes the pre- and post-survey and the observation checklists.

The flight program's basic training fleet consisted of 16 Cirrus SR-20 aircraft; 13 of which were GS models used for primary training, while the remaining three were GTS models that were used mainly for instrument training; however, they could be used for primary training as well. The aircraft are flown for two types of lessons: dual, which has an instructor and a student on board, and solo, with only the student on board. Each lesson was approximately an hour and a half long with two to three lessons scheduled per week.

Instrumentation

Two instruments were used to gather data: a pre- and post-survey concerning human factors and an observation checklist. The human factors survey utilized portions of Wiegmann and Shappell's (2003) HFACS model to examine areas that could provide

Table 3

Student Demographics

	Pre-Survey				Post-Survey				Observation Checklist			
	Cont. (n = 10)		Exp. (n = 16)		Cont. (n = 8)		Exp. (n = 8)		Cont. (n = 7)		Exp. (n = 13)	
Demographic	N	%	N	%	N	%	N	%	N	%	N	%
Flight course												
Private Pilot	8	80.0	9	56.3	6	75.0	5	62.5	5	71.4	5	38.4
Commercial Pilot I	2	20.0	2	12.5	2	25.0	2	25.0	2	28.6	3	23.1
Commercial Pilot II	0	0.0	5	31.3	0	0.0	1	12.5	0	0	5	38.4
Instrument and Commercial	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total Flight Time (Hours)												
0-40	8	80.0	5	31.3	6	75.0	2	25.0	0	0	1	7.7
41-100	1	10.0	4	25.0	2	25.0	3	37.5	5	71.4	6	46.2
101-200	1	10.0	7	43.8	0	0.0	3	37.5	2	28.6	6	46.2
201+	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Age												
18-21	10	100.0	15	93.8	8	100.0	8	100.0	7	100.0	12	92.3
22-25	0	0.0	1	6.3	0	0.0	0	0.0	0	0.0	1	7.7
26 +	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Gender												
Male	9	90.0	12	75.0	7	87.5	5	62.5	7	100.0	10	76.9
Female	1	10.0	4	25.0	1	12.5	3	37.5	0	0.0	3	23.1

answers to the question: Which human factors are causing the discrepancies between procedures and practice with respect to clearing turns, and can these discrepancies be reduced through BBS? Dekker (2005) stated that determining the discrepancy between procedure and practice is crucial to improving the safety of an organization. The HFACS survey (see Appendices A and B) was developed by the researcher and was evaluated by peers within the flight training program to determine its validity. Internal consistency reliability was estimated for items 1 and 3-9 of the pre-survey using Chronbach's Coefficient Alpha and SPSS software. The student survey yielded an alpha of .82 for 8 items and 26 participants, and the instructor survey had an alpha of .54 for 8 items and 13 participants. In general, an alpha between .70 and .80 is adequate for newly developed instruments and basic research (Nunnally & Bernstein, 1994). The instructor survey reliability was relatively low due to the small number of items and participants. The survey was distributed to the students and instructors in the flight program before and after the study through online Qualtrics survey software. The information provided on the pre-survey specified the areas that needed to be targeted in the training session as part of the implementation of BBS, while the post-survey helped determine if there was improvement in these areas as a result of BBS. The HFACS survey focused specifically on the areas of organizational influences (resource management, organizational climate, and organizational process), unsafe supervision (inadequate supervision, planned inappropriate operations, failure to correct problem, and supervisory violations), preconditions for unsafe acts (physical environment, technological environment, adverse mental states, crew resource management), and unsafe acts (skill-based errors, decision errors, and routine violations) (see Figure 5). These areas were selected based on the researcher's experience with the problem of the study: students' failure to perform clearing turns. The areas that were excluded (adverse psychological states, physical and mental limitations, personnel readiness, perceptual errors, and exceptional violations) were not applicable to the nature of the problem. The relationship of each survey item to its corresponding HFACS category is illustrated in Table 4. The descriptions of the categories were derived from examples provided by Wiegmann and Shappell (2003). The data collected from the survey included quantitative and qualitative data. The quantitative data produced means and standard deviations for further analysis. The qualitative data gathered from the open-ended question were coded and analyzed.

Of the 46 instructors, 14 agreed to participate; however, only 13 instructors actually completed the pre-survey (28% completion rate). The pre-survey was distributed to 149 students, and was completed by 26 students (17% completion rate). The 13 instructors who completed the pre-survey were sent the link for the post- survey, and all but one instructor completed the post-survey for an n of 12 (92% completion rate). All of the students who completed the pre-survey received a link to complete the post-survey regardless of whether they submitted any observation checklists. Students who did not complete the pre-survey, but who completed at least one observation checklist were also invited to complete the post-survey; however, none of these students did so. The total number of students who received the survey link was 36, of which 16 completed the post-survey (44%), with eight from the control group and eight from the experimental group. Student participation decreased 20% for the control group and 50% for the experimental group between the pre- and post-surveys.

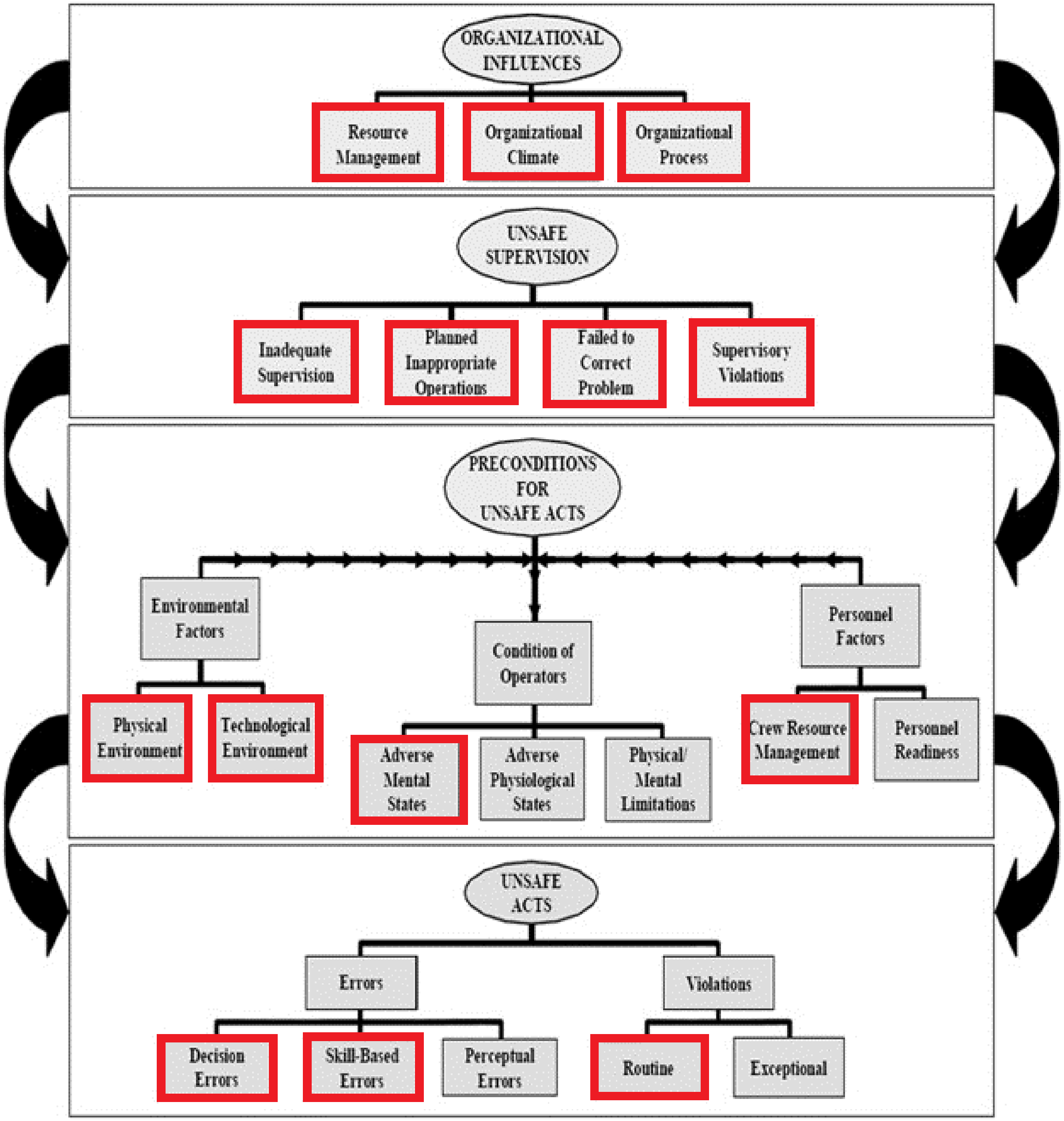

Figure 5. HFACS Categories Included in the HFACS Survey

Table 4

Relationship of HFACS Survey Items to HFACS Categories

Pre-survey Item	HFACS Category	Description
1. How often do you do clearing turns?	Routine violations	Not performing clearing turns is accepted practice
2. What are some of the reasons you don't do clearing turns?	NA	NA
• I forget.	Skill-based errors	Omitting steps in a procedure, negative habit
• My instructor told me not to.	Supervisory violations	Violated established procedures
• They take time away from getting the lesson done.	Organizational process	Requirements to complete all the maneuvers in a flight period (quotas), time pressure
• They are not part of the procedures for the maneuver.	Decision errors	Inadequate knowledge of existing procedures
• The traffic system will alert me to other aircraft in the area.	Technological environment	Reliance on a system with limitations, complacency
• The chances of me hitting another plane are slim.	Adverse mental state	Complacency, overconfidence
• They are not important.	Organizational climate	Norms and rules, values, beliefs, and attitudes
3. My instructor makes sure that I complete clearing turns before beginning a maneuver.	Inadequate supervision	Failure to provide proper training, guidance
4. My instructor corrects me if I do not complete a clearing turn before a maneuver.	Failure to correct problem	Failure to correct a safety hazard, failure to initiate corrective action
5. My instructor does not think clearing turns are important.	Organizational climate	Norms and rules, values, beliefs, and attitudes
6. When I try to do a clearing turn, my instructor discourages it.	Crew resource management	Interactions with instructor affecting students' actions

7. There are too many maneuvers in a lesson to do clearing turns and complete. the lesson	Planned inappropriate operations	Program managers overloading students with tasks
8. It is acceptable to not do a clearing turn if the lesson can be completed.	Resource management	Production is valued over safety
9. I am less likely to do a clearing turn if the weather is nice.	Physical environment	Weather conditions encouraging complacency
10. The FAA provides specific guidance on how to conduct a clearing turn (how much heading change, amount of bank, etc.)	Organizational process	Procedures created by the Federal Aviation Administration that provide guidance to the students and instructors
11. The flight department provides specific guidance on how to conduct a clearing turn (how much heading change, amount of bank, etc.)	Organizational process	Procedures created by the flight department that provide guidance to the students and instructors

The observation checklist was used to collect quantitative data regarding the proper use of clearing turns to answer the first research question: Is there a significant increase in the utilization of clearing turns prior to initiating training maneuvers by students in the flight program when BBS is implemented into flight training? According to Krause et al. (1990), there are several steps involved in developing the checklist used by the observer. The first step is to identify critical safety-related behaviors. This can be accomplished through analysis of incident reports, interviews with workers, worker observations, and reviews of procedures manuals. In this study, the HFACS survey provided this information. Next, the safety-related behaviors must be clearly defined in terms of what constitutes safe performance of a task. A clear standard of safe performance will increase the reliability of the observations since the observers will know exactly what is considered safe and unsafe behavior. While the FAA has specified when to complete a clearing turn in various publications (Federal Aviation Administration, 1983, 2003, 2014), there are no specific criteria provided regarding how to perform a clearing turn (degrees of heading change, bank, etc.), nor does the flight program involved in this study provide guidance, only that it must be completed prior to beginning all maneuvers. Therefore, a performance objective for clearing turns was created that was clear, measurable, and repeatable (Federal Aviation Administration, 2008). It included a description of exactly how many degrees of heading change and in what direction to turn when completing clearing turns. Once this was complete, the final step was to prepare an observation checklist for use by the observers.

It is important to use positive terminology in the checklist (Krause et al., 1990; Loafmann, 1998; McSween, 2003). The checklist should focus on the number of safe practices and avoid negative terms such as unsafe. This helps to ensure that everyone is clear with respect to those safe practices that are targeted, and employees become more inclined to accept the program rather than the traditional negative approach. Once the checklist is complete, it should be reviewed by all employees for accuracy, completeness, and clarity before it is implemented by the observation team.

This checklist was used by the participants in the experimental and control groups to record the safe practices that occurred during flight. It was comprised of the desired safe practice, which is clearing turn use, and columns for marking safe practices, concerns, and comments (see Appendices C and D). The percentage of safe behaviors was then calculated by dividing the number of safe observations by the total number of observations. Several blanks were provided in the checklist to allow students and instructors sufficient space to add any additional behaviors that they would like to improve, independent of the research questions. During data collection, students were observed by their instructors on dual flights or through self-observation on solo flights, and the student’s use of clearing turns were recorded on the observation checklist. When the student completed a clearing turn prior to initiating a maneuver, it was marked in the “Number Safe” column, and failure to complete a clearing turn prior to starting a maneuver was marked in the “Number of Concerns” column. If the student forgot initially to perform a clearing turn, but then stopped before completing the next step in the procedure to perform the clearing turn, it was marked in the safe column. If the student had to be reminded to complete a clearing turn prior to completing the next step in the procedure, it was marked in the concern column. After each flight, the students in the experimental group received feedback on their individual performance through the calculation of their percent safe observations. They also received weekly feedback on their progress as a group through e-mail updates. This encouragement was to serve as the consequence for reinforcing the use of clearing turns. The intrinsic reward of experiencing improvement could lead to further efforts to use clearing turns. The effectiveness of BBS was evaluated through a visual analysis of the group’s change in cumulative percent safe score over the course of the study to determine if there was a significant increase. The experimental group’s percent safe was also compared to the control group to determine if BBS was related to the increase in clearing turn use, or if other factors or variables were affecting outcomes.

Observation checklists were provided to all the students of the instructors who participated in the pre-survey regardless of whether or not the student completed the pre-survey. For the experimental group, 21 students received checklists, 13 of which submitted data for at least one flight for a response rate of 62%. There were 12 students in the control group who received checklists, and seven provided at least one observation for a response rate of 54%. The observation period lasted 40 days, and data were recorded on 19 of those days. The experimental group completed approximately 94 training flights over the research period, and submitted 19 observation checklists (20%), and the control group flew 43 times and submitted 20 observation checklists (47%). The average number of flights per student was 7.2 for the experimental group and 6.1 for the control group. The average number of observation checklists submitted was 1.5 for the experimental group and 2.9 for the control group. For solo flights, none of the students in the experimental group completed observations while the students in the control group submitted nine observations. For dual flights, the instructors submitted 10 observations for the experimental group and five for the control group; observations were completed by both the instructor and student for six experimental group and four control group dual flights. There were five observations that did not denote who completed the observation checklist, three for the experimental group and two for the control group.

Data Collection

The data were collected through two sources: a pre- and post-survey concerning human factors and observation checklists (see Appendices A, B, C and D). With respect to the ABC’s of BBS, the surveys examined the antecedents to the behavior being observed, while the observation checklists served as the consequences to change the behavior. Each student and instructor was assigned a unique number which was used on both instruments to facilitate tracking and comparison and allow for confidentiality of the participants. The HFACS surveys were used to find potential weaknesses in the system that may need to be addressed by BBS. They also provided information on whether BBS reduced the gap between procedure and practice. The surveys were distributed through the Qualtrics web-based survey software to the control and experimental groups. The participants were contacted through an e-mail message that included a cover letter with a link to the survey (see Appendices E and F). The cover letter emphasized the importance of the study to encourage responses, and requested that the participants complete the survey by the deadline date. If the survey was not completed within the specified time frame, a follow-up e-mail was sent.

The BBS observer checklist (see Appendix C) was used by the instructors and students of the experimental group to facilitate daily feedback, or if the students were on a solo flight, they completed the checklist after their flight to evaluate their performance. Daily feedback is critical to the effectiveness of BBS since it aids in identifying obstacles to safe behaviors and assists in developing and reinforcing safe behaviors (Loafmann, 1997). These data were collected on each dual and solo flight for six weeks. The instructors and students in the control group completed a checklist that simply recorded the number of clearing turns without using it for feedback (see Appendix D).

There were some limitations to the data collection plan. According to Ary, Jacobs, and Sorensen (2010), a potential problem of internal validity is experimenter effects. In previous studies of BBS, the fact that the subjects were being observed had some effect on the increase in safe behaviors; however, over time, there was still a significant increase in safe behaviors. Additionally, since the students in the program work one-on-one with their instructors in the aircraft, they were accustomed to being observed and critiqued. Therefore, the use of a checklist during flight lessons was a concrete method to measure their improvement. The self-observations conducted by the students could be subject to bias; although, there was emerging research that indicated that this was an effective strategy for promoting safety for employees who are working alone (Olson & Austin, 2006). Another factor that could impact internal validity is testing (Gall et al., 2007). It is possible that the pre-survey could affect the results of both the post-survey and observation checklists. The data collected from the surveys were also subject to issues with self-reporting of clearing turn improvement; however, some of the inaccuracies should have been eliminated by the daily feedback on the correct use of clearing turns from the observation checklists. There was also the possibility that there were responses perceived to be socially acceptable. Since the survey was voluntary, it was assumed that those who participated in the survey were similar to those who chose not to participate. Further, the online data collection methods for the survey may have produced low response rates.

Data Analysis

The data collected from the surveys were analyzed with SPSS software to provide percentages, means, and standard deviations. Two types of statistical significance tests were performed on the pre-and post-survey data for each group: an unpaired, two tailed t-test and Fisher's exact test. These tests were performed at a 95% confidence interval with significance at the $p < .05$ level. The unpaired t-test was chosen because pairing individual responses was inhibited by high non-response rates on the post-survey in the experimental student group, which would have necessitated discarding a large part of the data. Prior to conducting the t-test, the data were examined for normality and equality of variances (Gall et al., 2007). The data were found to be normally distributed through analysis of the QQ Plots and histograms. The equality of variances (or homogeneity) was determined through Levene's Test in SPSS, and all items produced a p-value of greater than .05 (i.e. equal variances) with the exception of Item 6 for the student control group's pre- and post-survey comparison. This item had a variance p-value of .000, indicating that the variances were not equal; therefore, the t-test p-value was adjusted accordingly through SPSS.

Due to the large percentage of missing data from the experimental group on the post survey, an attempt was made to adjust for the non-response bias that could impact the study's results through a procedure suggested by Miller and Smith (1983). A comparison of the characteristics of the respondents to the non-respondents was made to determine if the two groups were similar, and if so, it could be assumed that those who did not respond would have given the same responses as those who did complete the post-survey. After examining various aspects of the two groups, it was determined that they were dissimilar; therefore, bias may have been introduced into the survey results, which could limit their generalizability.

For the survey, a t-test was performed on items 1,3, 4, 5, 6, 7, 8, and 9 which allowed for the comparison of means between the two groups to determine if there was a significant difference between pre- and post-survey data (Gall et al., 2007). Items 5, 6, 7, 8, and 9 were negatively worded items, and their values were reverse coded to allow the human factors to be ranked to answer the first part of Research Question 1. For items 2, 10, and 11, which involved proportions, Fisher's exact test was performed to determine the p-values. This test is generally used when the sample sizes are small, as was the case with this study. The program used for Fisher's exact test was R, a statistical programming language. The results of both tests were then described further through written interpretation. The responses to the open-ended question were categorized and coded before being evaluated and interpreted.

The observation checklist was used to determine if there was an increase in the use of clearing turns. The percentage of safe behaviors was calculated by dividing the number of clearing turns performed by the total number of observations (i.e., maneuvers) for each lesson that data were collected. The cumulative percentage of safe behaviors was calculated for each day, graphically depicted, and examined visually to determine if there was a change in the number of clearing turns that were performed, as the small number of data points prohibited statistical analysis. The effectiveness of the BBS program was determined, accordingly.

CHAPTER 4: FINDINGS

This chapter presents the findings from the pre- and post-survey and observation checklists. The data from the pre-survey were used to answer the first part of the research question related to which human factors are causing the discrepancies between procedures and practice with respect to clearing turns. The data from the pre- and post-survey were used to answer the research question related to determining if those discrepancies were reduced through the implementation of BBS. The means of the pre- and post-survey were evaluated at the $p < .05$ level of significance. The final research question as to whether or not there was a significant increase in the utilization of clearing turns prior to initiating training maneuvers by students in the flight program after the implementation of BBS was answered by the observation checklist. The Likert responses for items 5, 7, 8, and 9 were 1 = Strongly Disagree, 2 = Disagree, 3 = Undecided, 4 = Agree, and 5 = Strongly Agree. For the items that involved the frequency that a particular event occurred (items 1, 3, 4, and 6), the responses were coded as 1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Most of the Time, and 5 = Always. The means of the control and experimental groups were also examined to determine if there were any significant differences ($p < .05$) between the two groups at the beginning and conclusion of the study.

For the observation checklists, the daily percent safe was calculated for each group by taking the number of clearing turns completed by each student per day divided by the number of maneuvers or observations that were taken on that day. The cumulative percent safe was calculated for each date by dividing the total number of clearing turns by the total number of observations up to that date. This section examines the findings of the pre-survey, post-survey, and observation checklists in relation to their respective research questions; see Table 7 for a summary of the results for both surveys.

Research Question 1, part 1: *Which human factors are causing the discrepancies between procedures and practice with respect to clearing turns?*

The combined results of the HFACS pre-survey for the instructor (n = 13) and student groups (n = 26) were examined for this research question (see Tables 5 and 6). The pre-survey indicated that there were several human factors that interfered with clearing turn use. For the instructors, planned inappropriate operations was the first ranked reason clearing turns were not being completed (M = 2.92, SD 1.04), indicating that instructors believed that there were too many maneuvers in a lesson to perform both clearing turns and maneuvers within a single flight period. The second ranked factor was routine violations (M = 3.62, SD = .51), which assumed that not performing clearing turns is an accepted practice, and was evident in that students were performing clearing turns from sometimes to most of the time. The third ranked factors included failure to correct problem, where the instructors did not correct their students if they did not perform clearing turns (M = 3.62, SD = 1.03), and resource management, which involves completing the lesson within a specified time frame (M = 3.62, SD = .95).

Table 5

Instructor Pre-survey Ranking of Human Factors

Item #	Ranking	Human factor	Mean	SD
7	1	Planned inappropriate operations	2.92	1.04
1	2	Routine violations	3.62	0.51
4	3	Failure to correct problem	3.69	1.03
8	3	Resource management	3.69	0.95
3	4	Inadequate supervision	4.00	0.71
5	5	Organizational climate	4.08	0.86
9	6	Physical environment	4.38	0.51
6	7	Crew resource management	4.69	0.48
			%	
2.1	1	Skill-based errors	69.2	
2.2	2	Supervisory violations	61.5	
2.3	3	Organizational process	46.2	
2.8	4	Other	23.1	
2.5	5	Technological environment	7.7	
2.4	6	Decision errors	0	
2.6	7	Adverse mental state	0	
2.7	8	Organizational climate	0	
10		FAA organizational process		
	1	Yes	38.5	
	2	No	30.8	
	2	Not sure	30.8	
11		Flight program organizational process		
	1	No	69.2	
	2	Yes	15.4	
	2	Not sure	15.4	

On the student pre-survey, the number one factors of concern were planned inappropriate operations (M = 3.46, SD = .99), where program managers are overloading students with tasks, and resource management (M = 3.46, SD = 1.03), where production is valued over safety. All the participants believed that there were too many maneuvers

Table 6

Student Pre-survey Ranking of Human Factors

Item #	Ranking	Human factor	Mean	SD
7	1	Planned inappropriate operations	3.46	0.99
8	1	Resource management	3.46	1.03
9	2	Physical environment	3.58	0.95
1	3	Routine violations	3.85	0.61
4	4	Failure to correct problem	4.00	1.06
3	5	Inadequate supervision	4.04	0.77
5	6	Organizational climate	4.19	1.02
6	7	Crew resource management	4.92	0.27
			%	
2.1	1	Skill-based errors	65.4	
2.2	2	Supervisory violations	26.9	
2.5	3	Technological environment	19.2	
2.3	4	Organizational process	15.4	
2.8	4	Other	15.4	
2.4	5	Decision errors	3.8	
2.6	5	Adverse mental state	3.8	
2.7	6	Organizational climate	0	
10		FAA organizational process		
	1	Not sure	61.5	
	2	Yes	30.8	
	3	No	7.7	
11		Flight program organizational process		
	1	Yes	57.7	
	2	Not sure	38.5	
	3	No	3.8	

to complete a lesson and were willing to omit clearing turns so that the lesson could be completed. The third ranked factor was the physical environment (M = 3.58, SD = .95), indicating that the students were more likely to omit a clearing turn if the weather was such that traffic would be easier to see. The fourth ranked factor was routine violations with a mean of 3.85 and SD of .61, where not doing clearing turns is accepted practice.

The factor organizational process involved procedures created by the FAA and the flight program that provide guidance to students and instructors regarding how to perform a clearing turn. Although there are no set procedures regarding how to perform a clearing turn by either organization, the majority of instructors and students responded “yes” and “not sure” with the exception of the students’ responses for flight program organizational process, where the majority of the students responded “no”. This means that this factor is an area of concern as the majority of instructors and students assumed there were procedures in place when there were not, or were uncertain as to whether or not there was a procedure.

Item 2 on the pre-survey had participants choose those factors that were reasons clearing turns were not completed. The HFACS category skill-based errors, which involve omitting steps in a procedure and negative habits, had the largest percentage of responses for both students and instructors at 65.4% and 69.2%, respectively. The students were generally more likely to forget or omit the first step of the procedures, clearing turn, than all of the other factors in this item. Supervisory violations, which are a violation of established procedures, were the second most selected item for the students (26.9%) and instructors (61.5%). The instructors were highly likely to tell their students not to perform a clearing turn, despite the fact that it was part of the flight program’s procedures to do so. The effects of organizational processes, which involve requirements to complete all the maneuvers in a flight period (quotas) and time pressure, was the third most selected item for the instructors (46.2%), and the fourth most selected item for the students (15.4%). This suggests that there was pressure apparent to get the maneuvers completed in one flight period, so clearing turns were omitted to achieve this goal. For the students, the technological environment, or relying on the traffic system in the aircraft was ranked third (19.2%), even though it had limitations.

For the open-ended item labeled “other, please describe” in Item 2, three instructors provided written responses. The responses included:

1. “If they have just done a maneuver with significant heading change and are looking outside properly, we should have seen the traffic already.”
2. “Sometimes during the previous maneuver we clear the area. For example, after steep turns I will go into the stall. This helps efficiency. However, I probably should do them every time.”
3. “If we are doing stalls, I usually won’t have them do a clearing turn between each individual stall since our heading hasn’t changed for the most part.”

The common theme with these responses was that sometimes a maneuver was substituted for a clearing turn, even though the two are not interchangeable. This is a type of procedural error, which is when the pilot applies a procedure that is not appropriate for the situation. It is also related to organizational process, since the procedure for conducting a clearing turn is not defined by the flight program, the pilots developed an alternate procedure for the situation. With respect to the student survey, four students provided responses to “other, please describe”. Their statements included:

1. “I feel that the area is already clear.”
2. “There haven’t been any planes around us.”
3. “We checked the area visually.”

4. “I do clearing turns every time.”

The first two responses involve an adverse mental state, which is comprised of complacency and overconfidence. Similar to the instructors, the third response is related to procedural error and organizational process. The last response was written since there was no option for students who always do clearing turns.

Research Question 1, Part 2: *Are the discrepancies reduced through the implementation of BBS?*

This part of the research question was answered through analyzing the pre- and post-survey responses. It was determined that there was no significant change ($p < .05$) for the instructors and students, either positive or negative, between the means of the pre- and post-survey responses for all items (see Table 7). P-values were also calculated comparing the responses of the control and experimental groups for each survey and were evaluated at the $p < .05$ level of significance. The groups were largely equivalent at the beginning and end of the study except for two items. For the instructors, item four, which concerned the HFACS area of failure to correct problem, was the only test that was significant, $t(10) = 3.54$, $d = 2.07$, 95% CI [.63, 2.75], when comparing the post-surveys of the control and experimental instructors ($p = .005$). The experimental group instructors were less likely to correct their students if they forgot to perform a clearing turn after receiving BBS training than the control group instructors who received no training. For the students, the choice “I forget” on item 2 was significant ($p = .046$, 95% CI [.02, 1.21]), on the pre-survey, possibly indicating that the students in the experimental group were more likely to forget clearing turns than the students in the control group prior to treatment; however, this difference diminished on the post-survey ($p = .569$).

Table 7

Aggregate Survey Results

		Instructors			Students		
		Cont.	Exp.	p	Cont.	Exp.	p
1. How often do (does) you (your student) do a clearing turn before a maneuver? *[Routine violations]*							
Pre-Survey	M	3.57	3.67	.751	3.80	3.88	.768
	(SD)	(.535)	(.516)		(.422)	(.719)	
Post-Survey	M	4.14	3.40	.074	3.88	4.00	.758
	(SD)	(.690)	(.548)		(.835)	(.756)	
	p	.109	.428		.807	.697	
2. What are some of the reasons that you (your student) don't (doesn't) do clearing turns?							
•I (they) forget. *[Skill-based errors]*							
Pre-Survey %		42.9	100.0	.070	40.0	81.3	**.046**
Post-Survey %		71.4	100.0	.470	87.5	62.5	.569
	p	.592	1.0		.066	.362	
•My instructor (I) told me (them) not to. *[Supervisory violations]*							
Pre-Survey %		57.1	66.7	1.0	30.0	25.0	1.0
Post-Survey %		57.1	60.0	1.0	37.5	12.5	.569
	p	1.0	1.0		1.0	.631	
•They take time away from getting the lesson done. *[Organizational process]*							
Pre-Survey %		28.6	66.7	.242	10.0	18.8	1.0
Post-Survey %		28.6	80.0	.286	0.0	25.0	.467
	p	1.0	1.0		1.0	1.0	

	Instructors			Students		
	Cont.	Exp.	p	Cont.	Exp.	p
•They are not part of the procedures for the maneuver *[Decision errors]*						
Pre-Survey %	0.0	0.0	1.0	10.0	0.0	1.0
Post-Survey %	0.0	0.0	1.0	12.5	0.0	1.0
p	1.0	1.0		1.0	1.0	
•The traffic system will alert me (us) to other aircraft in the area. *[Technological environment]*						
Pre-Survey %	14.3	0.0	1.0	10.0	25.0	.617
Post-Survey %	0.0	0.0	1.0	12.5	0.0	1.0
p	1.0	1.0		1.0	.262	
•The chances of me (us) hitting another plane are slim. *[Adverse mental state]*						
Pre-Survey %	0.0	0.0	1.0	0.0	6.3	1.0
Post-Survey %	0.0	0.0	1.0	0.0	12.5	1.0
p	1.0	1.0		1.0	1.0	
•They are not important *[Organizational climate]*						
Pre-Survey %	0.0	0.0	1.0	0.0	0.0	1.0
Post-Survey %	0.0	0.0	1.0	0.0	0.0	1.0
p	1.0	1.0		1.0	1.0	
•Other						
Pre-Survey %	28.6	16.7	NA	30.0	6.3	NA
Post-Survey %	14.3	0.0	NA	12.5	0.0	NA
p	NA	NA		NA	NA	

			Instructors			Students		
			Cont.	Exp.	p	Cont.	Exp.	p
3. My instructor (I) makes sure that I (my student) complete(s) clearing turns before beginning a maneuver. *[Inadequate supervision]*								
	Pre-Survey	M	4.00	4.00	1.00	3.90	4.13	.482
		(SD)	(.816)	(.632)		(.738)	(.806)	
	Post-Survey	M	4.00	3.60	.255	3.88	3.88	1.00
		(SD)	(.577)	(.548)		(1.25)	(.835)	
		p	1.00	.297		.958	.486	
4. My instructor (I) corrects me (my student) if I (he/she) do (does) not complete a clearing turn before a maneuver. *[Failure to correct problem]*								
	Pre-Survey	M	3.86	3.50	.557	4.00	4.00	1.00
		(SD)	(.690)	(1.38)		(1.25)	(.966)	
	Post-Survey	M	4.29	2.60	***.005***	3.88	4.13	.664
		(SD)	(.488)	(1.14)		(1.36)	(.835)	
		p	.205	.275		.841	.758	
5. My instructor (I) does (do) not think clearing turns are important. *[Organizational climate]*								
	Pre-Survey	M	2.00	1.83	.744	1.60	1.94	.423
		(SD)	(.577)	(1.17)		(.699)	(1.81)	
	Post-Survey	M	1.57	1.60	.930	2.13	1.75	.579
		(SD)	(.535)	(.548)		(1.25)	(1.39)	
		p	.175	.693		.274	.733	

			Instructors			Students		
			Cont.	Exp.	p	Cont.	Exp.	p
6. When I (my student) try (tries) to do a clearing turn, my instructor (I) discourages (discourage) it. *[Crew resource management]*								
	Pre-Survey	M	1.29	1.33	.867	1.00	1.13	.262
		(SD)	(.488)	(.516)		(.00)	(.342)	
	Post-Survey	M	1.29	1.40	.711	1.25	1.25	1.00
		(SD)	(.488)	(.548)		(.463)	(.707)	
		p	1.00	.840		.170^	.561	
7. There are too many maneuvers in a lesson to do clearing turns and complete the lesson. *[Planned inappropriate operations]*								
	Pre-Survey	M	3.14	3.00	.817	2.70	2.44	.521
		(SD)	(.900)	(1.27)		(.823)	(1.09)	
	Post-Survey	M	2.86	3.40	.326	2.38	3.00	.230
		(SD)	(1.06)	(.548)		(.518)	(1.31)	
		p	.598	.530		.346	.277	
8. It is acceptable to not do a clearing turn if the lesson can be completed. *[Resource management]*								
	Pre-Survey	M	2.29	2.33	.933	2.70	2.44	.538
		(SD)	(.756)	(1.21)		(1.16)	(.964)	
	Post-Survey	M	3.00	3.20	.749	2.25	2.50	.554
		(SD)	(.816)	(1.30)		(.707)	(.926)	
		p	.115	.283		.351	.881	

		Instructors			Students		
		Cont.	Exp.	p	Cont.	Exp.	p
9. I am less likely to do (have my student do) a clearing turn if the weather is nice. *[Physical environment]*							
Pre-Survey	M	1.71	1.50	.471	2.80	2.19	.109
	(SD)	(.488)	(.548)		(.919)	(.911)	
Post-Survey	M	1.86	2.40	.326	1.13	2.38	.346
	(SD)	(.690)	(1.14)		(.398)	(.916)	
	p	.663	.119		.878	.640	
10. The FAA provides specific guidance on how to conduct a clearing turn. *[Organizational process]*							
	•Yes						
	Pre-Survey %	42.9	33.3	1.0	30.0	31.3	1.0
	Post-Survey %	28.6	20.0	1.0	62.5	37.5	.619
	p	1.0	1.0		.341	1.0	
	•No						
	Pre-Survey %	42.9	16.7	.559	10.0	6.3	1.0
	Post-Survey %	57.1	80.0	.578	25.0	0.0	.466
	p	1.0	.080		.559	1.0	
	•Not Sure						
	Pre-Survey %	14.3	50.0	.266	60.0	62.5	1.0
	Post-Survey %	14.3	0.0	1.0	12.5	62.5	.119
	p	1.0	.182		.066	1.0	

	Instructors			Students		
	Cont.	Exp.	p	Cont.	Exp.	p
11. The flight program provides specific guidance on how to conduct a clearing turn. *[Organizational process]*						
•Yes						
Pre-Survey %	28.6	0.0		50.0	62.5	.689
Post-Survey %	28.6	20.0		50.0	37.5	1.0
p	1.0	.455		1.00	.391	
•No						
Pre-Survey %	71.4	66.7		0.0	6.3	1.0
Post-Survey %	57.1	40.0		37.5	25.0	1.0
p	1.0	.567		.069	.249	
•Not Sure						
Pre-Survey %	0.0	33.3		50.0	31.3	.425
Post-Survey %	14.3	40.0		12.5	37.5	.569
p	1.0	1.0		.152	1.0	

Note. Boldface indicates a p-value that is significant at the $p < .05$ level. The ^ indicates a p-value that has been adjusted for unequal variances.

Research Question 2: *Is there a significant increase in the utilization of clearing turns prior to initiating training maneuvers by students in the flight program after BBS implementation?*

The results of the observation checklist are presented in Figure 6. The control group performed a consistently higher percentage of clearing turns each day than the experimental group. The cumulative percentages for each group remained fairly stable over time with neither group improving or decreasing their clearing turn use during the observation period. Aside from the first day of observations, the cumulative percentage for each group did not vary much more than 5%. The control group completed clearing turns on 70% to 75% of the maneuvers, while the experimental group was slightly lower in clearing turn completion at 65% to 70%. The BBS neither positively nor negatively affected clearing turn use prior to initiating training maneuvers.

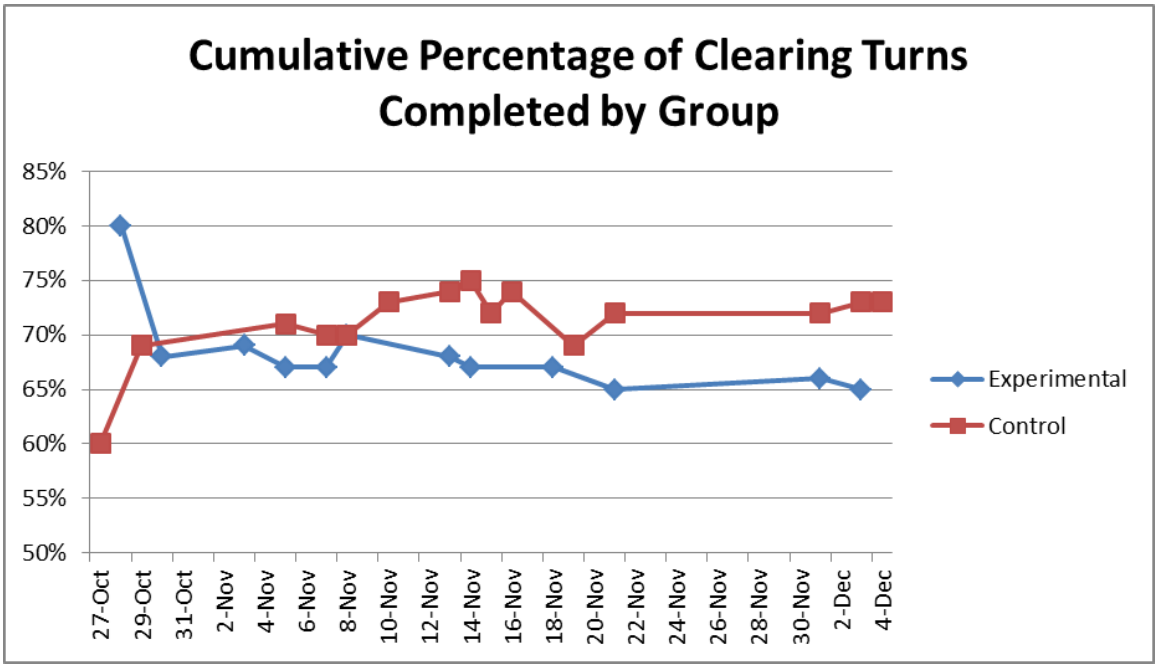

Figure 6. Cumulative Percent of Clearing Turns Completed by Group

The observation checklists included an area for comments. The comments from the experimental group included: “both concerns were ground reference maneuvers”, “used prior maneuvers as clearing turns, had limited time for all maneuvers”, “used steep turn as a clearing turn”, “used a maneuver as a clearing turn”, and “not enough time in slot/lesson to complete all turns”. The comments from the control group included: “no clearing turns immediately after steep turns”, “we did steep turns twice, no clearing turns”, “forgot twice – stopped maneuver and did turn before starting maneuver”, “did clearing turns before all maneuvers”, and “not enough time in dual review lesson to do clearing turns”. The general themes of the responses for the experimental group were:

1. Using a maneuver as a clearing turn (3)
2. Not enough time to perform clearing turns and maneuvers (2)
3. Not performing clearing turn before a specific type of maneuver (1)

For the control group, the general themes were:

1. Not performing a clearing turn before a specific type of maneuver (2)
2. Not enough time to perform clearing turns and maneuvers (1)
3. Forgetting (1)
4. Clearing turns completed before each maneuver (1)

These comments were all similar in nature to the findings from the HFACS surveys in that procedural errors, organizational process, and skill-based errors were cited as reasons for not completing clearing turns during a flight lesson.

In summary, this chapter examined the findings of the pre- and post-survey for instructors and students, and the data from the observation checklists. It was determined that there were several human factors areas that were interfering with clearing turn usage.

Upon examining the HFACS survey, there were no significant changes in the responses of the control and experimental groups when comparing the pre- and post-surveys. There were some significant differences between the groups on a few items, namely the instructor post-survey item 4 and the student pre-survey Item 2. The observation checklists did not reveal any changes in the percentage of clearing turns completed for either group in the study.

CHAPTER 5: CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

The purpose of this study was to determine if BBS could effectively motivate students to complete a clearing turn prior to every training maneuver. The objectives of this study, therefore, included: (1) Identify those human factors that cause the discrepancies between procedures and practice with respect to clearing turns, and if those discrepancies are reduced through the implementation of BBS and (2) Determine if there is a significant increase in the frequency of clearing turns completed by students in the flight program when BBS is implemented into flight training. The research questions that were posited to achieve these objectives included: (1) Which human factors are causing the discrepancies between procedures and practice with respect to clearing turns, and are those discrepancies reduced through the implementation of BBS? and (2) Is there a significant increase in the utilization of clearing turns prior to initiating training maneuvers by students in the flight program after BBS implementation.

Conclusions

Midair collisions were the ninth leading cause of fatalities in general aviation between 2001 and 2011 (Federal Aviation Administration, 2012); failure to see and avoid is the most commonly stated cause of these accidents. Although flight training accounts for an eighth of the total flying in general aviation, nearly one-third of midair collisions occur during instructional flights (Aircraft Owners and Pilots Association, 2010); therefore, it is important that students and instructors adequately clear the area of traffic to decrease the potential of a midair collision. However, according to the data gathered in this study, clearing turns were omitted from sometimes to most of the time by the participants, a fact that was also confirmed by the observation checklist, which revealed that students were on average only completing clearing turns 70% of the time. The findings from the pre-survey indicate that there are many human factors that could be responsible for this occurrence.

The instructor pre-survey found those human factors that had the greatest impact on clearing turn use were planned inappropriate actions and skill-based errors. The instructors believed that it was difficult to complete both clearing turns and the maneuvers in the lesson during one period The instructors also felt that they did not have enough time to complete clearing turns, which is related to the fact that there were too many maneuvers in each lesson. These are factors that must be rectified at the organizational and supervisory level. This could have also lead to the instructors failing to correct their students if they forgot to initiate a clearing turn and telling them not to complete a clearing turn. The fact that students forget to initiate clearing turns may be due to students who are new to flight training, and can potentially be improved by further training and familiarization with the flight program’s procedures.

Similar human factors were found when examining the student responses to the pre-survey. Like their instructors, the students believed that there were too many maneuvers to complete in one flight period, and that there was pressure to complete the lesson. They also noted that their instructor would tell them not to complete a clearing turn, presumably to make more time for maneuvers. These are related to organizational influences and unsafe supervision. The students tended to forget to complete a clearing turn, and were less likely to initiate a clearing turn when the weather was such that traffic would be easier to see.

The observation checklists indicated that there was no improvement in clearing turn use for the experimental group after the implementation of BBS, and clearing turn use remained fairly stable over time for both groups. This may be due to several different factors. The observations provided by both groups were low in number and sporadic over the duration of the study. This could have led to difficulties in determining a trend, and since consistent feedback is crucial to behavioral change, it could have also impacted the effectiveness of BBS. Another possible reason for the lack of change is that the policies established by the flight program (i.e. lesson requirements to complete a certain number of maneuvers) may not have allowed for improvements in this area. Also, more thorough training in BBS could have been provided to the experimental group to increase the effectiveness of the training. Another factor that could have been involved was the weather at the time of the study, which limited available training times and increased pressure to complete the course before the end of the semester. It also limited the opportunities to reinforce clearing turn behaviors. The participants may have also been concerned with maximizing the amount of time spent practicing and perfecting maneuvers since flight time is costly; therefore, they could have omitted clearing turns. Lastly, there were several remarks on both the surveys and observation checklists that indicated maneuvers were occasionally used in lieu of clearing turns. To alleviate this human factor, the FAA and flight program should provide more guidance as to what constitutes a clearing turn and ensure that pilots are knowledgeable with respect to the criteria.

Implications

This study has revealed several human factors areas that were preventing students from performing clearing turns. It is also clear that while the FAA and flight program suggest performing clearing turns prior to every maneuver, students and instructors are not completing them 100% of the time. Accordingly, there are several implications for policy, practice, and future research.

The human factors that were causing instructors and students to omit clearing turns were primarily caused by the flight program's policies that created pressure to complete a lesson at the expense of clearing turns. This pressure was evident in instructors telling students to omit clearing turns and placing lesson completion above clearing turns. This would indicate that the flight program should review its flight lessons and take steps to ensure that an environment is created that would allow time for clearing turns.

With respect to implications for practice, flight training organizations should closely examine the human factors that may be preventing the use of clearing turns. This would allow for effective targeting of practices that would help alleviate these factors. Instructors are an important key to ensuring good habits in their students, as evidenced by the influence they exhibit on their student's clearing turn use. Therefore, it is crucial that instructors are properly guiding their students during flight training.

There are also several implications for future research. While this study did not show BBS to be effective in reducing human factors or increasing safe behavior regarding clearing turns, additional research should be conducted within the flight training environment to determine if it has the potential to do so when implemented properly, consistently, and over a longer period of time. Another implication for research is the use of HFACS as a way of identifying the human factors areas that need focus by an organization to improve safety. While designed originally to provide systematic procedures for analyzing accidents, the HFACS model was effective in identifying the human factors that were causing pilots to omit clearing turns when used in a survey format. Future research should focus on this use of HFACS.

In summary, students are not executing clearing turns to the level specified by the FAA and flight program due to pressure to complete lessons in a timely manner. There is a need to revisit each lesson to ensure that there is enough time to complete clearing turns before every maneuver. This can help reduce the potential of a midair collision.

Recommendations

This study, like most studies, had some limitations. The population selected (i.e. students in a four-year Part 141 training program within a large research institution) and small sample size limit the generalizability of the results. There were also low participation rates on the surveys and observation checklists, in addition to a high non-response rate of 50% for the students in the experimental group on the post-survey, all of which may have affected the study’s findings and conclusions. However, there were some key recommendations for policy, practice, and future research that arose from this study.

Recommendations for policy:

1. Flight training organizations and the FAA should clearly define what constitutes a clearing turn so that there is no question as to which procedure pilots should follow. This would also alleviate issues where pilots use different procedures that do not technically meet the definition of a clearing turn.
2. Adequate training in collision avoidance should be provided to flight instructors so that they can model appropriate and safe habits and transfer them to their students.
3. Flight training organizations should verify that the time needed to practice the maneuvers in each flight lesson can be accomplished within a flight period such that clearing turns are not compromised.

Recommendations for practice:

1. Flight training organizations should use the HFACS model in a proactive manner to determine the factors that could cause unsafe behaviors. An example of this type of practice could include distributing surveys to instructors and students to determine the safety issues within an organization.
2. Instructors should determine the reasons why their students are forgetting clearing turns and develop strategies to remember them.

Recommendations for future research:

1. Studies should be conducted over a longer period of time to determine the broader effects of BBS since previous research has reported that the benefits require time to be manifested. This study occurred during months where the weather was not conducive to students flying routinely, and the gaps between flight lessons could have resulted in BBS not being as effective as it potentially could have been.
2. Ensure that the human factors that are related to policies established by the training organization are eliminated prior to implementing BBS. Because this was not accomplished, it was most likely difficult for students and instructors to overcome these organizational influences to improve their clearing turn use. This would allow BBS to be more effective in changing the factors related to individual influences.
3. Due to the small sample size, it was difficult to determine statistically if BBS had an effect on the antecedents and consequences of clearing turn use; therefore, future research should attempt to increase the number of participants and improve the response rates on the surveys and observation checklists. The primary means of recruiting students and instructors for their participation in this study was a food incentive. Perhaps including in the recruitment materials a statement describing how the study will directly benefit the participants in their development as a professional pilot may have encouraged more participation. While this study did not do so, it is important to follow-up with the students and instructors who did not

complete the study through some form of interview to determine the reasons why. This information can be used to create incentives that would be effective in encouraging continued participation. Another method to increase the sample size would be to collaborate with other flight training organizations that have similar characteristics.

4. Since this was a longitudinal study, there were issues with attrition. Future research should attempt to correct for non-response immediately following the conclusion of the study. Additional reminders could be sent to increase the survey response rate. If this is unsuccessful, Miller and Smith (1983) offer several different ways to control for non-response error that may be helpful to researchers, including comparing the respondents to the population, respondents to non-respondents, early to late respondents, and double-dipping non-respondents.
5. Implement a procedure that verifies that the participants actually watched the training video. BBS is not effective when participants are not well trained (DePasquale & Geller, 1999). It is also not effective when implemented incorrectly. These could be reasons why there was no significant change in the experimental group's performance.
6. Different methods of recording clearing turn use should be explored in future research, since self-reporting the number of clearing turns may not have produced accurate results. If the aircraft are equipped with GPS that record the aircraft's flight path, the ground track could be examined for evidence of clearing turns. Another alternative could include installing

video cameras in the aircraft to observe clearing turn use. In lieu of recording, the researcher could personally observe the training flights without revealing to the participants the nature of the observations. It also may be possible to conduct this study in a simulator that utilizes visuals with the capability of introducing other aircraft as a collision hazard to encourage participants to clear the area.

7. The training provided to the participants should cover the limitations of any traffic systems that are installed in the aircraft. This could help participants understand how to correctly use the traffic system and help increase the importance of clearing turns.
8. While this study focused on a Part 141 flight program, future research could be conducted in a Part 61 program, or compare the two types of programs to ascertain if there are any differences in human factors and clearing turn performance after implementing BBS.
9. The survey item concerning whether the FAA and the flight program specified procedures for clearing turns should be revised to include a space for participants to describe the procedure, so that it can be determined what they believe the procedure to be.
10. Future research should include more opportunities for students and instructors to interact with each other to facilitate peer encouragement towards safe behavior.

In summary, it is important that flight training organizations continuously evaluate the human factors that could be preventing safe behaviors. The HFACS model can be used to create a survey specific to the areas of concern to ensure that all human factors are examined. This type of proactive approach could assist in preventing accidents. While BBS was not shown to be effective in this study due to various limitations, it has the potential to be effective in reducing unsafe behaviors; therefore, it may be worthwhile for flight training organizations to pursue its use in the future.

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APPENDICES

Appendix A

HFACS Student Survey

INSTRUCTIONS: Please read the following questions and choose the response that most closely reflects how you perform clearing turns while you are training in university aircraft. Your responses will be completely anonymous, so please be honest in your responses. NOTE: The following questions refer to this semester only.

1. How often do you do a clearing turn before a maneuver?	
☐	Always
☐	Most of the time
☐	Sometimes
☐	Rarely
☐	Never
2. What are some of the reasons you don't do clearing turns? Check all that apply.	
☐	I forget.
☐	My instructor told me not to.
☐	They take time away from getting the lesson done.
☐	They are not part of the procedures for the manuever.
☐	The traffic system will alert me to other aircraft in the area.
☐	The chances of me hitting another plane are slim.
☐	They are not important.
☐	Other, please describe:
3. My instructor makes sure that I complete clearing turns before beginning a maneuver.	
☐	Always
☐	Most of the time
☐	Sometimes
☐	Rarely
☐	Never
4. My instructor corrects me if I do not compete a clearing turn before a maneuver.	
☐	Always
☐	Most of the time
☐	Sometimes
☐	Rarely
☐	Never

5. My instructor does not think clearing turns are important.	
☐	Strongly Agree
☐	Agree
☐	Undecided
☐	Disagree
☐	Strongly Disagree
6. When I try to do a clearing turn, my instructor discourages it.	
☐	Always
☐	Most of the time
☐	Sometimes
☐	Rarely
☐	Never
7. There are too many maneuvers in a lesson to do clearing turns and complete the lesson	
☐	Strongly Agree
☐	Agree
☐	Undecided
☐	Disagree
☐	Strongly Disagree
8. It is acceptable to not do a clearing turn if the lesson can be completed.	
☐	Strongly Agree
☐	Agree
☐	Undecided
☐	Disagree
☐	Strongly Disagree
9. I am less likely to do a clearing turn if the weather is nice.	
☐	Strongly Agree
☐	Agree
☐	Undecided
☐	Disagree
☐	Strongly Disagree
10. The FAA provides specific guidance on how to conduct a clearing turn (how much heading change, amount of bank, etc.)	
☐	Yes
☐	No
☐	Not sure
11. The flight program (i.e. procedures manual, training) provides specific guidance on how to conduct a clearing turn (how much heading change, amount of bank, etc.)	
☐	Yes
☐	No
☐	Not sure

12. Demographic Information	
What flight course are you currently enrolled in?	
☐	Private Pilot
☐	Commercial Pilot I
☐	Commercial Pilot II
☐	Commercial and Instrument
Approximately how many total flight hours do you currently have?	
☐	0-40
☐	41-100
☐	101-200
☐	201 or greater
What is your age?	
☐	18-21
☐	22-25
☐	26 and older
What is your gender?	
☐	Female
☐	Male

Appendix B

HFACS Instructor Survey

INSTRUCTIONS: Please read the following questions and choose the response that most closely reflects how you perform clearing turns while you are training in university aircraft. Your responses will be completely anonymous, so please be honest in your responses. NOTE: The following questions refer to this semester only.

1. How often do your students do a clearing turn before a maneuver?	
☐	Always
☐	Most of the time
☐	Sometimes
☐	Rarely
☐	Never
2. What are some of the reasons your students don’t do clearing turns? Check all that apply.	
☐	They forget.
☐	I tell them not to.
☐	They take time away from getting the lesson done.
☐	They are not part of the procedures for the manuever.
☐	The traffic system will alert me to other aircraft in the area.
☐	The chances of us hitting another plane are slim.
☐	They are not important.
☐	Other, please describe:
3. I make sure that my students complete clearing turns before beginning a maneuver.	
☐	Always
☐	Most of the time
☐	Sometimes
☐	Rarely
☐	Never
4. I correct my students if they do not compete a clearing turn before a maneuver.	
☐	Always
☐	Most of the time
☐	Sometimes
☐	Rarely
☐	Never

5. I do not think clearing turns are important.	
☐	Strongly Agree
☐	Agree
☐	Undecided
☐	Disagree
☐	Strongly Disagree
6. When my student tries to do a clearing turn, I discourage it.	
☐	Always
☐	Most of the time
☐	Sometimes
☐	Rarely
☐	Never
7. There are too many maneuvers in a lesson to do clearing turns and complete the lesson	
☐	Strongly Agree
☐	Agree
☐	Undecided
☐	Disagree
☐	Strongly Disagree
8. It is acceptable to not do a clearing turn if the lesson can be completed.	
☐	Strongly Agree
☐	Agree
☐	Undecided
☐	Disagree
☐	Strongly Disagree
9. I am less likely to have my student do a clearing turn if the weather is nice.	
☐	Strongly Agree
☐	Agree
☐	Undecided
☐	Disagree
☐	Strongly Disagree
10. The FAA provides specific guidance on how to conduct a clearing turn (how much heading change, amount of bank, etc.)	
☐	Yes
☐	No
☐	Not sure
11. The flight program (i.e. procedures manual, training) provides specific guidance on how to conduct a clearing turn (how much heading change, amount of bank, etc.)	
☐	Yes
☐	No
☐	Not sure

12. Demographic Information	
What flight instructor certificates do you currently possess? (Check all that apply)	
☐	CFI
☐	CFII
☐	MEI
☐	BGI
☐	AGI
☐	IGI
Approximately how many total flight hours do you have?	
☐	200-250
☐	251-500
☐	501-1000
☐	1000 or greater
Approximately how many hours of instruction have you given?	
☐	0-40
☐	41-100
☐	101-200
☐	201-500
☐	501-1000
☐	1001 or greater
Are you a:	
☐	Part-time flight instructor
☐	Full-time flight instructor
What is your age?	
☐	18-21
☐	22-25
☐	26 and older
What is your gender?	
☐	Female
☐	Male

Appendix C

Experimental Group Observer Checklist

To calculate % Safe: Take the total number safe divided by the total number of observations.

ID Number:	Completed by (circle one): Instructor / Student	Date:	Time:

Instructions: Record the number of times you observe each safety practice and the number of times you had a concern. Check the important positive practices you plan to recognize and the significant concerns you plan to discuss, if any. **Do not** record the names of persons.

Safety Practice	Number Safe	Number of Concerns	Comments (No Names)	% Safe
Clearing turn initiated prior to beginning maneuver				

Appendix D

Control Group Observer Checklist

ID Number:	Completed by (circle one): Instructor / Student	Date:	Time:

Instructions: Record the number of times a clearing turn was completed prior to beginning a maneuver and when it was not completed. **Do not** record the names of persons.

	Yes	No	Comments (No Names)
Clearing turn initiated prior to beginning maneuver			

Appendix E

Letter to Students

Dear Student,

I am conducting a study about clearing turn use in the flight department. Please take a few moments to complete the following survey. It will not take much of your time, less than 5 minutes, and your input will help you and future students become safer pilots. Please complete the survey by [date]. Your participation is voluntary and your responses will remain anonymous. You must be at least 18 years of age to participate in this survey.

Thank you for your time!

Sincerely,

Ronda Cassens, Aviation Continuing Lecturer, Safety Officer

765-494-1532

rcassens@purdue.edu

James Greenan, Committee Chair

765-494-7314

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Appendix F

Letter to Instructors

Dear Instructor,

I am conducting a study about clearing turn use in the flight department. Please take a few moments to complete the following survey. It will not take much of your time, less than 5 minutes, and your input will help your students become safer pilots. Please complete the survey by [date]. Your participation is voluntary and your responses will remain anonymous. You must be at least 18 years of age to participate in this survey.

Thank you for your time!

Sincerely,

Ronda Cassens, Aviation Continuing Lecturer, Safety Officer

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VITA

VITA

RONDA ELAINE CASSENS

DEPARTMENT: Curriculum and Instruction

AREA OF SPECIALIZATION: Career and Technical Education

ADVISOR/CHAIR: James Greenan

EDUCATION

PhD	Purdue University, West Lafayette, 2015 Department: Curriculum and Instruction Dissertation: *The Effectiveness of Behavior-based Safety in the Flight Training Environment*
M. S.	Purdue University, West Lafayette, 2010 Department: Curriculum and Instruction Thesis: *Elements Related to Teaching Pilots Aeronautical Decision Making*
B. S.	Purdue University, West Lafayette, 1999 Department: Aviation Technology
A. S.	Purdue University, West Lafayette, 1997 Department: Aviation Technology

PILOT RATINGS

First Class Medical, ATP Multi-engine and Commercial Airplane Single-engine with Instrument Rating, Flight Instructor Airplane Single and Multi-engine with Instrument Rating

PROFESSIONAL EXPERIENCE

January 2011 - Present	Safety Officer for Purdue University, West Lafayette, IN. Counsel students that have been involved in a safety related occurrence, respond to safety concerns, collect incident data, and organize safety meetings with students.
January 2000 – Present	Aviation Continuing Lecturer for Purdue University, West Lafayette, IN. Instruct college students for their private, commercial/instrument, multi-engine, and flight instructor licenses.
May 1999 – January 2000	Certified Flight Instructor for P&N Flight and Charter, Marion, IA. Instructed private pilots, did part-time line and office work, aerial photography, airplane rides, and sightseeing flights.
August 1998 – May 1999	Certified Flight Instructor for Purdue University, West Lafayette, IN. Part-time instructed college freshman and sophomores towards their commercial license.

PROFESSIONAL AFFILIATIONS

- University Aviation Association
- National Intercollegiate Flying Association
- Aircraft Owners and Pilots Association

PRESENTATIONS

Cassens, R. E., Young, J. P., Greenan, J. P., Brown, J. M. (2011, September). Elements related to teaching pilots aeronautical decision making. Paper presented at the University Aviation Association Fall Conference, Indianapolis, IN.

Cassens, R. E., Young, J. P., Greenan, J. P., Brown, J. M. (2011, September). Elements related to teaching pilots aeronautical decision making. Poster presented at the University Aviation Association Fall Conference, Indianapolis, IN.

Cassens, R. E. (2010, April). *Elements related to teaching pilots aeronautical decision making.* Presented at the Applied Aviation Graduate Research Symposium, West Lafayette, IN.

Cassens, R. E. (2010, April). *Elements related to teaching pilots aeronautical decision making.* Poster presented at the Applied Aviation Graduate Research Symposium, West Lafayette, IN.

PUBLICATIONS

Cassens, R. E., Young, J. P., Greenan, J. P., Brown, J. M. (2011). Elements related to teaching pilots aeronautical decision making. *Collegiate Aviation Review, 29(1)*, 10-27.

AWARDS

- First Place Poster, "Elements related to teaching pilots aeronautical decision making", University Aviation Association Spring Conference, Indianapolis, IN, 2011.
- First Place Poster, "Elements related to teaching pilots aeronautical decision making", Applied Aviation Graduate Research Symposium, Purdue University, 2010
- Third Place Presentation, "Elements related to teaching pilots aeronautical decision making", Applied Aviation Graduate Research Symposium, Purdue University, 2010
- 2006 Indiana General Aviation Flight Instructor of the Year