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AIRFRAME PARACHUTE KNOWLEDGE AND DEPLOYMENT SCENARIOS: A COLLEGIATE PERSPECTIVE

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As airframe parachutes in general aviation aircraft become more popular, training is essential in fostering a willingness to use the system in the appropriate situation. Aviation decision-making literature suggests that individuals make choices based on experience and pattern matching, such as emergency situations and airframe parachute deployment scenarios. This led the researchers to investigate the knowledge and perspectives of collegiate pilots who train in aircraft equipped with airframe parachutes. Participants completed a surveyfocused on airframe parachute knowledge and scenario-based examples. Training experts were used to validate the parachute deployment scenarios used in the instrument. Responses indicate that pilots find aircraft with a parachute safer than those without, but several participants reported inconsistencies with training for the use of the parachute. Findings suggest that when new safety technology is implemented into aircraft, training is necessary to ensure the technology is understood and implemented to its fullest effect and level of safety.

Airframe parachutes have become more common in the general aviation and light sport aircraft markets (McMahon, 2008). BRS Aviation, an airframe parachute manufacturer, reports that over 30,000 parachutes have been installed on general aviation aircraft and over 294 total lives have been saved from these safety devices (2012). These safety devices provide pilots or passengers the option of deploying an airframe parachute system, in certain emergency situations, that will lower the entire aircraft safely to the ground. However, in order for this safety device to be effective, pilots must be trained and willing to use it in an appropriate setting. The purpose of this study was to examine the knowledge and perspectives of a sample of collegiate pilots who use an aircraft equipped with an airframe parachute for primary training at the subject university. The research investigated student and instructor perceptions of usage scenarios and training for the airframe parachute system safety device equipped on the subject university's training aircraft. Errors occurring within the deployment decision-making process were reviewed, as well as the recent literature on perceptions and training to use an airframe parachute.

Review of Literature

Aviation Decision-Making in Critical Contexts

Decision-making is defined by O'Hare (2003) as "the act of choosing between alternatives under conditions of uncertainty" (p. 203). A key term within this definition is uncertainty. Since the effects may not be clear, the decision-maker must assess the situation based on incoming cues to determine the most appropriate outcome. Decisions may be further broken down into static and dynamic decisions (Craig, 2000). Static decisions are those which may not have a time component associated with them, while dynamic decisions occur within a more fluid environment where time pressure is associated with the decision.

Decision-making within the aviation field is frequently discussed within the context of naturalistic decision-making (NDM). When viewing decision-making through the lens of NDM, it is recognized that in real-world situations, there is likely to be some uncertainty with the outcome of a decision (O'Hare, 2003). NDM is defined as "an attempt to understand how people make decisions in real-world contexts that are meaningful and familiar to them" (Lipshitz, Klein, Orasanu, & Salas, 2001, p. 332). Unlike classical decision-making (CDM), in NDM it was found that persons did not identify and compare all options before making a decision, but rather, used previous experience and pattern matching to rapidly identify the appropriate outcome(s) (Klein, 2008; Orasanu, 1995). A key component of this is the term previous experience. As will be discussed in the current study, this is one reason why training for emergency situations such as an airframe parachute deployment is essential because in a real-life emergency, it may be easier to recognize the scenario than if this training had never been completed. Klein's Recognition-Primed Decision (RPD) model discusses how people use the matching of patterns and previous experience when it is necessary to make decisions (Klein, 2008). If the person recognizes the cue inputs from a previous situation, they will be likely to attempt the outcome that proved successful in the last experience.

Current Perspectives and Training on Airframe Parachute Decision-Making

An earlier study completed by McMahon (2008) investigated pilot perceptions of airframe parachute systems. An electronically administered survey gathered information on perceptions of airframe parachutes along with four scenarios for participants to consider if they would use the system. Over 1,000 participants completed the survey, however, these participants may or may not have ever flown or been trained on airframe parachutes or their usage. Participants indicated that 77% felt an aircraft with a parachute system was safer than one without. When isolated by flight instructors, those instructors with less than 2 years of experience were more likely to deploy the parachute system in the four scenarios, but this group also believed that the parachute system would lower them gently to the ground, an inaccurate perception. Young flight instructors, 94%, indicated that training on a parachute system was not necessary. McMahon (2008) concluded that flight schools using parachute equipped aircraft should invest in training so pilot expectations are more in line with the realities of using the system, along with a pre-flight briefing in how and when to use these safety systems. In the current study, the population consists of pilots who are trained in flying aircraft equipped with an airframe parachute system.

Research completed by Blickensderfer, Strally, and Doherty (2012) reviewed the impacts of scenario-based training on decision-making and airframe parachute deployment. Scenario-based training (SBT) has historically been used within aviation to train pilots for real-world situations, and it recently has had a renewed focus as the result of the FAA Industry Training Standards (FITS) program (Summers Halleran & Wiggins, 2010). Blickensderfer, Strally, and Doherty (2012) utilized undergraduate and graduate students, who held private pilot certificates with instrument ratings, for their study. None of the participants had experience flying an aircraft equipped with an airframe parachute. In their findings, it was reported that participants that received the SBT received significantly higher measures in overall pilot performance and higher self-efficacy than those in the control group (Blickensderfer, Strally, & Doherty, 2012). In terms of the overall decision to use the parachute the groups were not significantly different. The experimental group did, however, perform better on additional measures regarding the airframe parachute such as timing and altitude to deploy, along with a review of landing options (Blickensderfer, Strally, & Doherty, 2012). The researchers recognized that a number of participants in the pre-test flight admitted to forgetting about the possibility of using the airframe parachute, which suggests the need for training.

A major impetus for the current study was an earlier work by Winter, Fanjoy, Lu, Carney, and Greenan (2013) who found very few participants recognized a CAPS deployment situation when one was encountered on a flight in an aircraft training device. In that study, participants completed a scripted flight simulation in which they were flying on an instrument flight plan in instrument conditions with a ceiling of 400 feet above ground level (AGL). An expert panel validated the flight script before the experiment began, and it was determined that a CAPS deployment was the most appropriate outcome. However, in conducting the experiment, only nine out of 22 participants deployed the airframe parachute and of the nine who did deploy, only three followed the correct procedure as outlined in the aircraft's operating handbook (Winter, et al., 2013).

Methods

Participants

The participants consisted of members of the flight-training department at the subject university. Eligible participants were either students or flight instructors who completed training in the Cirrus aircraft. In total, 252 participants were deemed to be eligible to complete the survey: 49 flight instructors and 203 students. Over the three weeks the survey was available, 77 participants responded to the request, resulting in a response rate of 30%. However, only 63 participants completed the survey accurately, and therefore, only these responses were used in the data analysis. Of the 63 participants analyzed, 22 were flight instructors, a 45% response rate for this subgroup. The student subgroup had 41 responses or 20%.

Instrument

A survey was deemed the most appropriate and efficient instrument to collect data to answer the research question (Gall, Gall, & Borg, 2007). The authors developed questions, and the instrument was divided into two sections: general CAPS knowledge and scenario-based examples. Experts from Cirrus Aircraft, specifically the manager and director of flight training served as the content experts and validated the questions. A Cronbach's Alpha of 0.763 and 0.816 were recorded for the general CAPS knowledge and scenario-based examples sections, respectively, indicating a high level of reliability (Hinton, Brownlow, McMurry, & Cozens, 2005).

Procedure

The instrument was created on a web-based tool available at the subject university, which assisted in maintaining participant anonymity throughout the study, and the subject university's Institutional Review Board (IRB) provided an approval for the study. After the instrument was developed and checked for content validity, it was sent to the 252 eligible participants via e-mail addresses that were granted to the researchers from flight training records. The initial e-mail explained the purpose, instructions, and eligibility requirements to participate in the study and included a link to complete the survey. The survey window remained open for approximately 3 weeks near the end of the Spring 2013 semester and participants received three e-mail reminders requesting participation.

Results and Discussion

Demographic Information

Participants had a rather large variance in some of the demographic categories, especially within the flight instructor subgroup. For the students, the mean age was just over 19 years old and students reported an average of 150 and 101 total flight hours and total Cirrus flight hours, respectively. Flight instructors had a mean age of around 24 years old, with a median of 21 years of age. Large variances existed in the flight experience categories for this group due to some participants having in excess of 12,000 total flight hours. While the mean total flight time for flight instructors was 2,672 hours, the median was 700. Similarly, for total dual given flight time, the average was 928, with a median of 230 hours. Experience for flight instructors in the Cirrus aircraft had less variance. The average total Cirrus flight experience for flight instructors was 326 hours and total dual given in Cirrus aircraft was 251 hours. On average, instructors held a flight instructor certificate for approximately 7 years. A summary of these demographic findings is provided in Table 1. Participants represented a wide range of certificates held. Approximately two thirds reported holding at least a private pilot certificate with 46% holding instrument ratings, and 29% held Certified Flight Instructor certificates.

Table 1.
Demographic Characteristics of Students and Flight Instructors

	Students				Flight Instructors			
	n	M	*SD*	Median	n	M	*SD*	Median
Age	31	19.71	1.53	19.00	16	24.56	6.51	21.50
Total Flt Hrs.	41	150.48	83.75	150.00	22	2672.77	4803.25	700.00
Total Cirrus Hrs.	40	101.18	46.52	100.00	22	326.09	255.86	285.00
Total Dual	NA	NA	NA	NA	21	928.29	1697.44	230.00
Total Dual Cirrus	NA	NA	NA	NA	22	251.00	250.87	150.00

General CAPS Attitude/Knowledge

The purpose of this survey section was to gather participant's attitudes and knowledge on the general principles behind CAPS. In the current study, the majority of students (95%) and flight instructors (96%), responded that they would use the parachute in an appropriate deployment scenario. However, two students disagreed and one flight instructor strongly disagreed with this statement. When asked if operating an aircraft with an airframe parachute was safer than one without, a higher percentage of students (85%) strongly agreed or agreed with this statement than flight instructors (68%). This finding closely relates to the results found by McMahon (2008) where 77% of respondents indicated a parachute system increased the aircraft's safety.

Flight activity and risk assessment. Questions were also asked regarding incorporation of the parachute into normal flight activity and risk assessment. There were inconsistent responses from participants when asked if a CAPS briefing was included as part of the takeoff briefing. Student and flight instructor responses were very close on this question with 53% of students and 50% of flight instructors strongly agreeing or agreeing with this statement. Thirty-seven percent of students either strongly disagreed or disagreed with this statement, while 10% remained neutral compared to 32% of instructors who strongly disagreed or disagree while 18% remained neutral. When asked to compare risk taking in aircraft equipped with an airframe parachute an interesting dichotomy appeared. The majority of participants indicated that *they* would not assume more risk when flying a parachute equipped aircraft with both students and instructors, 83% and 82% respectively, strongly disagreeing or disagreeing with this statement. However, when asked is they thought *others* would assume more risk only 29% of students and 37% of instructors strongly disagreed or disagreed with this statement. This finding suggests that participants may believe the parachute system would cause others to take more risks, yet they do not believe this bias would impact them.

CAPS training. When asked if they had received adequate training on when and when not to use the airframe parachute, 76% of students strongly agreed or agreed slightly more compared to 63% of the flight instructors. Both groups felt, however, that training is necessary when flying an airframe equipped aircraft as 100% of flight instructors strongly agreed or agreed with this statement and 91% of the students. This is very different from the results found by McMahon (2008) in which 94% of her grouping of new instructors (those with less than 2 years experience) felt training was not necessary. It is possible that these participants did not have a complete understanding of the parachute system or perhaps they had never flown an aircraft with a parachute, which was not a requirement to participate in the study by McMahon. The current study was also interested in determining if participants had completed training in the advanced aircraft training devices (AATD) that were available at the university to complete parachute deployment scenarios. The findings from this question are mixed yet seem to indicate that many participants did not complete training in the AATD. Of the students, 69% answered strongly disagree or disagree and 63% of the flight instructors. More instructors, 37% agreed or strongly agreed that they had completed AATD training, but only 15% of students shared this feeling; a few students, 17%, neither agreed nor disagreed with the statement.

Students were mixed in their response to whether they would be fearful of damaging the aircraft from a CAPS deployment with 44% strongly disagreeing or disagreeing while 42% strongly agreeing or agreeing. Some students, 15%, remained neutral. More flight instructors, 77%, strongly disagreed or disagreed with this sentiment, 19% strongly agreed or agreed, and 5% remained neutral. For the student group, this question produced a significant negative correlation between the support they felt they would receive from the flight training program if they used the parachute system, $r = -0.311$, $p = 0.024$, which suggests that the more fear students had of damaging the aircraft, the less they felt the flight training program would support their decision to deploy the parachute. Flight instructors experienced an opposite, yet insignificant relationship, $r = 0.219$, $p = 0.094$. Flight instructors were much less fearful of damaging the aircraft from a CAPS deployment than were students. Additionally, 73% of flight instructors felt their decision to use the parachute would be supported by the flight training program compared to 63% of students.

Scenario-Based Examples

A series of 11 scenario-based questions were asked of participants to gauge their willingness to use the airframe parachute system in real-world situations, using a strongly disagree to strongly agree scale. In all scenarios, participants were instructed to identify those situations in which they would *use* the airframe parachute. They were also instructed to assume they were flying a Cirrus SR20 G3 aircraft and out of gliding distance to an airport. The use of an airframe parachute will always involve some subjectivity on the decision-making of the pilot, however, based on these recommendations from Cirrus aircraft and the aircraft operator, there should become clear situations that favor the use of CAPS and clear situations when traditional pilot techniques, such as a forced landing may be more appropriate. Guidance on the correct response was provided from the Cirrus SR20 Pilot’s Operating Handbook (POH), and through experts at Cirrus Aircraft. Cirrus Aircraft (2008) provides guidance to pilots on which scenarios are appropriate to use CAPS and these scenarios include: a mid-air collision, structural failure, loss of control, forced landing in inhospitable terrain and pilot incapacitation. Additionally, a CAPS deployment is also the required response to recover from a spin or in the event of an aircraft ditching (forced landing in water). Of the 11 scenarios, eight were designed to favor a CAPS deployment, while three were considered to not be CAPS usage scenarios.

Time of day. Three of the scenarios involved emergencies that sought to identify how time of day may influence the decision to deploy the airframe parachute: two involving engine failures and one complete electrical failure. Based on responses to these scenarios, whether day or night conditions prevailed influenced participant’s decision regarding CAPS. When presented with an engine failure over Indiana during daytime conditions, no students or flight instructors agreed or strongly agreed that a CAPS deployment should be completed. Similarly, in a scenario that involved a complete electrical failure in daytime VFR conditions, 100% of flight instructors and 91% of the students strongly disagreed or disagreed with a CAPS deployment. One student agreed, and three students remained neutral. The response offered by participants in these scenarios appears to be in accordance with the Cirrus SR20 G3 POH which states, “if a forced landing is required because of engine failure, fuel exhaustion, excessive structural ice, or any other condition CAPS activation is only warranted if a landing cannot be made that ensures little or no risk to the aircraft occupants” (p. 10-5). However, when presented with a scenario the involved an engine failure at night over Indiana, participants became more diverse in their responses. While 59% of flight instructors agreed or strongly agreed with a CAPS deployment in this scenario, only 39% of students felt the same. A possible confounding issue with this scenario may be the perceived visual references available to the pilot, which may influence a pilot's decision to use CAPS or attempt a forced landing. Cirrus subject matter experts strongly recommended a CAPS deployment in this scenario.

Location. Two scenarios presented emergency situations over different types of geographical conditions. When asked about an engine failure that occurred over inhospitable terrain, 100% of the instructors and 98% of the students strongly agreed or agreed that a CAPS deployment was the most appropriate outcome. One student neither agreed nor disagreed. When participants were presented with a scenario that involved ditching the aircraft in water, only 73% of the flight instructors and students strongly agreed or agreed that a CAPS deployment was appropriate. These questions provided an interesting finding because both scenarios clearly state, in the aircraft's POH, that a CAPS deployment should be completed.

Weather. Four scenarios presented various weather conditions, with three of them representing an engine failure in IMC, but with varying above ground level (AGL) ceilings: 1,500 AGL, 1,000 AGL, and 500 AGL. The purpose of these question was to attempt and determine how ceiling height would influence the decision-making of the pilots and to understand when most felt the parachute became a better option over a forced landing. It appears that when the ceiling was at 1,500 AGL, participants were divided in their likelihood of deploying the parachute. As the ceiling lowers, more participants indicated they were more likely to deploy the airframe parachute. When descending and the aircraft is under control, Cirrus Aircraft recommends pilot's make the determination to use CAPS no later than 2,000 AGL (2013).

Participants also replied to a scenario that involved a flight in IMC and accumulating ice where they were no longer able to maintain altitude. Students and flight instructors were divided in thirds with approximately one third strongly disagreeing or disagreeing, one third neither agreeing nor disagreeing, and one third agreeing or strongly agreeing. It was unclear from the results why the participants were so divided in their response to this scenario; however, the ceiling provided in this question was 1,500 AGL, which participants may have felt it allowed them time to continue and address the situation. Despite no longer being able to maintain altitude, participants may have felt the aircraft was still controllable. Subject matter experts from Cirrus Aircraft strongly recommended a CAPS deployment to this scenario.

Aircraft control. Two scenarios dealt with aircraft control. When asked regarding loss of aircraft control, the majority of students and flight instructors, 76% and 82% respectively, strongly agreed or agreed that CAPS should be used. However, 12% of the students and 5% of the instructors either strongly disagreed or disagreed with a CAPS deployment in this scenario. While this only represented 5 students and 1 flight instructor, it was concerning to see that when control of the aircraft was lost, a few participants appeared to still be resistant to using CAPS.

Participants were also presented with a scenario that involved an aircraft spin at 1,500 AGL. The Cirrus SR20 G3 POH (2008) states, "the aircraft is not approved for spins, and has not been tested or certified for spin recovery characteristics. The only approved and demonstrated method of spin recovery is activation of the Cirrus Airframe Parachute System" (p. 3-29). While 63% of students and 55% of the flight instructors strongly agreed or agreed with this statement, the other participants were neutral, disagreed or strongly disagreed. In the comments section of the survey one student provided the following comment: "I strongly disagree with using it right away after entering a spin. Altitude permitting, I would make a couple of attempts to recover before pulling the CAPS, regardless of manufacturer or university policy." While this finding is of concern, further research is needed to gain a better understanding to determine if this discovery is representative of the population and as to why some participants appeared reluctant to deploy the CAPS in this scenario despite the manufacturer and POH guidance.

Conclusions, Recommendations, and Limitations

After analysis, the researchers found that there appears to be training discrepancies among participants. These discrepancies appear in the scenario-based examples and the general CAPS knowledge/attitude. Within the CAPS knowledge/Attitudes sections of the survey, the majority of participants indicated that they felt safer in an aircraft equipped with a CAPS system, however participants believed that a CAPS system caused other pilots to assume greater risk. How the participants are reducing their own risk is unknown. Furthermore, there appears to be issues of standardization among participants' standard briefings, specifically the take-off briefing, where participants are not considering briefing the operations of the CAPS system and appropriate use. This issue is further compounded with participants indicating the need for proper training, yet few participants stating they received AATD deployment training. Further research is needed to determine the effect that non-AATD deployment training has versus AATD deployment training.

When the researchers analyzed the scenario-based examples, several additional examples of training discrepancies were noted. Some of the larger issues arise when there is a disparity between Cirrus Aircraft experts and the participants. Most notably the unwillingness, as indicated by the participants, to deploy the parachute when Cirrus Aircraft experts would strongly recommend a CAPS deployment. When analyzing the responses the main concern is why there is a disparity among highly trained participants in a standardized training program and their willingness to use and understanding of the CAPS system. Since participants indicated the need for training, the researchers would conclude that any training should include a well-established and understood policy on the use and consequences of a CAPS deployment.

With any research there are limitation to that study. The researchers understand that a limited sample from a single training program may affect the generalizability to the whole of training programs. Furthermore, the researchers were unable to match responses of students to their instructors. Therefore, the researchers were unable to determine if the training disparity is isolated to specific instructors teaching their student non-standard procedures. Finally, the researchers understand that a low response rate will influence the analysis of the data.

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