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The Perceived Benefits of Airbag Systems in General Aviation Aircraft

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THE PERCEIVED BENEFITS OF AIRBAG SYSTEMS IN GENERAL AVIATION AIRCRAFT

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Abstract

Airbags have been used in cars for years and are just starting to be developed for use in General Aviation (GA) aircraft but there exists a perception that aircraft airbag systems may be more harmful than beneficial. Many GA accidents involve high gravitational impacts taking place during the taxi, takeoff and landing phases of flight. This study will use descriptive methodology to survey members of three local flying clubs to obtain their perception regarding airbags in general aviation aircraft. It was hypothesized that a majority of the survey respondents would support the use of airbags in general aviation aircraft. The results indicated that generally pilots supported the use of airbag systems in General Aviation aircraft.

Introduction

Airbags have long been used in automobiles but have only recently entered into use in aviation applications. In September of 1997, Federal Motor Vehicle Safety Standard 208 mandated vehicles be equipped with airbags (http://www.nhtsa.gov/cars/rules/import/fmvss/index.html, part 208, 2010). When airbags were mandated for use in automobiles, the systems were initially met with some resistance from the public (Pantagraph, 1990). Reports of 66 people being killed by airbag explosions were used to tarnish airbag safety (Scanlon, 1997, p. 1). The purpose of this study is to examine public perception of active inflatable restraint systems (AIRS), or airbags, and their use in aviation. A large disparity exists between accident rates in commercial and General Aviation (GA). There is a need for increased safety in general aviation, with accident rates being over 30 times those of commercial aviation (Berth, n.d.). A large percentage of GA accidents take place during the taxi, take-off, climb and landing phases of flight. Data from the National Transportation Safety Board from the year 2001, the last year available, reflects that 66.78% of GA accidents took place during the taxi, take-off, climb and landing phases of flight (http://www.ntsb.gov/aviation/stats.htm, 2010, p. 1).

The researcher is a private pilot and has flown numerous single engine aircraft and has limited experience in multi-engine aircraft. The researcher also has a Bachelor of Science in Flight Technology from Central Washington University, and completed this proposal while concurrently working on a Master of Aeronautical Science degree from Embry Riddle Aeronautical University. Additionally, the researcher spent one year working at a flight school at Boeing Field (KBFI) as a Customer Service Representative and Customer Service Supervisor. This experience has allowed the researcher to gain significant expertise in the field. The researcher initially learned of airbags in airplanes through seeing the AmSafe Airbag system in his flight training and background in the aviation industry. Upon discovery of the system, the researcher was surprised that this system did not receive the exposure in the media which such an important safety device should receive.

The purpose of this research was to gather and present data regarding public perception of airbag systems and their use in general aviation aircraft. The perceived benefits of having an airbag system in general aviation aircraft were also investigated. It was anticipated that perceived benefits may not be recognized by general aviation pilots.

General Aviation (GA) incidents, accidents, and fatal accidents continue to occur every year. Many of these events occur during the cruise, taxi, and takeoff phases of the flight. Advances of safety equipment that can better protect passengers during these phases of flight should continue to be examined and implemented to improve the safety record of these phases of flight. According to Barth (2005) safety regulations introduced in the late 1980's have enhanced occupant safety inside the aircraft cabin (p. 1). Despite this improvement, GA has a much higher rate of accidents when compared to commercial aviation (32 times and 18% higher respectively) (p. 1). Table 1 shows the accident rates and fatalities in United States general aviation from the years 1990 to 2009. Table 2 shows the accident rates for the year 2009 and also shows a significant difference between GA and commercial accident rates.

Table 1
Accidents, Fatalities, and Rates 1990 through 2009, U.S. General Aviation

Accidents			Fatalities		Accidents per 100,000 Flight Hours		
Year	All	Fatal	Total	Aboard	Flight Hours	All	Fatal
1990	2242	444	770	765	28510000	7.85	1.55
1991	2197	439	800	786	27678000	7.91	1.57
1992	2110	450	866	864	24780000	8.51	1.81
1993	2064	401	411	740	22796000	9.03	1.74
1994	2021	404	430	723	22235000	9.08	1.81
1995	2055	412	431	727	24906000	8.21	1.63
1996	1908	361	636	619	24881000	7.65	1.45
1997	1840	350	631	625	25591111	7.17	1.36
1998	1902	364	624	618	25519000	7.43	1.41
1999	1905	340	621	615	29426000	6.5	1.16
2000	1837	345	596	585	27838000	6.57	1.21
2001	1727	325	562	558	25431000	6.78	1.27
2002	1715	345	581	575	25545000	6.69	1.33
2003	1741	352	633	630	25998000	6.68	1.34
2004	1617	314	559	559	24888000	6.49	1.26
2005	1670	321	563	558	23168000	7.2	1.38
2006	1523	308	706	547	23963000	6.35	1.28
2007	1652	288	496	491	23819000	6.93	1.20
2008	1566	275	494	485	22805000	6.86	1.21
2009	1474	272	474	465	20456000	7.2	1.33

Table 1 Note: Data in this table from year 2009 is preliminary. Table showing Accident rate for U.S. GA for the last 19 years. Table from http://www.ntsb.gov/aviation/Table10.htm (2010).

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Table 2
Accidents, Fatalities, and Rates, 2009 Preliminary Statistics U.S. General Aviation

	Accidents		Fatalities	
	All	Fatal	Total	Aboard
U.S. Air Carriers Operating under 14 CFR 121				
Scheduled	26	1	50	49
Non-Scheduled	4	1	2	2
U.S. Air Carriers Operating under 14 CFR 135				
Commuter	2	0	0	0
On-Demand	47	2	17	14
U.S. general aviation	1474	272	474	465

Table 2: Data and table from NTSB all 2009 data is preliminary .Table from http://www.ntsb.gov/aviation.

The data for this study was gathered through a survey of three local flying clubs, a professional pilot organization, and student pilots at Embry-Riddle Aeronautical University. The goal was to send out as many surveys as needed to obtain at least 100 respondents. The environment was standardized across respondents. However the location where the respondent completed the questionnaire was not controlled. Thus, it is likely participants responded in quite a wide range of settings: some respondents might have been in quiet settings; while others in noisy and busy atmospheres such as a local airport flying club.

Airbag Background

The airbag, itself, is not new technology. The airbag was first used in cars in the United States in the 1950's with federal use mandates being introduced in 1991. In 1998, dual airbags (passenger and driver) were required (Hutt & Wallis, 2004). Likewise, according to Bloch (1998), by 1996 most automobiles were equipped with an airbag for the driver and some had airbags for the passenger (p. 1780). This represents a period of nearly 40 years from discovery and development to mandated use.

Despite a long history of use in automobiles, airbags have only recently been successfully developed for aircraft. The transfer of airbag systems from automobiles to aircraft was initially considered relatively simple. Zimmerman and Rogers of Simula Government Products wrote an article in 1995 describing the differences in automobile and aviation applications of air bags. They found that with aircraft, it is difficult to calculate specific deceleration models because of limited production runs, much different acceleration forces and high cost. For example, a helicopter experiences a deceleration during missile launch, which is a scenario not shared with automobiles. Due to this deceleration the system was designed to deactivate during some situations. Zimmerman and Rogers noted that one of the challenges to developing an air bag system for aircraft is the variety and different loads of airframes. This challenge mostly prohibits a one-fits-all system (1995).

Despite previous attempts at airbag implementation in aircraft and advanced systems presently in place in automobiles, the General Aviation (GA) market is not at the same level as other areas in transportation. GA is the operation of civil aircraft which do not transport passengers commercially (Dictionary.com, 2010, p. 1). As recently as 2006, the AmSafe system was still in the final stages of development and the system was in the process of being tested for a supplemental type certificate (Department of Transportation, 2008, p. 2). This represents a large gap between automobile airbag use/mandating and aviation applications in GA aircraft.

> Airbags serve a simple purpose: to protect the occupants of a vehicle during a crash. The design of the airbags is crucial to their operation. Airbag systems consist of a deflated balloon stored in the steering wheel or fascia [and] is rapidly inflated under high pressure to protect the occupant [which] deploy when the force of impact is the equivalent of hitting a brick wall at 10-15 mph, or another car of similar weight at a collision speed of 20-30 mph (Hutt & Wallis, 2004, p. 272).

The above definition covers what an airbag does but is vague in terms of how it deploys and how it is triggered. Airbags are triggered when a collision is detected by various sensors; the airbags are rapidly inflated with nitrogen gas, which deploys at a speed of 100-200 mph after which the bag quickly deflates (Hutt & Wallis, 2004). Additionally, the sensors measure deceleration and may deploy in an event of high deceleration even without a collision. The airbag deploys very quickly and has been timed to deploy in 1/20th of a second. During deployment the airbag is filled by various gases. Directly after full deployment, the airbag begins the deflation process with gas escaping through vents in the airbag. The escaping gases can contain harmful chemicals including sodium hydroxide (NTSHA, 2010).

Air bags, by their design, are only usable during the first impact in a multiple impact event. This is due to the airbags being designed to deflate quickly after deployment. This requirement does present a problem, an airbag will not deploy in a second or third collision if it has already deployed (NTSHA, 2010). Although rare a second or third collision is a reality in the case of a mid-air collision between two aircraft.

The AmSafe system has been tested and evaluated for use in aircraft by the U.S. Government. The AmSafe Aviation Inflatable Restraint (AAIR) system was tested in a Federal Aviation Administration (FAA) study regarding the effects of side facing seats using anthropomorphic test dummies. DeWeese and Moorcroft conducted the study and concluded the AmSafe system was "effective in reducing the lateral flailing of the occupant and significantly reduced head accelerations, neck loads, chest acceleration [and] rib deflections" (2007, p. 14).

The AmSafe AIR system (AAIR) is the first certified system of its kind to see widespread use in different types of aircraft (Business Wire, 2006). In its simplest terms, the AmSafe system is an "inflatable restraint system is either [SIC] a two-, three-, four-, or five point safety belt restraint system consisting of a shoulder harness and a lap belt with an inflatable airbag attached to either the lap belt or the shoulder harness" (Department of Transportation, November 2008, p. 3). In order to better understand how the system works, the AmSafe system "behaves like an automotive inflatable airbag except the airbag is integrated into the lap belt and inflates away from the seated passenger" (Department of Transportation, May 2008, p. 2).

Current AIRS systems have been "being installed as standard equipment on approximately 80 percent of all new single-engine general aviation aircraft" (U.S. Newswire 2008, p. 1). According to DeWeese and Moorcroft (FAA, 2007), the physical parts of the AmSafe system include the end release buckle, electronic module assembly, inflator, interface cable, diagnostic tool connector, detachable shoulder harness, airbag belt, and inertia reel (p. 3).

The system utilizes electronic sensors that detect an impact and then deploy the airbags. The system of sensors controlling the deployment must be reliable to avoid an inadvertent deployment. If this type of deployment were to occur it could pose a danger to the occupants (Department of Transportation, November 2008). The actual deployment of the airbags relies on pyrotechnic charges for activation (Department of Transportation, May 2008).

Airbag Injuries

A major complaint about airbags is that when the airbags deploy they can actually cause injury and not necessarily protect the occupants in a vehicle. Hutt and Wallis (2004) found that automobile injuries and deaths in the United States of America (USA) and the United Kingdom (U.K.) have declined in recent years despite increases in traffic volume. In contrast, this device does have some of the risks involved with its use. Crowley and Dalgard (2000) investigated airbags and their use in automobiles and proposed that airbags added energy to a crash rather than absorbing energy. They also added, there is a trade-off to the increased safety from airbags. The authors maintain that the airbag is a supplemental safety device that should be used in conjunction with a safety belt.

The National Safety Council has released statistics on fatalities from air bag deployments since 1990. As of 1999, 175 deaths have resulted from airbag deployments and of these deaths, 104 deaths were children. To the credit of the airbag systems, the National Safety Council also noted these statistics were calculated from over 3.3 million deployments resulting in over 6,377 lives saved. The high number of deaths among children resulted from being too close to the airbag when it deployed (1999). Airbags were also designed to be less powerful in the second generation of airbags which began to be used in 1999. These airbags were designed to reduce injuries to shorter people and children (English, 1997, pp. 1-2).

Unlike automobile airbag systems, the AmSafe system is designed to deploy away from the pilot or passenger. An advantage to this design is the previous risk of an airbag adding energy to an accident is mitigated. Crowley and Dalgard (in press) also examine the issue of injuries arising from correct airbag usage. The authors discuss the human eye and its potential for injury due to airbag deployment. Another type of injury covered is those which might result from an airbag deploying against an object such as "eyeglasses frames and tobacco pipes... [This is known as a] missile injury" (p. 37). Such an injury may be unpreventable in GA with pilots regularly using charts, pencils, pens and flight computers.

Aviation Safety Record

Airbags require a high level of reliability and safety to function successfully. Airbags have built in safety systems which prevent them from exploding and causing harm to the occupants. The airbags deploy when they reach a temperature of 300 degrees Fahrenheit or higher (NTHSA,

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2010). This temperature marks the upper limit of an airbag temperature range and is a design feature of the airbag.

The AmSafe system is not the first use of airbags in aviation. The US Army demonstrated a system developed for use in its Black Hawk Helicopters in 1999. Part of the requirements the Army put forth were the airbag system must be able to deploy in flight and allow the pilot to maintain control of the aircraft. This is a safety requirement meant to ensure protection of the pilot or passenger during an unwanted airbag deployment. The test proved successful and the pilots were able to maintain control of the helicopter after airbag deployment. This system is known as the Cockpit Airbag System or CABS (Newswire, 1999).

The CABS system was installed in multiple contracts in Army helicopters during the early 2000's. One contract included installation in 612 Black Hawk and 221 Kiowa Warriors. This system is similar to the AmSafe system in it consists of a crash sensor, gas generators, and airbags. The differences lie in the fact that it is used in military aircraft (rotary) and the system consists of four total airbags (Business Wire, 2003).

In order for airbags to be accepted into civilian general aviation, a justification for their use must exist. The need for just such a device is made obvious in a recent aircraft accident during takeoff (Safety & Technology, 2008, p. 1). This particular accident involved "a Learjet that crashed on takeoff at Columbia Metropolitan Airport, killing four people and injuring two popular musicians" (Anonymous, Spartanburg Herald Journal, 2008, p. 1). This accident, took place during the takeoff phase of flight, highlights the need for additional safety equipment to protect aircraft occupants during these phases of flight.

This accident is not unique in that people were killed or injured during the takeoff period of flight. According to data released by the National Transportation Safety Board (NTSB) in any given year roughly half of all General Aviation accidents take place during the taxi, take-off, climb, and landing phases of flight (NTSB, 2010). This is significant in that during these phases of flight there are a significant number of accidents. Also significant is the fact during these phases of flight an airbag system would be the most effective. Additionally, the U.S. Army has, from the years 1990 to 1999, identified 30 aviators which have died in potentially survivable crashes (Helis.com, 1999).

In addition to these statistics, additional data are available that indicate the accident rate as it relates to the phase of flight. According to the National Transportation Safety Board's (NTSB) annual review of accidents for the year 2001, of 1749 reported accidents involving General Aviation (GA) aircraft, 52 accidents were reported to have taken place during the taxi phase of flight and 337 accidents during the take-off phase of flight. This is compared with 299 accidents taking place during the cruise phase of flight.

According to the NTSB in the year 1990, 2242 general aviation accidents were recorded, with 444 fatal accidents resulting in 770 fatalities. By the year 2009 the number of GA accidents recorded dropped to 1474 with 272 fatal accidents resulting in 474 fatalities (NTSB, 2010). This figure indicates a 61% decrease in fatalities from the year 1990 to 2009. Similarly the number of accidents dropped from 2242 in 1990 to 1474 in 2009, a drop of 65%.

Additionally, the NTSB found 477 accidents took place during the landing phase of flight and 160 accidents took place during the approach phase of flight. Combining these numbers results in 1026 accidents (or 58% of all accidents) taking place during the taxi, take-off, approach and landing phases of flight (NTSB 2010).

Installation Complications

The following section addresses problems that might interfere with AmSafe installation on specific aircraft in the general aviation fleet. Safety systems such as the AmSafe system will always add weight and cost money. In regard to weight requirements, the AmSafe system in a Baron or Bonanza aircraft would add 2.8 pounds to the aircraft weight. The cost for an add-on kit for these aircraft models is $3600 and includes two restraints (Salerno, 2008). The added weight would reduce the useful load of the aircraft. Additionally, the cost of kit and installation may prove to be an expense that may not be perceived as affordable by every operator. In such a situation a pilot or operator might choose not to install the kit and take the risk of flying without it. As discussed previously, this system would provide the pilot with extra protection during the most hazardous phases of flight.

Hypothesis

The airbag has long been employed as a safety device in automobiles and has only recently been used in aviation. Considering the high rate of accidents and fatalities in GA, when compared with commercial aviation, additional safety equipment is needed. This survey and research is designed to test pilot's perception of the value of airbags in aviation. It is hypothesized that pilots will support the use of airbags in general aviation aircraft.

Method

Research Model

This study utilized a quantitative method and was specifically descriptive or survey based. It was hypothesized that a majority of the surveyed population would support the use of airbags in general aviation aircraft. The survey was handed out at three local FBO's and was made available to the respondents over the internet through the website www.surveymonkey.com. Additionally the survey was sent to some of the researcher's family and colleagues in the aviation industry.

Survey Population

The population targeted for this project was anyone involved with aviation and General Aviation (GA). This includes pilots and passengers flying or riding in GA aircraft. The sample group were respondents who are pilots and fly from three local flying clubs, were students at Embry Riddle or were pilots with Delta Airlines. This group was selected for their knowledge of aviation and GA. The sample size was 79 respondents. Of these respondents almost half, or 39 out of 79 (49.4%), were commercial pilots. Many of these respondents already had experience or knowledge of AIR systems in general aviation aircraft. This population was predicted to have a working and technical knowledge of aircraft and the aircraft systems at large.

Distribution Method

The survey statements were manually entered into the website Surveymonkey.com by the respondents. The respondents also had the choice to fill out a hard copy with the surveys that were made available at the local FBO's. These respondents were also given a cover letter informing them of the purpose of the survey and how to send the survey to other pilots. The last part of the cover letter thanked them for their participation. Finally, a number of surveys were distributed to students of Embry-Riddle Aeronautical University at the Seattle and Tacoma campuses. These respondents were simply given a piece of paper with the web address of the survey and were informed of the purpose of the survey in person.

Instrument

The instrument used in the data gathering of this project was a survey delivered via the internet, specifically surveymonkey.com. The results of the survey were compiled on surveymonkey.com and then entered into Microsoft Excel 2007 for analysis. The survey is referenced below and can also be found in its entirety in Appendix A.

The instrument for this survey was created by the researcher to evaluate the hypothesis that the population supports the use of airbags in general aviation aircraft. The first statement determined what flight ratings the respondent currently holds. The next statement attempted to establish how much flight time the participant had acquired. These two statements were used to represent the respondents' level of flight training and experience.

The next set of statements directly assessed whether participants support the use of airbags in aviation. The statements addressed the respondents' knowledge on issues of system operability to the perceived benefits of airbags in and outside of aviation. The survey also tested the respondents' perception of adapting the existing GA fleet to accept airbag use. The complete list of the statements in survey can be found in Appendix I.

The instruments were designed to utilize a Likert-type interval scale. The survey responses have been assigned values with 5 being Strongly Agree, 4 being Agree, 3 being neutral, 2 being Disagree, and 1 being Strongly Disagree. Numerical values were assigned to these scores. These values were then imported into an Excel spreadsheet and analyzed. The data was then broken down by each statement and interpreted into the mean and standard deviations.

Procedures

The survey was made available on surveymonkey.com and a flyer listing the web address was distributed to three local flying clubs and to local flying students at Embry Riddle Aeronautical University's Seattle Campus. Interested respondents simply typed in the web address listed on the flyer. This took the respondents to Surveymonkey.com where they were able to complete the survey. After the respondent had responded to the first five statements they were directed to go onto the second page of the survey. On the second page of the survey the respondents responded to the remaining five statements. At the end of the survey the respondent clicked "finish" to complete the survey.

Surveys were made available on July 10th 2010. By the end of the first week 33 people had responded to the survey. The survey ended on August 4th at 11:59 pm with a total of 79 respondents. A total of 120 surveys were distributed and the survey response rate was 65.8%.

Treatment of the Data

The mean, median, and mode and standard deviation of each item were calculated. Composite scores were also calculated (after reverse-scoring the appropriate items).

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Results

Overall, the surveys which were handed out in hard copy form had a lower response rate when compared with the online response rate. Of 50 hard copy surveys only 10 were returned. This represents a response rate of 20%. Surveys which were distributed through online methods had 69 surveys returned with 75 surveys being distributed. This represents a response rate of 92%.

The surveys were completed by individuals ranging in qulaifications from student pilots to Airline Transport Pilots (ATP). The hardcopy surveys were distributed over a geographic area of approximately 50 nautical miles. The surveys were distributed at two FBO's at Boeing Field (KBFI) and one FBO at Olympia Airport (KOLM). Additionally surveys were completed by Embry Riddle Aeronautical University students at the Seattle Campus.

The online surveys were completed by respondents mostly located in the Pacific Northwest. The opportunity existed for survey responses to be entered from across the world and only required internet access to complete the survey. Surveys were also completed by Delta pilots based in Atlanta, GA. The online survey response rate was much higher than the hard copy response rate. The online survey response rate was 92% compared with only a 20% response rate of hard copy surveys.

The complete results from the survey are located in Appendix B. The results from the "agree" statements, or statements which are written to support the hypothesis are listed in Table 3. Respondents that agreed with these statements were in support of the hypothesis.

In contrast the results from the "disagree" statements are listed in table # 4. Survey respondents who agreed and supported these statements were supporting the null hypothesis. These statements were designed to be negative statements and are a tool to further determine the support of the hypothesis.

Table 3

Agree Statements

Statement #	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
3	35	27	11	3	3
4	2	18	24	21	15
5	58	17	3	1	0
6	11	29	20	12	6

Table 4

Disagree Statements

Statement #	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
7	5	14	22	28	11
8	15	22	16	14	10
9	2	4	15	29	29
10	4	18	25	19	13

The overall scores from the data collected from the survey as listed in the graph numbered figure # 1. As evidenced by the graph the scores for statements number five and number 9 show the strongest agreement and disagreement with the associated statements. These statements also had the smallest standard deviation associated with them.

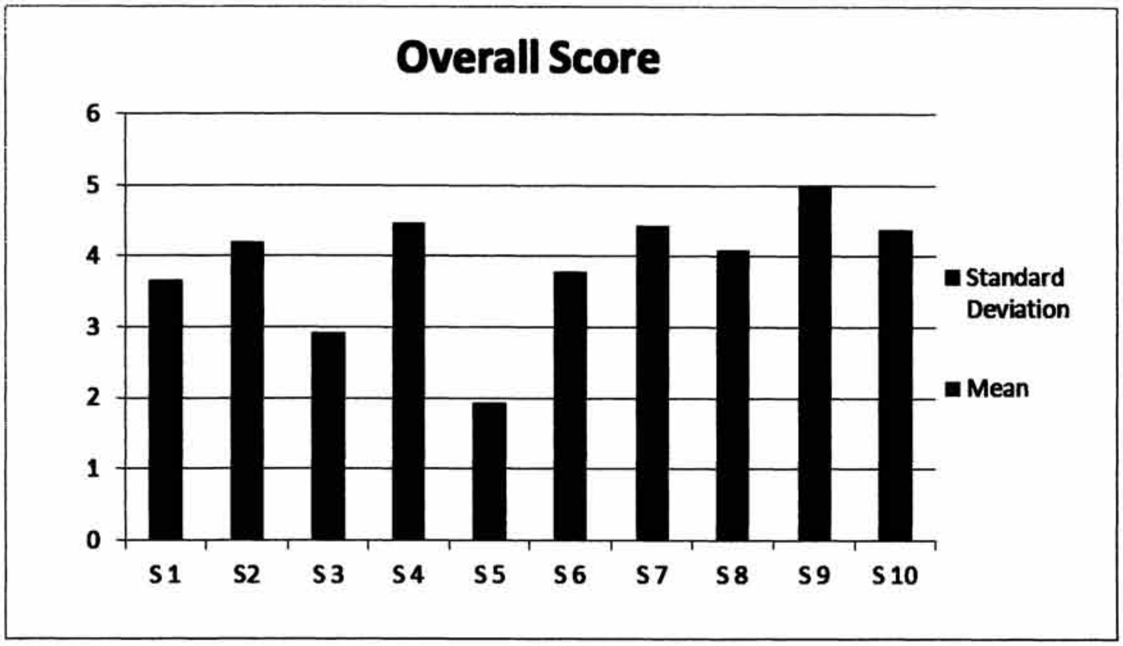

Figure 1: Graph showing Mean and Standard Deviation Scores of the survey data.

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The data in Table 5 indicate the summary of responses in the respective categories of number of respondents (n), mean (m), standard deviation (SD), Chi-Square data (X^2), degrees of freedom (df), and the significance (p Value). This table could be expanded to show the expected and actual range of responses. The highest mean score was 3.95.

Table 5
Summary of Responses

Statement	n	M (SD)	Chi- Square	df	p Value
1	79	2.81 (0.84)	1.976	1	0.160
2	79	3.06 (1.13)	3.765	1	0.052
3	79	1.88 (1.03)	47.087	1	0.000
4	79	3.36 (1.10)	4.571	1	0.033
5	79	1.31 (0.63)	72.053	1	0.000
6	78	2.65 (1.13)	8.345	1	0.004
7	80	3.32 (1.11)	6.897	1	0.009
8	77	2.76 (1.31)	2.770	1	0.096
9	78	3.95 (1.08)	42.250	1	0.000
10	78	3.24 (1.13)	1.852	1	0.174

Item #1

This is the current flight rating currently possessed. Of the respondents that responded to this statement six were student pilots and nineteen were private pilots. These numbers when combined account for over 30% of the respondents. Just under half of the pilots responded as being commercial pilots (49.4%). The final category, Airline Transport Pilot (ATP), represented the remaining 20% of pilots.

The mean of Item 1 was 2.81 with a standard deviation of .84. This distribution was close to expected with the exception of the number of Airline Transport Pilots (ATP). The author did not expect such a high number of ATP's to respond to the survey and estimated they would make up less than 10% of the survey respondents.

Item #3

Item 3# "The benefits of airbags are well known and accepted." The mean was 1.88 with a standard deviation of 1.03. Of the survey respondents 62 supported the statement. Of the survey respondents 6 did not support the statement. Of the survey respondents 11 had no opinion.

Table 6
Agree/Disagree Results for Item Statement #3

Result	Agree	Disagree
Observed	62	6
Expected	34	34

The data for Item #3 is presented as follows. The Chi-Square analysis found significant departures from the expected response with scores of $X^2(1)= 47.087$, $p<.001$. This is a significant value and the hypothesis was supported. Further research is needed to thoroughly understand the score and its overall significance.

Item #4

Item #4 "the benefits of airbags in general aviation (GA) are well known and accepted." The mean was 3.36 with a standard deviation of 1.10. Of the survey respondents 20 supported the statement. Of the survey respondents 36 did not support the statement. Of the survey respondents 24 had no opinion. The number of people having no opinion is quite high; this may be due to pilots only a limited number of aircraft and not knowing how common or uncommon this system is in GA aircraft.

Table 7
Agree/Disagree Results for Item # 4

Result	Agree	Disagree
Observed	20	36
Expected	28	28

The data for Item #4 is presented as follows. The Chi-Square analysis found significant departures from the expected response with scores of $X^2(1)= 4.571$, p .033. This is a significant value and the hypothesis was supported. Further research is needed to thoroughly conclude the score and its overall significance.

Item # 6

Item #6 "airbags in airplanes would raise the level of safety in General Aviation (GA) with minimal modifications to aircraft." The mean was 2.65 with a standard deviation of 1.13. Of the survey respondents 40 supported the statement. Of the survey respondents 18 did not support the statement. Of the survey respondents 20 had no opinion.

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Table 8
Agree/Disagree Results for Item # 6

Result	Agree	Disagree
Observed	40	18
Expected	29	29

The data for Item #6 is presented as follows. The Chi-Square analysis found significant departures from the expected response with scores of $X^2(1)=8.345, p=.004$. This is a significant value and the hypothesis was supported. Further research is needed to thoroughly conclude the score and its overall significance.

Item #7

Item #7 "airbags, when installed in an aircraft, would provide little protection to a pilot or passenger during any phase of flight." The mean was 3.32 with a standard deviation of 1.11. Of the survey respondents 19 supported the statement. Of the survey respondents 40 did not support the statement. Of the survey respondents 22 had no opinion.

Table 9
Agree/Disagree Results for Item # 7

Result	Agree	Disagree
Observed	19	40
Expected	29.5	29.5

The data for Item #7 is presented as follows. The Chi-Square analysis found significant departures from the expected response with scores of $X^2(1)=6.897, p=.009$. This is a significant value and the respondents rejected the null hypothesis. Further research is needed to thoroughly conclude the score and its overall significance.

Item # 8

Item #8 "airbag modifications could not be easily made to the existing fleet of General Aviation (GA) aircraft." The mean was 2.76 with a standard deviation of 1.31. Of the survey respondents 37 supported the statement. Of the survey respondents 24 did not support the statement. Of the survey respondents 16 had no opinion.

Table 10

Agree/Disagree Results for Item # 8

Result	Agree	Disagree
Observed	37	24
Expected	30.5	30.5

The data for Item #8 is presented as follows. The Chi-Square analysis found significant departures from the expected response with scores of $X^2(1)=2.770$, $p=.096$. This is an insignificant value and the respondents failed to reject the null hypothesis. Further research is needed to thoroughly conclude the score and its overall significance.

Item # 9

Item #9 "airbags are inherently dangerous and do not offer any additional level of protection in an accident." The mean was 4.00 with a standard deviation of 1.00. Of the survey respondents 6 supported the statement. Of the survey respondents 58 did not support the statement. Of the survey respondents 15 had no opinion.

Table 11

Agree/Disagree Results for Item #9

Result	Agree	Disagree
Observed	6	58
Expected	32	32

The data for Item #9 is presented as follows. The Chi-Square analysis found significant departures from the expected response with scores of $X^2(1)= 42.250$, $p<.001$. This is a significant value and the respondents rejected the null hypothesis. Further research is needed to thoroughly conclude the score and its overall significance.

Item # 10

Item #10 "airbag systems are impractical in General Aviation (GA) aircraft due to their weight." The mean was 3.24 with a standard deviation of 1.13. Of the survey respondents 22 supported the statement. Of the survey respondents 32 did not support the statement. Of the survey respondents 25 had no opinion.

Table 12

Agree/Disagree Results for Item # 10

Result	Agree	Disagree
Observed	22	32
Expected	27	27

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The data for Item #10 is presented as follows. The Chi-Square analysis found significant departures from the expected response with scores of $X^2(1)=1.852, p=.174$. This is an insignificant value and the respondents failed to reject the null hypothesis. Further research is needed to thoroughly conclude the score and its overall significance.

Discussion

The overall mean score for the survey respondents was 2.84 with a standard deviation score overall of 1.04 indicating support for the hypothesis. Some of this data, when considering the standard deviation of 1.04 would put some of the 66% of all respondents (+/- 1SD) in support of the null hypothesis. Using the Likert type scale a mean of 3 or higher would indicate a support for the null hypothesis. A mean of 2.9 or lower would represent a support for the hypothesis. This support is not as strong as the researcher originally predicted. This may be due to the high number of Airline Transport Pilots in the sample. These individuals may be flying bigger aircraft and may have forgotten some of the dangers associated with flying GA aircraft.

Results may have been different had GA passengers been included in the survey. This may have increased the number of respondents and thus increased the sample size. Another survey which attempts to only target GA passengers and their perceptions may yield vastly different findings.

Conclusion

The results of this survey suggest a general support for the use of airbags and airbag systems in General Aviation aircraft. However, we are still far away from the implementation of airbags in avaition that may reduce the number of accidents and fatalities during the taxi, takeoff, and landing phases of flight. The results of this survey are reflecting the opinions and perceptions of General Aviation pilots. These results may be vastly different when applied to different populations such as military pilots.

The safey attitude among pilots is a strong asset for General Aviation and further provides support for the importance of continuous improvement in the areas of safety and technology. The use of this technology has proved successful in multiple modes of transportation. The shift towards safer GA fleets should receive just as much praise as the shift to safer cars.

The researcher suggests that the expansion in this use of technology is vital for the future of GA. The decreased costs which could be associated with adoption of airbags would provide much needed relief from the high and commonly increasing costs of flying. Marketing safer planes and safer systems may lead to an uptick in GA much like the uptick experienced after the passage of the GA revitalization bill in 1994.✈

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References

Anonymous. (2003, April). Simula Receives Orders for its Cockpit Air Bag Systems- CABS-; Army Orders for Black Hawk and.... *Business Wire.* Retrieved from http://www.allbusiness.com/government/government-bodies-offices-government/5960910-1.html.

Barth, T. B. (2005). Evaluations and Survivability of Inflatable Restraint Systems in Small Fixed Wing Aircraft. Retrieved December 3, 2008 from http://www.amsafe.com/resources/

Bloch, B. (1998) Advanced Designs for Side Impact and Rollover Protection. Retrieved May 18, 2010 from http://www.autosafetyexpert.com/Assets/Docs/article-sideimpact.pdf.

Car makers pushing air bags after years of resistance. [FINAL Edition]. (1990, September 9). *Pantagraph*, p. F1. Retrieved July 28, 2009, from ProQuest Newsstand. (Document ID: 83813328).

Crowley & Dalgard. Proceedings of the Technical Cooperative Program Workshop: Inflatable Restraints in Aviation. *United States Army Aeromedical Research Laboratory Report No. 2000-21*. Retrieved August 20, 2010 from http://www.stormingmedia.us/42/4234/A423483.html.

Diamond Aircraft to Install the AmSafe Aviation Inflatable Restraint System (AAIR®) on Board New DA40 and DA42 Models; AAIR Now Available on 75 Percent of All New Single-Engine General Aviation Aircraft. (24 April 2006). *Business Wire*, 1. Retrieved July 26, 2009, from ProQuest Newsstand. (Document ID: 1026349141).

English, R. For The Financial Post. (1997, November 14). Making airbags slower, safer [Daily Edition]. Financial Post, p. 30. Retrieved July 1, 2010, from Canadian Newsstand Complete. (Document ID: 260329301).

Federal Aviation Administration. (2007). *Assessment of injury potential in aircraft side-facing seats using ES-2 anthropomorphic test dummy.* Retrieved July 24, 2009 from http://www.faa.gov/library/reports/medical/oamtechreports/2000s/media /200713.pdf.

Federal investigators collecting evidence in SC jet crash. (2008, September 23). *Spartanburg Hera–d - Journal*, 1. Retrieved December 3, 2008, from ProQuest Newsstand database. (Document ID: 1560251251).

Final special conditions: AmSafe aviation; inflatable restraints installation; approved model list of normal and utility category airplanes, and agricultural airplanes certificated in the normal/utility/restricted Category: federal register extracts. (2008, November). *Department of Transportation (DOT) Documents / FIND*. Retrieved July 26, 2009, from ProQuest Central. (Document ID:1590566251).

Hutt, J. & Wallis. L (2004). *Injuries caused by airbags: a review*.Trauma, 6(4),271-278. Retrieved July 13, 2009, from Proquest.

Life-saving AmSafe aviation airbag system now available for general aviation retrofit. (2008, Apr 17). *U.S.Newswire*. Retrieved from http://search.proquest.com

National Highway Traffic Safety Administration. (2010). *Aviation Accident Statistics.* Retrieved May 18th, 2010 from http://www.ntsb.gov/aviation/stats.htm.

National Highway Traffic Safety Administration. (2007). *Counts of Frontal Air Bag Related Fatalities and Seriously Injured Persons.* Retrieved June 8th, 2010 fromhttp://www-nrd.nhtsa.dot.gov/Pubs/AB0707.PDF.

National Highway Traffic Safety Administration. (2010). *Federal Motor Vehicle Safety Standards and Regulations.* Retrieved July 1st, 2010 from http://www.nhtsa.gov/cars/rules/import/fmvss/index.html#P595.

https://commons.erau.edu/jaaer/vol22/iss2/6
DOI: https://doi.org/10.15394/jaaer.2013.1399

National Highway Traffic Safety Administration. (2010). *What Happens After a Deployment.* Retrieved May 18, 2010 from http://www.nthsa.gov/people/injury/airbags/airbags03/page5/html.

National Highway Traffic Safety Administration. (2010). *When a Collision Occurs.* Retrieved May 18, 2010 from http://www.nthsa.gov/people/injury/airbags/airbags03/page4/html.

National Highway Traffic Safety Administration. (2010). *When Do Air Bags Deploy?* Retrieved May 18, 2010 from http://www.nthsa.gov/people/injury/airbags/airbags03/page3/html.

National Safety Council. (1999). *Statistical Breakdown of Air Bag Fatalities.* Retrieved May 18, 2010 from http://www2.nsc.org/partners/status3.htm.

National Traffic Safety Board. (2010). *Accidents Fatalities and Rates 1990 through 2009, U.S. General Aviation.* Retrieved from http://www.ntsb.gov/aviation/Table10.htm

National Traffic Safety Board. (2010). *Accidents Fatalities and Rates,2009 Preliminary Statistics U.S. General Aviation.* Retrieved from http://www.ntsb.gov/aviation.

Newswire. (1999). *The US Army Demonstrates Simula's Cockpit Air Bag System (CABS) in Its UH-60A/L Black Hawk Helicopters.* Retrieved May 18, 2010 from http://www.helis.com/news/1999/h60abag.htm.

Safety & Technology Trends. (2008, November). *Air Safety Week*, 22(42), p. 1 Retrieved November 20, 2008, from ABI/INFORM Trade & Industry database. (Document ID:1588305841).

Salerno, J. (2008, October 1). Baron and bonanza inflatable restraints. *Business & Commercial Aviation, 4.* Retrieved December 4, 2008 from http://www.lexisnexis.com.

Scanlon, T. (1997, August 27). An airbag expert full of hot air :[2 Edition]. Washington Times, p. A.15. Retrieved July 1, 2010, from ProQuest Newsstand. (Document ID: 13665667).

Special Conditions: AmSafe, Inc., Various Transport Category Airplanes; Inflatable Restraints :Federal Register Extracts. (2008, May). *Department of Transportation (DOT) Documents / FIND.* Retrieved July 26, 2009, from ProQuest Central. (Document ID: 1481546201).

Zimmerman R. & Rogers, J. Crash Sensors for Inflatable Restraint Systems. (1995, Oct.). 33rd *Annual Safe Symposium*. Pages 152-161.

Appendix A

Survey Statements

The following statements (excluding 1 & 2) will be evaluated by the survey respondents on a Likert scale of 1 to 5. With the number 1 representing the respondent strongly agrees with the statement. The number 2 will represent the respondent somewhat agrees with the statement. The number 3 will represent the respondent is neutral towards the statement. The number 4 will represent the respondent somewhat disagrees with the statement. Finally the number 5 will represent the respondent strongly disagrees with the statement.

1. This is the current flight rating or license I currently posses.

2. This is my total number of flight hours to date.

3. The benefits of airbags are well known and accepted.

4. The benefits of airbags in general aviation (GA) are well known and accepted.

5. Many accidents take place during the taxi, take-off and landing phases of flight.

6. Airbags in airplanes would raise the level of safety in General Aviation (GA) with minimal modifications to aircraft.

7. Airbags, when installed in an aircraft, would provide little protection to a pilot or passenger during any phase of flight.

8. Airbag modifications could not be easily made to the existing fleet of General Aviation (GA) aircraft.

9. Airbags are inherently dangerous and do not offer any additional level of protection in an accident.

10. Airbag systems are impractical in General Aviation (GA) aircraft due to their weight.

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Appendix B

Survey Results

Statement	Number of Respondents	Percentage
1. This is the current flight rating or license I currently posses.		
Student Pilot	6	7.6%
Private Pilot	19	24.1%
Commercial Pilot	39	49.4%
Airline Transport Pilot (ATP)	16	20.3%
Total	79	100.0%
2. This is my total number of flight hours to date.		
-0-99 Hours	11	13.9%
-100-500 Hours	15	19.0%
- 501-1000 Hours	11	13.9%
- 1001- Hours and Above	42	53.2%
Total	79	100.0%
3. The benefits of airbags are well known and accepted.		
- Strongly Agree	35	44.3%
- Somewhat Agree	27	34.2%
- Neutral	11	13.9%
- Somewhat Disagree	3	3.8%
- Strongly Disagree	3	3.8%
Total	79	100.0%
4. The benefits of airbags in general aviation (GA) are well known and accepted.		
- Strongly Agree	2	2.5%
- Somewhat Agree	18	22.8%
- Neutral	24	30.4%
- Somewhat Disagree	21	26.6%
- Strongly Disagree	15	19.0%
Total	79	100.0%
5. Many accidents take place during the taxi, take-off and landing phases of flight.		
- Strongly Agree	58	73.4%
- Somewhat Agree	17	21.5%
- Neutral	3	3.8%
- Somewhat Disagree	1	1.3%
- Strongly Disagree	0	0.0%
Total	79	100.0%

Statement	Number of Respondents	Percentage
6. Airbags in airplanes would raise the level of safety in General Aviation (GA) with minimal modifications to aircraft.		
- Strongly Agree	11	14.1%
- Somewhat Agree	29	37.2%
- Neutral	20	25.6%
- Somewhat Disagree	12	15.4%
- Strongly Disagree	6	7.7%
Total	78	100.0%
7. Airbags, when installed in an aircraft, would provide little protection to a pilot or passenger during any phase of flight.		
- Strongly Agree	5	6.4%
- Somewhat Agree	14	17.9%
- Neutral	22	28.2%
- Somewhat Disagree	28	3590.0%
- Strongly Disagree	11	14.1%
Total	80	100.0%
8. Airbag modifications could not be easily made to the existing fleet of General Aviation (GA) aircraft.		
- Strongly Agree	15	19.5%
- Somewhat Agree	22	28.6%
- Neutral	16	20.8%
- Somewhat Disagree	14	18.2%
- Strongly Disagree	10	13.0%
Total	77	100.0%
9. Airbags are inherently dangerous and do not offer any additional level of protection in an accident.		
- Strongly Agree	2	2.6%
- Somewhat Agree	4	5.1%
- Neutral	15	19.2%
- Somewhat Disagree	29	37.2%
- Strongly Disagree	29	37.2%
Total	78	100.0%
10. Airbag systems are impractical in General Aviation (GA) aircraft due to their weight.		
- Strongly Agree	4	5.1%
- Somewhat Agree	18	23.1%
- Neutral	25	32.1%
- Somewhat Disagree	19	24.4%
- Strongly Disagree	13	16.7%
Total	78	100.0%

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