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Mary E. Johnson, Ph.D., Editor

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Mary E. Johnson, Editor

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No juried publication can excel without the tireless efforts of experts in the field volunteering their time to serve as anonymous reviewers. Indeed, the ultimate guarantors of quality and appropriateness of scholarly materials for a professional journal are the knowledge, integrity, and thoroughness of those who serve in this capacity. The thoughtful, careful, and timely work of the *Editorial Board* and each of the following professionals added substantively to the quality of the journal, and made the editor's task much easier. Sincere thanks are extended to each reviewer for performing this critically important work. In addition to the members of the *Editorial Board*, the other reviewers for this issue include:

Tyler Babb	Middle Tennessee State University
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John Young	Purdue University

STATEMENT OF OBJECTIVES

The *Collegiate Aviation Review* is published semi-annually by the University Aviation Association. Papers published in this volume were selected from submissions that were subjected to a blind peer review process, for presentation at the 2015 Fall Education Conference of the Association in Utah.

The University Aviation Association is the only professional organization representing all levels of the non-engineering/technology element in collegiate aviation education. Working through its officers, trustees, committees and professional staff, the University Aviation Association plays a vital role in collegiate aviation and in the aviation industry.

The University Aviation Association accomplishes its goals through a number of objectives:

> To encourage and promote the attainment of the highest standards in aviation education at the college level.
>
> To provide a means of developing a cadre of aviation experts who make themselves available for such activities as consultation, aviation program evaluation, speaking assignments, and other professional contributions that stimulate and develop aviation education.
>
> To furnish a national vehicle for the dissemination of knowledge relative to aviation among institutions of higher education and governmental and industrial organizations in the aviation/aerospace field.
>
> To foster the interchange of information among institutions that offer non-engineering oriented aviation programs including business technology, transportation, and education.
>
> To actively support aviation/aerospace-oriented teacher education with particular emphasis on the presentation of educational workshops and the development of educational materials in the aviation and aerospace fields.

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Call for Papers

The *Collegiate Aviation Review* (*CAR*) is the refereed journal of the University Aviation Association (UAA). Both qualitative and quantitative research manuscripts relevant to aviation are acceptable. The *CAR* review process incorporates a blind peer review by a panel of individuals who are active in the focus area of each manuscript. Additional recommendations are also provided by the editors of the *CAR*. A list of all reviewers is published in each edition of the *CAR* and is available from the *CAR* editor.

Authors should e-mail their manuscript, in Microsoft Word format, to the editor at CARjournal@uaa.aero no later than **January 5 (Spring 2016 issue)** or **April 5 (Fall 2016 issue).** Previous editions of the *CAR* should also be consulted for formatting guidance. Using Times New Roman 12 point font with 1.25" margins, the paper should be single spaced with a space before and after each heading. All paragraphs are to be formatted as 'justified'. Manuscripts must conform to the guidelines contained in the *Publication Manual of the American Psychological Association, 6th edition*. Specifically, this means that submissions should follow the formatting found in the manual, e.g. proper use of the headings, seriation, and in-text citations. The references section must be complete and in proper APA format. Submissions that include tables and figures should use the guidelines outlined in the APA manual. In order to better align the *CAR* with the general research community, submissions using quantitative analysis should take into account the recommendations of the APA Task Force on Statistical Inference. Papers that do not meet these expectations will be returned to the author for reformatting.

All submissions must be accompanied by a statement that the manuscript has not been previously published and is not under consideration for publication elsewhere. Further, all submissions will be evaluated with plagiarism detection software. Instances of self-plagiarism will be considered the same as traditional plagiarism. Submissions that include plagiarized passages will not be considered for publication.

If the manuscript is accepted for publication, the author(s) will be required to submit a final version of the manuscript via e-mail, in "camera-ready" Microsoft Word format, by the prescribed deadline. All authors will be required to sign a "Transfer of Copyright and Agreement to Present" statement in which (1) the copyright to any submitted paper which is subsequently published in the *CAR* will be assigned to the UAA and in which (2) the authors agree to present any accepted paper at a UAA conference to be selected by the UAA, if requested. Students are encouraged to submit manuscripts to the *CAR*. A travel stipend for conference attendance up to $500 may be available for successful student submissions. Please contact the editor or UAA for additional information.

Questions regarding the submission or publication process may be directed to the editor by email to: CARjournal@uaa.aero.

Editor's Commentary

The University Aviation Association (UAA) publishes the *Collegiate Aviation Review* (*CAR*) as its peer-reviewed journal. As mentioned in the Spring 2015 edition editor's commentary, the papers published in the *CAR* address aviation research issues pertinent to both collegiate aviation education and the global air transport system. With this span of aviation research, *CAR* articles are both relevant and accessible to academia, industry, non-governmental organizations, and governmental bodies. This viewpoint echoes one of the UAA objectives - "To furnish a national vehicle for the dissemination of knowledge relative to aviation among institutions of higher education and governmental and industrial organizations in the aviation/aerospace field." The *CAR* is one of those vehicles.

In this edition, authors submitted nine articles to the *CAR* for review. After the work of the reviewers and revisions by authors, there were five articles that were completed and accepted for this issue. My hope is that readers learn new information from the articles and that these articles inspire additional research questions to be pursued. There is no shortage of interesting and relevant research questions in the exciting, diverse, and dynamic aviation/aerospace field.

The members of the editorial board and the other reviewers listed in this edition deserve sincere appreciation from the UAA members for their time and energy expended to review the broad array of articles submitted to the journal. At the Fall Conference in Utah, you may have a chance to meet one of the Publications Committee or the reviewers listed in this edition or in the Spring edition. If you do, then I encourage you to thank them for their service to UAA. Careful, complete, and timely reviews are necessary for the peer-review process to work and are vital for a vibrant research community to thrive. Without these reviewers and the countless other reviewers for previous editions of the *CAR*, there would be no *CAR*. A special thanks to Dick Fanjoy for working with me while the Publications committee seeks a new associate editor.

If you have a question about publishing in the *CAR*, please do not hesitate to contact me. Thank you to all who actively support the *CAR* and our voice of collegiate aviation, the UAA.

Sincerely,

Mary E. Johnson, Editor

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How Trust in Commercial Airline Pilots is Affected by Their Perceived Sociability: A Mediation Analysis

Stephen Rice, Scott R. Winter, and Russell Tokarski
Florida Institute of Technology

Abstract

Sociability relates to one's preference to interact with others or remain alone. The current study sought to determine how a pilot's perceived sociability would relate to consumers' trust ratings in their pilot using participants from India and the United States. Consumers were presented with one of two scenarios. In the control condition, the pilot was described as sociable, while in the other, the pilot was presented as unsociable. Participants were then asked to rate their trust in the pilot based off of these cues. In general, participants indicated that the pilot who was perceived as unsociable was less trusting compared to the pilot that was perceived as sociable. Americans tended to be more extreme in their trust ratings of the pilots than those participants from India. Finally, affect measures were also collected, and it was found that affect completely mediated the relationship between the sociable/unsociable conditions and trust ratings.

Introduction

Previous studies have examined how perceived sociability effects the public's perception of an airline pilot's mental health (Winter & Rice, in press). The current study has taken this a step further by examining how the perceived sociability affects the public's trust in the pilot and predicts that affect will mediate the relationship between sociability and trust. The literature review will establish the link between a pilot's sociability and how it affects the trust of the pilot.

Sociability

Cheek and Buss (1981) defined sociability as "a tendency to affiliate with others and to prefer being with others to remaining alone" (p. 330). A person's sociability has been divided into two types: introvert or extrovert (Winter & Rice, in press). Introverts are those who prefer to avoid social situations, while extroverts are usually thought of as outgoing and personable. A person may tend toward one type or the other, dependent on the situation or circumstance. Based on the outward cues of sociability that one purveys, others will form a perception of that person based on a mental model that is biased by stigma and affect. In a previous study, Rice and Winter (in press) noted that a pilot's perceived sociability led passengers to believe the pilot had some type of psychological disorder. This raises the question that if the same behavior were perceived in the person, but that person was not the pilot of the passenger's airplane; would it have led to the perception of a psychological disorder? At the same time, as Caldwell (2012) has explained, an individual's sociability has been associated with the levels of the neuropeptides; oxytocin and vasopressin, produced in the hypothalamus, and it could indicate a psychological disorder.

Fiske (1993) has posed that people tend to overreact to perceived negative information about a person. This is supported by Taylor's (1991) mobilization-minimization hypothesis. This poses that people respond to negative perceptions by first mobilizing psychologically, cognitively, emotionally, and socially, then by minimizing this internal stimuli. As far back as De Laguna (1919), it was recognized that perception and emotion are separate constructs, and that perceptual cues (perceptual qualities) are what spark emotional response (affective qualities). Now that it is established that perceptions are influenced by emotions, or affect, it will be necessary to establish what affect is and how it influences trust.

Affect and Stigmas

Recent research on affect has focused on its influence on decision-making (Bodenhausen, 1993; Bower, 1991; Clore, Schwarz, & Conway, 1994; Forgas, 1995; Loewenstein, 1996; Schwarz & Clore, 1996; Zajonc, 1998). It has been suggested that emotions assist in the decision making process when multiple streams of information require immediate processing simultaneously, and when there is the need for coordination of psychological, behavioral, and experiential responses (Frijda, 1986; Levenson, 1994; Oatley & Johnson-Laird, 1996). It has even been suggested that cognitive processes may be interrupted by emotions during events that require deliberation, especially when those emotions are directing attention, memory, and judgment (Johnson-Laird & Oatley, 1992; Lazarus, 1991; Schwarz, 1990; Simon, 1967; Tooby & Cosmides, 1990). It has also been suggested that because of this, certain social stigmas may be the result of negative emotions (Winter & Rice, in press). It seems that stigmas and affect are heavily relied upon during quick decision making when limited information may be available. The affect heuristic is highly influenced by strong emotion, with less reliance on the cognitive process (Alhakami & Slovic, 1994). It has also been found that the affect heuristic has an inverse relationship with time pressure and emotional response (Finucane, Alhakami, Slovic, & Johnson, 2000; Lowenstein, Weber, Hsee, & Welch, 2001). Because of this research it could be suggested that affect has an impact on a person's perceptions of others, which could have an effect on their trust of that person.

Stigmas are defined as the prejudices that may be held against another because they are a part of or perceived to be a part of a specific group (Crocker, Major, & Steele, 1998). Usually stigmas are associated with negative emotional reactions. They have been found to be associated with age, sexual orientation, gender, obesity, ethnic background, and physical or mental disabilities (Crocker, Major, & Steele, 1998; Link & Phelan, 2001; Mahjan et al., 2008). These stigmas may cause additional barriers for those afflicted with them, such as, social, economic or interpersonal (Crocker & Major, 1989; Crocker, Voekle, Testa & Major, 1991; Jones et al., 1984). Mental illness was one such stigma recently explored in another study. It was found that airline pilots who were perceived to be antisocial were labeled with the stigma of mental illness (Winter & Rice, in press). Because of this stigma, it is theorized that pilots who are perceived as being less social than others will not be trusted.

Trust

Trust has been defined in many ways, but the most effective definition for the current study is the ability to predict and rely on another’s behavior (Deutsch, 1958; Eckel & Wilson, 2004; Ergeneli, Saglam, & Metin, 2007). If a person is able to rely on another's behavior, it means they have a significant amount of trust in that person. The perception is that if the person has trust in another and that trust is not fulfilled, then they are worse off than if they would not have trusted (Deutsch, 1958). Herein the basis for this research: if a passenger trusts a pilot to fly the aircraft and get them to their destination safely and the pilot fails to complete this task, the passenger would surely be worse off than if they would not have trusted in the first place.

There have been two forms of trust identified by McAllister (1995), cognitive and affect-based. Trust is cognition based because we *choose* who we trust and we base that decision on viable reasons (Lewis & Weigert, 1985). Affect controls trust through emotional bonds between individuals (Lewis & Weigert, 1985). If we do not trust another, we tend to hold that person in suspicion (Deutsch, 1958). For emotional or cognitive reasons, this person did not gain our trust, so we label them with the stigma of being untrustworthy.

Recent studies on trust and trust theory have centered on trust in automation, formulating the theory that the more failures in an automated system, the less a person trusted the system. It is believed that this can carry over to the human/human interaction systems as well. If a person is perceived to be unreliable, then the trust in them will wane (Winter, Rice, Reid, & Mehta, 2015). Previous studies evaluated trust as an organizational behavior. In these studies, it was found that trust affects employee empowerment and managerial trust, as well as the trust between individual employees or groups within the organization (Ergeneli, Saglam, & Metin, 2007). Mishra and Spreitzer (1998) have indicated that trust is dependent on one’s emotional belief that the other party is reliable, competent, open, and concerned. This statement falls into line with McAllister’s (1995) cognitive side of trust. If an individual or group provides evidence of being unreliable, incompetent, not open, or unconcerned about the other, they will be labeled as untrustworthy, causing an emotional response. This emotional response will provoke a negative stigma to be placed on that person.

In a previous study, it was found that social stigmas had an effect on a person's trust in an airline pilot, based on the pilot's gender, age, physical structure, and ethnicity (Winter, Rice, & Mehta, 2014). It has also been found that a person's trust is highly influenced by another's sexuality, or social status, suggesting that trust is highly affected by emotions. Through mediation analysis in these previous studies it was found that affect tends to have a mediating relationship between the condition and trust. Another study also found that persons in India and the United States felt that airline pilots who are perceived to be unsociable may be tagged with the stigma of mental illness (Winter & Rice, in press). The stigma of mental illness is one of negativity. In both India and the U.S., persons stigmatized as being afflicted with mental illness are viewed as unstable and are limited in their duties or responsibilities (Stanhope, 2002; Corrigan, Markowitz, & Watson, 2004), indicating a lack of trust in those individuals or bestowing upon them the stigma of untrustworthiness.

Current Study

The current study expands on previous research on pilot sociability (Winter & Rice, in press). The researchers were specifically interested in how trust ratings would be affected by perceived sociability. Since participants in the earlier study viewed unsociable pilots as more likely to have a mental illness, there was desire to determine if consumers would have lower trust ratings of unsociable pilots as well. Finally, the research team sought to determine whether affect was a mediating variable between sociability and trust. The study consisted of individuals from both India and the United States to inspect for any cultural differences. Affect measures were collected to determine if affect had any mediating effect on the relationship between sociability and trust. The authors predicted the following:

> H_1: Pilots who are viewed as unsociable will also be viewed as less trustworthy by participants.
>
> H_2: Americans will be more extreme in their Affect and Trust ratings compared to Indian participants. There is some evidence of this in previous studies (Rice et al., 2014; Remy, Winter, & Rice, 2014; Winter, Rice, & Mehta, 2014).
>
> H_3: Affect will act as a mediator, at least partially, between sociability and trust. There is some evidence of this in the mental health literature (Richardson & Rice, in press; Rice, Richardson, & Kraemer, in press).

Methods

Participants

Participants for the study were recruited from India and the United States via a convenience sample from Amazon's ® Mechanical Turk ® (MTurk). MTurk is an online repository of participants from around the globe that complete human intelligence tasks (HITs) for monetary compensation. Previous research (Buhrmester, Kwang, & Gosling, 2011; Germine et al., 2012) has demonstrated that data collected via MTurk is just as reliable as data collected from traditional laboratory settings.

Three hundred and nine participants (127 females) from India completed the study. The mean age for participants was 31.56 (*SD*=9.63). Three hundred and seventeen participants (135 females) from the United States completed the study. The mean age was 31.14 (*SD*=10.30).

Materials, Stimuli, and Design

An electronic consent form was completed by participants to verify they were at least 18 years old. In the control condition, participants reviewed the following scenario: *Imagine that you are on a commercial airline flight from one major city to another. As you are preparing to board, you overhear one of the flight attendants telling the other that the pilot has recently been acting like his usual cheerful self. He has been communicative with his crew and friends. He has posted positive messages on social media and Facebook in* *the past month. He has been pleasant to his co-pilots."* In the experimental condition, the following scenario was presented: *"Imagine that you are on a commercial airline flight from one major city to another. As you are preparing to board, you overhear one of the flight attendants telling the other that the pilot has recently been acting strange and not like his usual self. He has lost his temper twice in the past two weeks. He has not been very communicative with his crew or friends. He has avoided social media. He has not posted to Facebook in the past month. He has been rude to his co-pilot on several occasions."*

Participants from both conditions were asked three affect questions on a 7-point Likert-type scale to rate how the respective scenarios made them feel. These responses ranged from extremely negative/unfavorable/bad (-3) to extremely positive/favorable/good (+3), with a neutral option of zero. The gathering of these affect measures followed a similar procedure as completed in previous research (Rice, Richardson, & Kraemer, in press; Winter, Rice, & Mehta, 2014). Appendix B shows the affect measures.

Participants in both conditions were then asked to rate their trust in the pilot and how trustworthy they thought he/she would be based on the information provided in the scenario. The study used an instrument called the Trust in Commercial Airline Pilots (T-CAP) scale, which is provided in Appendix A. This instrument was validated by Rice, Mehta, Winter, and Oyman (2015) and consists of 5 items measured on a five-point Likert scale from strongly disagree (-2) to strongly agree (+2), with a neutral option of zero. Finally, demographic information was collected from participants before completion of the study.

The study used a three-way between-participants design. Country of Origin, Gender, and Sociability were the independent variables. The dependent variables for the study were affect (mediator variable) and trust.

Results

Factorial Analyses. First, a Cronbach's Alpha was conducted on the three Affect questions. Values ranged from .88 to .96, indicating high internal consistency. Therefore, these data were combined into one measure for analysis purposes. A three-way ANOVA was completed with Country, Gender, and Sociability as between-participant variables. For the Affect dependent variable, there was a significant main effect for Sociability, $F(1, 618) = 893.83$, $p < 0.001$, $np^2 = .59$, and there was a significant interaction between Sociability and Country, $F(1, 618) = 30.95$, $p < 0.001$, $np^2 = .05$. These data, shown in Figure 1, suggest that pilot sociability impacts Affect ratings of participants, and that participants from the United States produced more extreme responses in both conditions compared to participants from India ($p < 0.05$).

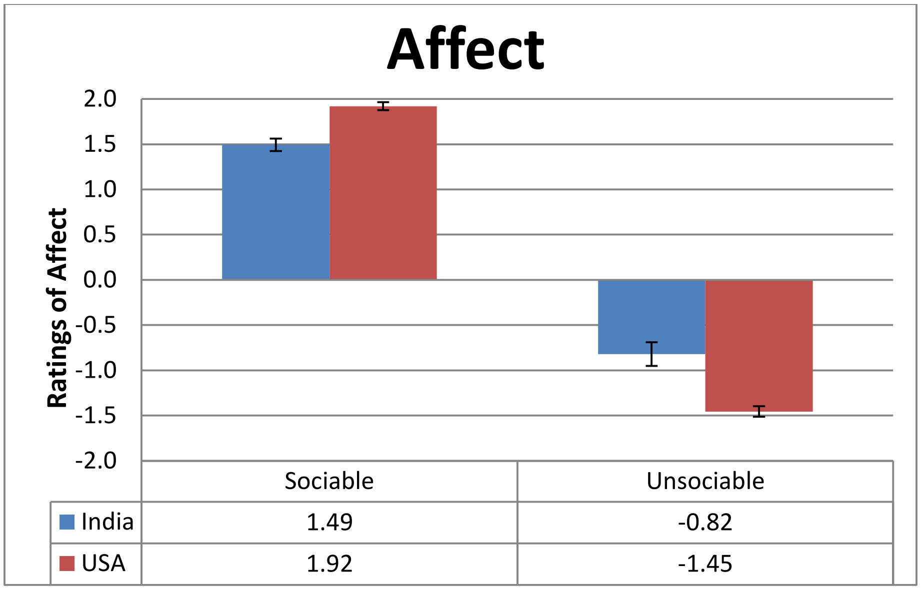

Figure 1. Affect data from the study (SE bars included).

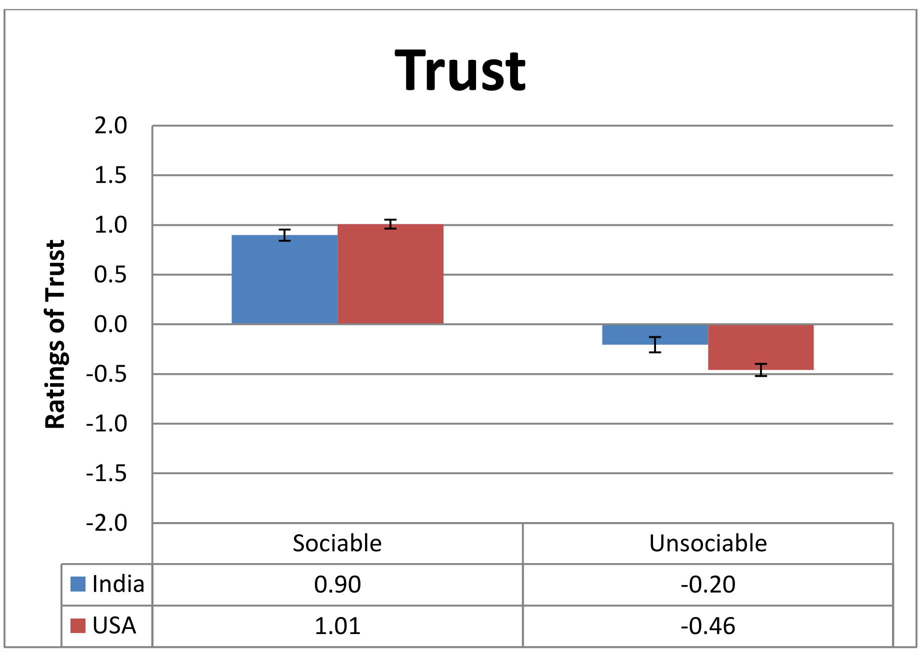

Figure 2. Trust data from the study (SE bars included).

The data for trust ratings were also subjected to a Cronbach's Alpha analysis. Values ranged from .88 to .92, indicating high internal consistency. Therefore, the trust measures were merged into one dependent variable for analysis. A three-way ANOVA, with Country, Gender, and Sociability as between-participant variables, indicated a significant main effect for Sociability, $F(1, 618) = 254.94$, $p < 0.001$, $np^2 = .41$, along with a significant interaction between Sociability and Country , $F(1, 618) = 8.65$, $p < 0.01$, $np^2 = .01$. As

Figure 2 shows, Americans tended to be more extreme in their responses; however, this was only statistically significant for the Unsociable condition ($p < 0.01$).

Mediation Analyses. Figure 3 provides a graphical depiction of the mediation analysis performed on the data for American participants. To complete a mediation analysis, a correlation must first exist between the initial variable (sociable or unsociable) and the outcome variable (trust). This relationship was shown to be significant, $r = .739$, $p < .001$. The standardized path coefficients were: condition to affect (.901, $p < .001$); affect to trust (.930, $p < .001$); condition to trust controlling for affect (-.100, $p = .157$). These data suggests that affect completely mediated the relationship between condition and trust for American participants.

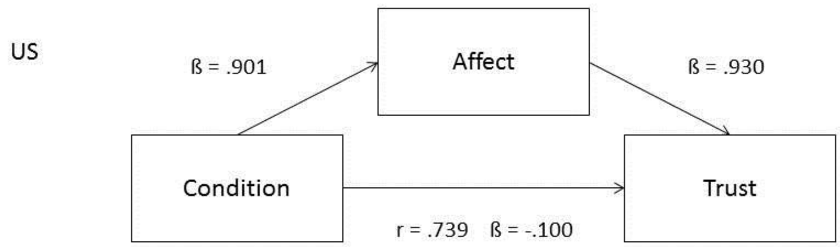

Figure 3. Path analysis for American participants.

Figure 4 depicts the mediation analyses for Indian participants. Before completing the mediation analysis, a significant correlation was shown to exist between the initial variable (sociable and unsociable) and outcome variable (trust), $r = .544$, $p < .001$. The standardized path coefficients were: condition to affect (.620, $p < .001$); affect to trust (.787, $p < .001$); and condition to trust controlling for affect (.056, $p = .177$). These data suggest that affect completely mediated the relationship between condition and trust for Indian participants.

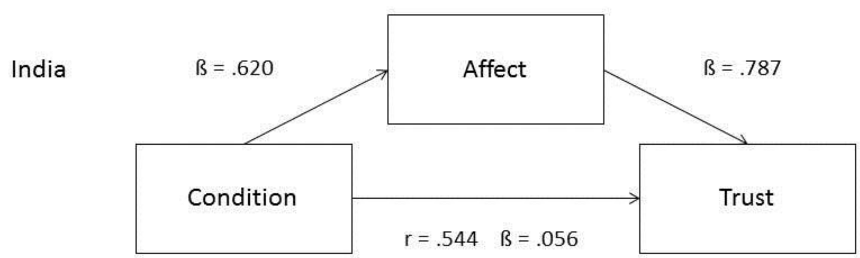

Figure 4. Path analysis for Indian participants.

General Discussion

This study determines how the perceived sociability of a pilot would influence the trust ratings of consumers. Prior research (Winter & Rice, in press) has demonstrated that sociability cues toward a pilot affect participant's opinion as to whether that pilot is suffering or likely to be suffering from a mental illness. Based on this finding, the authors wanted to determine how trust ratings would be affected by perceived sociability.

The first hypothesis predicted that pilots who were viewed as more sociable would also be viewed as more trustworthy than those viewed as less sociable. The data supported this hypothesis across both Indian and American participants. Pilots who were viewed as unsociable were identified as less trusting than those who were identified as sociable. As identified by Caldwell (2012), an individual's sociability level has been linked to various mental parameters and may be indicative of a psychological disorder. Additionally, Fiske (1993) has highlighted that persons tend to overreact toward negative information when received about another person. Therefore, it is not unreasonable to interpret participants' drops in trust ratings upon perceiving the pilot to be unsociable. Stigmas held towards those that are less sociable may also explain the drop in trust ratings. Crocker, Major, and Steele (1998) describe how prejudices are held against another because they are or are perceived to be part of a specific group, and these stigmas tend to be negative. Finally, people tend to trust most when they are able to predict the behavior and/or actions of another person (Deutsch, 1958; Eckel & Wilson, 2004; Ergeneli, Saglam, & Metin, 2007). If perceived as unsociable, it is plausible that participants may have felt the pilot was less predictable and therefore were willing to trust that individual less when compared to the sociable pilot.

The second hypothesis predicted that American participants would be more extreme in their ratings of trust than Indian participants as has been witnessed in previous studies (Rice et al. 2014; Remy, Winter, & Rice, 2014; Winter, Rice, & Mehta, 2014). The findings of the study, in general, support this hypothesis. When reviewing measures of affect and trust, American participants had higher ratings for the sociable pilot and lower ratings of the unsociable pilot than the Indian participants. However, while the trust rating for the sociable pilot was higher for Americans, it was not significantly different compared to the Indian participants. These findings, for the most part, are in agreement with the previously identified research. A possible explanation for these differences may be related to the specific cultures of each nationality. Americans tend to be more individualistic in their culture while Indians are more collectivist (Markus & Kitayama, 1991). Those from individualistic cultures are less likely to trust without question. Meanwhile those from collectivist cultures view themselves in the context of the population as a whole, may be more likely to trust without question, and less likely to challenge authority (Markus & Kitayama, 1991).

The third hypothesis predicted that Affect would act as a mediator, at least partially, between the sociability and trust ratings. Basis for this hypothesis was grounded in prior research from the mental health field (Richardson & Rice, in press; Rice, Richardson, & Kraemer, in press). The data supported this finding and Affect completely mediated the relationship between sociability and trust for both Indian and American participants. These findings suggest that the views held toward the trust ratings of a pilot perceived as sociable or unsociable are highly influenced by emotions, which can also affect judgment. This finding is similar to earlier studies that have shown Affect to mediate relationships toward trust in pilots (Remy, Winter, & Rice, 2014; Winter, Rice, & Mehta, 2014). Literature has shown that Affect plays a role in the decision-making process of individuals, especially when those decisions must be made in short periods of time. Additionally, the affect heuristic is highly influenced by strong emotions. It is possible that when participants were completing the study and had to quickly make a determination as to the trust of the pilot, emotional reactions heavily influenced the ratings.

Practical Implications and Limitations

It appears from the findings that participants were more trusting of a pilot perceived as more sociable. While pilots are employed to safely operate the aircraft, they also serve in the role of a company representative. Often times the flight crew are the most visible members of the airline. It is important for these persons to remember that their perceived sociability may have an effect on the consumer's overall experience during the flight, regardless of how well the flight goes. Further research should be completed to determine if similar findings are reported when the type of airline personnel is manipulated, such as flight attendants or gate agents. Additionally from an airline marketing perspective, portraying crew members in a sociable light may assist in creating trusting opinions of the flying public toward those individuals and the airline.

Certain limitations exist in the current study. First, the study is limited to those types of participants that complete online human intelligence tasks. These individuals tend to be current with technology, and a younger demographic. Therefore, generalizations of the findings must be limited to this population, which may not be representative of the population as a whole. Further research can expand the sampling technique to verify the results of this study and produce results with greater generalizability. Additionally, only two nationalities were reviewed in the current study, Indians and Americans. Further research could expand to various nationalities to see how other cultural aspects may influence the study's findings. Finally, participants may have been primed by the wording of the scenario for the pilot depicted as unsociable.

Conclusions

The findings of this study are similar to, and expand upon, previous studies completed in this field of research. When a pilot is perceived as sociable, participants tended to trust that pilot more than one that was perceived as unsociable. Americans, in general, tended to be more extreme in their trust ratings than Indian participants, which may be attributed toward the cultural differences between the two groups. Finally, affect completely mediated the relationship between the condition and trust ratings which signifies that participant responses were heavily influenced by emotions as opposed to cognition.

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Appendix A

Trust of Commercial Airline Pilots Scale

Please respond how strongly you agree or disagree with the following statements.

1. The pilot is dependable.

Strongly Disagree Disagree Neutral Agree Strongly Agree

2. The pilot is reliable.

Strongly Disagree Disagree Neutral Agree Strongly Agree

3. The pilot is responsible.

Strongly Disagree Disagree Neutral Agree Strongly Agree

4. The pilot is safe.

Strongly Disagree Disagree Neutral Agree Strongly Agree

5. The pilot is trustworthy.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Appendix B

Affect Measures

Please respond to how the scenario makes you feel:

Extremely Bad	Quite Bad	Slightly Bad	Neither Good nor Bad	Slightly Good	Quite Good	Extremely Good

Please respond to how the scenario makes you feel:

Extremely Unfavorable	Quite Unfavorable	Slightly Unfavorable	Neither Unfavorable nor Favorable	Slightly Favorable	Quite Favorable	Extremely Favorable

Please respond to how the scenario makes you feel:

Extremely Negative	Quite Negative	Slightly Negative	Neither Negative nor Positive	Slightly Positive	Quite Positive	Extremely Positive

Measuring Color Perception through Laser Mitigation Coatings on Aircraft Windshields

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Abstract

Ground-based laser illuminations directed towards arriving and departing aircraft have increased in the past decade. A laser aimed at the windshield of an aircraft may distract a pilot and compromise safety. Previous studies provided empirical evidence of laser intensity in the flight deck from ground-based laser illumination events and the potential for adverse effects to flight safety. Most recent studies focused on testing the application of various coatings to aircraft windshields in order to reduce the effects of laser exposure to crewmembers. Safe and efficient flight operations depend on the ability of a pilot to see normal spectrums of color. Therefore, this study used the Ishihara Pseudoisochromatic Plates Color Vision Test to investigate participants' color perception through an aircraft windshield coated with a photoresponsive nanocomposite film designed to reduce laser intensity from entering a flight deck. This study tested the hypothesis that there were no differences between color vision test scores when conducting trials with coated and non-coated windshields. Participants were individuals who held a current FAA medical certificate and held a minimum of a student pilot certificate (N = 104). Data analysis consisted of a repeated measures design that included within-subjects factors where each of the participants was tested from two trials, each under two conditions: coated and non-coated. The order of trials was altered using a counterbalancing technique which also provided a between-subjects factor. A paired-samples *t*-test was calculated to compare the mean of error by participants when taking the Ishihara Test through the non-coated windshield to the mean of the error by participants when taking the test through the coated windshield. No significant difference from the non-coated to the coated windshield was found ($t(103) = 1.274$, $p > 0.05$, $n = 104$). Findings suggest that effective color vision can be maintained through photoresponsive nanocomposite coatings.

Introduction

The safety record of aviation continues to improve with the number of fatal airline accidents in 2011 being the lowest in the last decade (Ranter, 2011). However, over the past several years laser illuminations directed at aircraft have increased in frequency and have led to safety concerns for the aviation community (Leiser, 2011). According to the Federal Aviation Administration's (FAA) Laser Safety Initiatives (2013), reports indicated a nine-fold increase in laser incidents between the years 2006 and 2012. For this study, laser illumination was defined as both the intentional and unintentional act of a laser beam striking an aircraft windshield during any phase of flight or ground operation. In a study by DeMik et al (2013) researchers utilized lasers which are readily available to the public, and shone them through three untreated aviation windshields. Researchers discovered that the highest potential risk to flight safety during illumination events is not necessarily eye injury, but the possibility of flight crews becoming distracted during critical phases of flight below 2000 feet.

Advancements in technology have been investigated in recent years in an attempt to reduce the potential dangers associated with laser illumination events that included the use of protective eyewear, smart goggles, and glare shields (Murphy, 2009). There is a patent pending on an active Laser Protection System (LPS) and was developed to provide an automatic adjustment response to laser light exposure and was developed in the form of both a visor and contact lens (Harvie, 2007). Lastly, glare shields can be used and deployed in the event of laser illumination events to reduce exposure.

One possible mitigation tactic is the use of protective eyewear on the flight deck. The benefits of eyewear may be outweighed by the consequences of the operational restrictions imposed on pilots. Laser eye protection in the form of filtered spectacles, visors and goggles can alter the environment in which pilots operate (Svec, 2005). Protective eyewear must be capable of allowing a normal spectrum of color and quantity of light to the pilot's eyes while blocking only the specific wavelengths associated with laser illumination events (Stewart, 2005). This may be challenging considering the availability of lasers in numerous hues and the necessity of ensuring there is no negative impact on color vision as colors associated with multi-function displays, electronic flight displays and annunciators are vital to the safe operation of the aircraft. "One case involved aircrew wearing yellow visors attempting to land on an unusable portion of the runway, they were unable to see the large yellow 'X' indicating the hazard" (Svec, 2005, p. 42).

A pilot's ability to discern color is needed for safe operation of an aircraft in critical phases of flight. Perception of color is necessary during the takeoff and landing phases of flight to differentiate and recognize items such as aircraft position lights, airport beacons, runway lights, approach slope indicators, light gun signals and obstruction lighting. Additionally, Part 67 of the Federal Aviation Regulations sets medical standards and certification requirements for airmen and mandates pilots to possess the ability to perceive those colors necessary for the safe performance of airman duties for all classes of medicals (FAA, 2015).

In a study conducted using active duty U.S. Air Force airmen, seven volunteers underwent comprehensive color vision testing to research the impact of Short Wavelength Absorbing Filters (SWAFs), such as High Contrast Visors (HCV), and selected waveband type Laser Eye Protection (LEP) devices on color vision (Young et al, 2000). These devices proved to significantly degrade color vision. Further research on low and bright illuminant conditions and the resulting impact on color vision were recommended.

Additional research in the medical and nursing field has demonstrated similar effects. One study indicated that laser protection devices may distort color perception by blocking the transmittance of specific light wavelengths (Teichman et al, 1999). Researchers tested the color confusion of urologists when wearing laser eye protection for laser soft tissue applications. They found that laser eye protection devices for potassium titanyl phosphate caused significant blue-yellow and red-green confusion.

It is noteworthy to mention that the use of visors, glasses, and glare shields are considered to be active mitigation countermeasures. Pilots must actively utilize these devices to protect themselves from laser illuminations. This may prove problematic during critical phases of flight, as it adds one additional item to a task-saturated environment. Considering this issue, Phillips et al (2015) recommended the use of a passive system, requiring no additional action from the pilots, through permanent photoresponsive nanocomposite films that are applied directly to an aircraft windshield to reduce the visual effects of laser illuminations. The coating selected for this current study was identified by researchers as having the most meaningful reduction in laser intensity with a mitigation effectiveness of approximately 80 percent (Phillips et al, 2015).

Statement of the Problem

The Federal Bureau of Investigations disclosed 3,960 FAA-reported laser illuminations directed towards aircraft in 2013, an increase from 384 reported incidents in 2006 (FBI, 2014). In response to the increase in laser illuminations over the previous decade, President Obama signed into public law the FAA Modernization and Reform Act of 2012, deeming it a federal crime to aim a laser at an aircraft. Despite these measures, laser illuminations continue to be a safety concern for aviation flight crews (FAA, 2013). At the time of this study, no previous research has been conducted to determine the effects of passive means, such as protective coatings on windshields, as related to color perception. In response to this problem, researchers investigated the impact of photoresponsive nanocomposite windshield coatings on participants' color perception.

Researchers in the study measured the impact of a coated windshield versus a non-coated windshield on the participant's color perception in an effort to answer the following hypotheses were tested:

1. There is no difference in the number of errors utilizing the Ishihara Color Test when conducting trials as viewed through coated and non-coated windshields.

2. There is no difference in the amount of time to complete the Ishihara Color Test when conducting trials as viewed through coated and non-coated windshields.

3. There is no difference in the number of errors utilizing the Ishihara Color Test when conducting trials based on the order of the windshield coating (non-coated vs. coated).

Methodology

Sample Population

Participants included only individuals who possessed a current FAA medical certificate with no restrictions for color vision and a minimum of a student pilot certificate. A total of 104 participants consisting of Lewis University students and instructors were tested. Participants ranged in age from 18 – 45 years old. Seven percent of participants in this study identified themselves as female and 93 percent of participants identified themselves as male.

Instrumentation

This study used Boeing 737 windshields, one coated with a laser protecting film and one non-coated windshield. The film selected was the most effective photoresponsive nanocomposite coating developed out of three films tested in a 2015 study by Phillips et al.. The Ishihara Test used by FAA medical examiners to test pilots for color perception was applied to conduct trials and calculate color vision performance scores. According to a validation study done by the FAA in 1993, the Ishihara Pseudoisochromatic 24-plate Color Vision Test has a respectable reliability with an alpha value of 0.98. Test-retest reliability was found to be k=1.00, therefore the FAA has accepted the Ishihara Test to provide consistent performance in aeromedical screening (FAA, 1993).

Data Collection

Participation in this study was strictly voluntary in nature and recruitment was in the form of classroom announcements, emails, and informational posters displayed at Lewis University. Participants were presented with a letter of consent and debriefed after each trial to remind them that participation and inclusion of their data was voluntary as approved by the Lewis University Institutional Review Board (IRB).

Each trial consisted of two tests: a test utilizing the non-coated windshield condition (control); and another under the coated windshield condition. The order of taking the tests was alternated among participants as a counter-balancing technique. The time required for each individual to take each test in its entirety was recorded in an attempt to determine if time is a significant factor in the success of each test. Participants identified the object or number designated on each color plate viewed through each windshield (Fig. 1). A researcher recorded both performance and time required while testing each windshield during the trial. In order to maintain the integrity of the Ishihara Test, registered nurses (RN), who were familiar with colorblindness testing procedures, conducted trials for each participant.

Figure 1. Photo representative of testing apparatus and participant.

Researchers utilized the Ishihara Test and testing was conducted according to standards set forth by the FAA (Fig. 2). The FAA has outlined the following techniques for all medical examiners (FAA 2014):

1. Test book should be held 30 inches from the participant;

2. Plates should be illuminated by at least 20 candles (or equivalent), preferably by a Macbeth Easel Lamp or a Verilux True Color Light;

3. Only three seconds are allowed for the participant to interpret and respond to a given plate; and

4. Participants are only tested using plates 1 to 15.

Researchers recorded and calculated responses given by each participant as a score ranging from 0 to 15 (correct response for each plate signifying one point) in order to determine any differences in color perception between the two trials using coated and uncoated windshields.

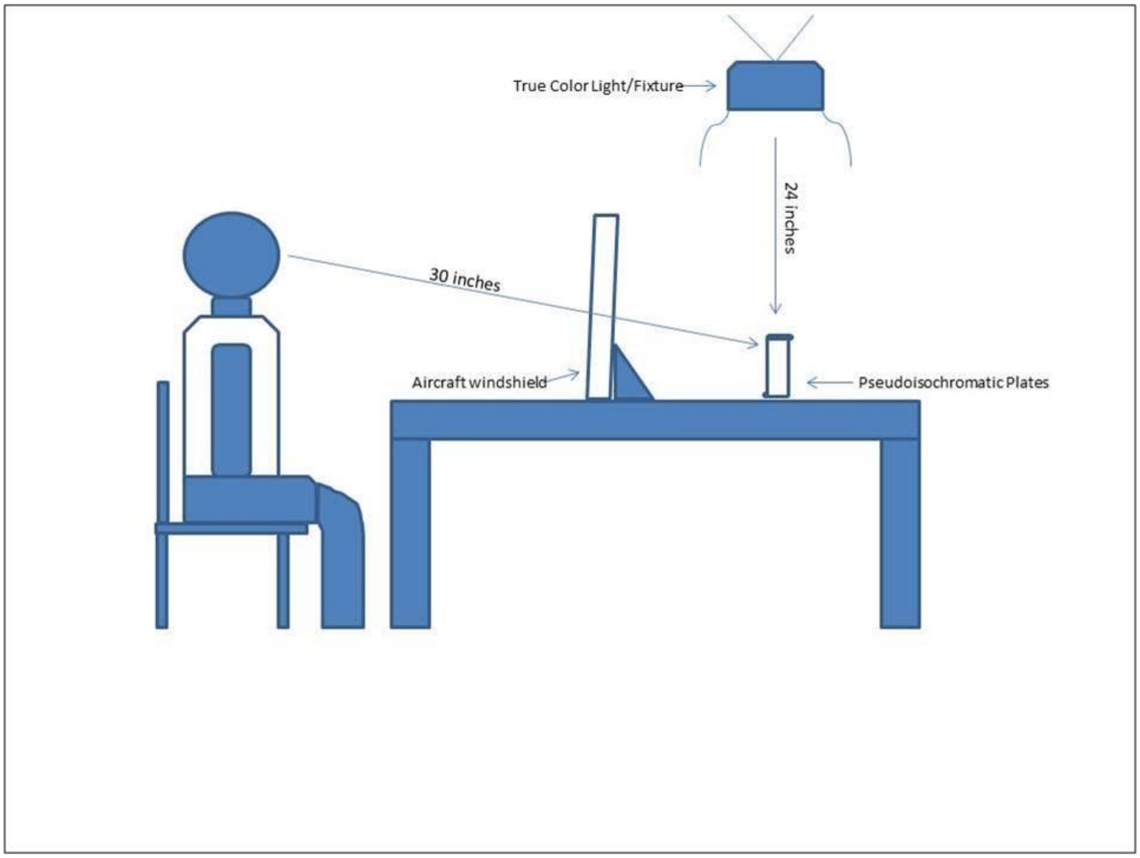

Figure 2. Depiction of participant and testing equipment during trials.

Statistical Analysis

The characteristics of this research study were consistent with a repeated measures design that included within-subjects factors where each of the participants provided data from two trials, each under a different condition (coated or non-coated). The order of trials (coated first or non-coated first) was altered using a counterbalancing technique which provided a between-subjects factor. All data for this study was entered into SPSS for analysis. The dependent variables were analyzed using a paired-samples *t* test to provide initial analysis for this study. There was also a between-subjects factor of order of trial.

The Type I error for this investigation was set at 0.05 ($\alpha = 0.05$). Minium, Clarke, and Coladarci (1999) noted that the Type I error of 0.05 is the most commonly used for this type of research. While this alpha gives a higher probability of incorrectly accepting a false alternative hypothesis (Type I error) than an alpha of 0.01, the results of this study were informational only. In this case the risk involved in a Type I error was small, and reducing the Type I error to 0.01 was not necessary.

Results

The findings of the data analysis support the stated hypothesis on each count.

Error

There was no difference in the number of errors utilizing the Ishihara Color Test when conducting trials as viewed through coated and non-coated windshields. A paired-samples *t* test was calculated to compare the mean of error by participants when taking the Ishihara Test through the non-coated windshield to the mean of the error by participants when taking the test through the coated windshield. The mean on the non-coated windshield was 0.24 (*sd* = 0.55) and the mean on the coated windshield was 0.34 (*sd* = 0.65). No significant difference from the non-coated to the coated windshield was found ($t(103) = 1.274$, $p > 0.05$, $n = 104$).

Time

There was no difference in the amount of time to complete the Ishihara Color Test when conducting trials as viewed through coated and non-coated windshields. A paired-samples *t* test was calculated to compare the mean of time utilized by participants when taking the Ishihara Test through the non-coated windshield to the mean of the time utilized by participants when taking the test through the coated windshield. The mean on the non-coated windshield was 25.03 seconds (*sd* = 4.82) and the mean on the coated windshield was 25.45 seconds (*sd* = 4.34). No significant difference from the non-coated to the coated windshield was found ($t(103) = 0.929$, $p > 0.05$, $n = 104$).

Order

There was no difference in the number of errors utilizing the Ishihara Color Test when conducting trials based on the order of the windshield coating (non-coated vs. coated).

An independent samples *t* test was calculated comparing the mean score of participants who took the Ishihara Test through the coated windshield first to the mean score of participants who took the test through the non-coated windshield first. No significant difference was found ($t(102) = -2.795$, $p > 0.05$, $n = 104$). The mean of the coated windshield time first ($m = 24.32$, $sd = 3.81$) was not significantly different from the mean of the non-coated windshield time first ($m = 23.73$, $sd = 4.58$). Of the104 participants, 53 were tested with the coated windshield first and 51 with the non-coated windshield first.

Discussion of the Results

The purpose of this study was to provide empirical evidence that the photoresponsive nanocomposite windshield coating does not negatively affect a participant's color perception. Researchers' specific goal was to evaluate if participants would demonstrate differences between color perception test scores when conducting trials utilizing coated vs non-coated windshields as a factor of: 1) overall errors made; 2) time recorded while taking each test; and 3) order of trials between windshields tested. Researchers hypothesized that the coating would demonstrate no significant impact on color perception errors on the Ishihara Test. Findings suggest that effective color vision can be maintained through photoresponsive nanocomposite coatings.

There is limited research regarding the impact of laser protective coating applications to windshields regarding the color perception of a user; however supporting research on protective eyewear or visors has demonstrated degradations to color perception (Young et al, 2000; Svec, 2005). Results from this study provide empirical evidence that the coating tested does not significantly affect participants' color perception. Although the windshield coating tested supported researchers' hypotheses, participants in the study did however provide comments that indicate further research into a more effective coating is necessary. Remarks included that the coated windshield was "blurry and tinted, but colors [were] unaffected" and that the coating "doesn't distort color but makes viewing hazy." Continued increases in reported intentional laser illuminations over the last decade lends further support to additional research on the development of an effective coating that does not distort perception.

The study limitations merit comment, specifically the environmental limitations. Trials for this study were administered within a controlled environment, established by the FAA as outlined in the Guide for Aviation Medical Examiners (FAA, 2014). Provisions for this study do not simulate all types of environmental conditions (weather, time of day, changes in ambient light) or other external stressors (fatigue or stress) which may exist during various phases of flight. Future research designs may benefit from the inclusion of varying weather and lighting conditions to better understand the coating's impact on color perception.

Recommendations for Future Research

The evidence available on the impact of laser illumination events on aircraft demonstrates that further research into the subject matter is both valuable and necessary. While this study suggests that the tested windshield coating does not significantly affect color perception, further research is required to demonstrate that the coating does not negatively impact the overall visibility and light available in the flight deck. Comments by participants regarding the blurriness of the film warrant investigation into various application techniques to improve clarity. In addition to investigating the windshield's coating on overall dilution or filtration, further exploration may be necessary regarding the effect that environmental conditions may have on life of the coating. Thermal testing would provide valuable information on the efficacy of the practical application of research in the commercial aviation environment.

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Inadvertent VFR-into-IMC Flights: A Qualitative Approach to Describing GA Pilots' First-Hand Experiences

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Abstract

The phenomenon of encountering instrument meteorological conditions (IMC) on a visual flight rules (VFR) flight has been the focus of several previous studies. Most of these past studies, though, have involved examining various databases quantitatively or via a mixed-methods approach in search of possible causal factors such as pilot characteristics, weather conditions, aircraft type, and time of day. Missing from the literature are qualitative studies that tell the story of pilots who actually experienced such flights. To help fill this gap in the aviation literature, the purpose of the current study was to describe the first-hand experiences of GA pilots who inadvertently flew VFR-into-IMC. Participants consisted of 11 male pilots who previously had flown from VFR-into-IMC inadvertently at some point during their aviation career. The study used a phenomenological approach to describe participants' shared experiences and then applied grounded theory to develop a set of conjectures derived inductively from participants' responses. Using Spradley's (1979) domain analysis to categorize common themes and patterns, the major domains of Weather Considerations and Expectations, Thoughts and Actions, and Postflight Experiences emerged. Major findings from the first domain revealed that as part of their preflight actions prior to departure, participants received a weather briefing, gave little consideration to overall weather conditions, neither expected nor anticipated IMC, and used a variety of communication resources to keep current with weather related issues. Major findings from the second domain revealed that participants recognized changes in the weather en route, used various communication resources to assess their current condition, reacted to IMC by trying to avoid and escape it, expressed feelings of trepidation about what they should do, were surprised over how the weather was not what they expected, and reverted to their training to get out of IMC. Major findings from the third domain revealed that participants' postflight actions ranged from doing nothing to submitting a report to NASA's ASRS, and that lessons learned included acquiring a heightened sense of situational awareness, a need to do a better job in alternative planning, and a greater appreciation for the weather. A comparison of these findings to past studies and theory are discussed, and implications and recommendations for practice and research are provided.

Introduction

Flying under visual flight rules (VFR) and continuing into instrument meteorological conditions (IMC) "is one of the most consistently lethal mistakes in all of aviation. Since 2002, more than 86% of all fixed-wing VFR-into-IMC accidents have been fatal, a higher proportion than for mid-air collisions, wire strikes, or pilot incapacitation" (Aircraft

Owners and Pilots Association, 2015, p. 1). According to a U.S. National Transportation Safety Board (NTSB) report, "about two-thirds of all general aviation (GA) accidents that occur in instrument meteorological conditions (IMC) are fatal, a rate much higher than the overall fatality rate for GA accidents" (NTSB, 2005, p. vii), and that VFR-into-IMC accidents were the number one cause of GA fatalities between 1983 and 2002 (Bazargan, 2005).

The VFR-into-IMC phenomenon is not restricted to the United States. For example, Canadian data for 1976–1985 were consistent with U.S. data for the same 10-year period. In the U.S., VFR-into-IMC accidents comprised 4% of GA accidents but accounted for 19% of the total fatalities (NTSB, 1989). In Canada, VFR-into-IMC accidents comprised 6% of GA accidents but accounted for 26% of all fatalities (Aviation Safety Study, 1990). Although the annual number of VFR-into-IMC accidents in Canada has decreased, "the annual number of fatalities in VFR-into-IMC accidents has remained generally constant" (Aviation Safety Study, 1990, p. 2). Similarly, in a review of 491 aviation accident and incident reports drawn from the Australian Transport Safety Bureau (ATSB) occurrence database, Batt and O'Hare (2005) reported that 75.6% of VFR-into-IMC accidents involved a fatality. Batt and O'Hare also concluded that the results of their study confirmed previous findings from NTSB (1989), Aviation Safety Study (1990), Goh and Wiegmann (2001), and Aircraft Owners and Pilots Association (AOPA, 2002).

Given that the average time from cloud entry to loss of control or ground impact is 178 seconds for pilots who lack adequate instrument flight training (Wilson & Sloan, 2003), flying from VFR-into-IMC without proper ratings or currency puts safety at risk. To gain insight into the VFR-into-IMC phenomenon, considerable attention has been given across the research spectrum ranging from studies in which archival data were analyzed to laboratory based intervention studies and theoretical explanations. With few exceptions, though, most of these studies have been empirical in nature. No studies to date have examined this phenomenon using a qualitative research approach. As a result, we endeavored to augment the current literature by conducting a qualitative study to describe the first-hand experiences of pilots who experienced a VFR-into-IMC flight.

Review of the Literature

Examining Data from NTSB, FAA, ASRS, and ADAB Records

In a study to determine causal factors that contributed to GA pilots' decision-making process to fly from VFR into IMC, Goh and Wiegmann (2001) analyzed fixed wing GA aircraft accident reports from NTSB and Federal Aviation Administration (FAA) databases from January 1990 to December 1997. Goh and Wiegmann found that during this targeted 8-year period the NTSB classified 409 accidents as being the result of VFR-into-IMC (approximately 50 per year). Of these 409 accidents, 92 (22.5%) were classified as being inadvertent, and 283 of these 409 cases (69.2%) were related to weather conditions. As noted by Goh and Wiegmann (p. 5), because the NTSB category of "inadvertent" means pilots did not intentionally fly VFR-into-IMC, these findings suggest that pilots who were involved in VFR-into-IMC accidents "may not have realized that the weather had deteriorated," and they support the explanation that "erroneous assessment of weather conditions may cause at least some pilots to fly into IMC unwittingly."

Ison (2014) examined 80 fatal GA accident reports from the NTSB (2013) accident database to determine what pilot- and situation-specific characteristics were correlated to VFR-into-IMC GA accidents: 40 involved VFR-into-IMC accidents and 40 involved non-VFR-into-IMC accidents. Pilot characteristics included certification, age, flight time, and whether or not the pilot received a weather briefing. Situation-specific characteristics included time of accident, type of terrain at the crash site, whether or not a flight plan was filed, and if there was contact with air traffic control (ATC) at the time of the crash. Ison also compared these characteristics to accident type: VFR-into-IMC vs. non-VFR-into-IMC. Of the eight targeted factors, only two were significant: type of terrain at the crash site (mountainous/elevated) and weather briefing (received), with the latter being the stronger of the two. Ison reported that "those involved in a fatal continued VFR flight into IMC were 19 times more likely to have received a weather briefing, controlling for other factors" (p. 16), and that "VFR into IMC accidents were 10 times more likely to involve mountainous/elevated terrain" (p. 16). When examined relative to accident type, Ison reported when controlling for terrain "If an accident was classified as VFR into IMC, it was more likely that the pilot received a weather briefing" (p. 17). Relevant to the current study, Ison concluded:

> Considering that pilots who were involved in continued VFR into IMC received a weather briefing, it points to the need to focus on weather education as well as hazardous pilot attitudes. Perhaps pilots are not heeding the warnings of weather briefers or sources either because they do not grasp the required knowledge to evaluate weather reports and factors (or) they may feel as though they are invulnerable due to having made the flight before, overconfidence, or other negative attitudes. (p. 22)

Knecht and Lenz (2010) examined interview data from 100 pilots who submitted weather-related incident reports in 2005–2006 to the Aviation Safety Reporting System (ASRS), which is a FAA sponsored program administered by the National Aeronautics and Space Administration (NASA). ASRS is a repository of aviation safety incident reports submitted voluntarily by "pilots, controllers, flight attendants, maintenance personnel, dispatchers, and other users of the National Airspace System, or any other person…(who knows of)…actual or potential discrepancies and deficiencies involving the safety of aviation operations" (ASRS, 2015, p. 1). The pilots who participated in Knecht and Lenz's study agreed to complete a questionnaire as a follow-up to the incident report they submitted. The questionnaire was mailed to the pilots after they gave their permission and consisted of sets of questions partitioned into six sections: (a) pilots' flight planning and weather briefings, (b) incident information, (c) contributing factors and consequences, (d) aircraft equipment, (e) instrument-related information, and (f) summary information. Knecht and Lenz analyzed the data from the first four sections of the questionnaire from a whole group perspective, and then disaggregated the data into three groups: non-instrument rated (non-IR) pilots, air transport pilots (ATP), and non-ATP IR pilots.

With respect to the overall group, Knecht and Lenz (2010) found that 95 of the 100 pilots received preflight weather briefings and used various sources, including Flight Service Station (FSS), Direct User Access Terminal System (DUATS), National Oceanic & Atmospheric Administration/National Weather Service NOAA/NWS, commercial vendors, The Weather Channel (TWS), and En-route Flight Advisory Service (Flight Watch), with 32 pilots using a single source. When compared to the weather forecast, 19 pilots reported that the actual weather was worse on departure, 35 reported it was worse en-route, and 38 reported it was worse at the destination. Some of the recovery strategies pilots reported using included descending and staying below the weather, deviating around the weather, climbing above the weather, and landing at an alternative site.

With respect to the 27 non-IR pilots, 5 were suspected of not obtaining an adequate preflight weather briefing, 13 had no actual instrument hours at the time of their incident, and 7 had between 8 and 128 instrument hours. During the en route phase of their respective flights, 14 reported they attempted to receive ATC assistance. As for their recovery strategies, the three most frequently used were to descend to stay below the weather, perform a 180-degree turn, and land at an alternative site. Knecht and Lenz (2010) concluded their findings by remarking that the non-IR pilot group appeared to have the least training and experience.

With respect to the 55 non-ATP IR pilots, all acquired a preflight weather briefing, with 32 of them using FSS as their primary source, and 36 reported that the actual weather was worse than what was predicted during one or more of the three flight phases. As for their recovery strategies, 20 of the pilots in this group descended to stay below the weather, but 30 flew directly into clouds or fog prompting Knecht and Lenz (2010) to surmise that non-ATP IR pilots are “More likely to fly straight into adverse weather, rather than deviate around it” (p. 16). Nearly two thirds (62%) indicated they tried to receive ATC assistance en route. Comparing non-IR and non-ATP IR pilots on weather-related differences, Knecht and Lenz reported that non-IR pilots are more deficient with respect to (among others) training, experience (number of flight hours), aircraft performance, and likelihood of recovery by deviating around the weather. (Reviews of the ATP group are not presented here because they are not relevant to the current study.)

Knecht and Lenz (2010, p. 21) concluded that their analysis revealed two major at-risk groups when applied to the context of VFR-into-IMC: non-IR pilots and “newly minted” IR pilots, and that each group has its own distinct training needs. Knecht and Lenz wrote: “Both groups need to be proactive about developing alternatives in the event of adverse weather. This means thinking about alternative actions *before* they are needed, not waiting until the last minute” (p. 22). Knecht and Lenz also indicated:

> Finally, both IR and non-IR pilots need a way to develop and maintain weather expertise in a safe setting. The most obvious and cost-effective ways to do this are through PC- and Web-based weather-skill testing and training programs, both in traditional knowledge-based format and flight simulator format. (p. 22)

As an alternative to examining accident records from NTSB/FAA and ASRS databases, Shappell et al. (2010) focused on two resources that had not been used in the past. The first was the FAA's Administrator's Daily Alert Bulletins (ADABs), which contain daily reports of aerospace accidents, incidents, and pilot deviations. The second was air traffic control (ATC) flight assist records of pilot-ATC communications related to safety issues such as ATCs helping pilots navigate around adverse weather. Pertinent to the current study, one area Shappell et al. focused their attention on was VFR-into-IMC events. Interview data from 25 pilots who experienced an adverse weather event were used for their study. Interview questions were developed from surveys used by NASA (2007) and Knecht (2008a, 2008b) and were mostly closed-ended. The questions were partitioned into several sections: aircraft information, pilot demographics (personological characteristics, pilot experience, and training), event information (participants described their weather encounter in detail), preflight planning information, and en route decision-making.

Some of the major findings relevant to the current study included (pp. 6–9): (a) all pilots acquired weather information as part of their preflight planning on the day of the weather encounter; (b) the pilots used a variety of sources to access weather information, and the three most frequently cited sources they consulted on the day of the weather encounter were FSS, NOAA, and the Weather Channel; (c) most of the flights were forecast to depart VMC; (d) most of the pilots encountered adverse weather en route; and (e) most pilots reported being aware of the adverse weather while en route. Based on their findings, Shappell et al. indicated that it appears GA pilots are not disregarding the rules but instead are simply committing decision errors, and that "Contrary to what the accident record seems to suggest, flight into adverse weather seems to be primarily due to the lack of appreciation/understanding of the hazards associated with adverse weather" (p. 12).

Laboratory Based Intervention Studies and Theory Testing

As noted earlier, several theories also have been applied to help explain VFR-into-IMC flights. These theoretical explanations include: (a) prospect theory (Levy, 1992), which posits that pilots who frame diverting from the planned flight as a loss will tend to continue the flight whereas pilots who frame diversion as a gain will tend to divert; (b) situation assessment (Wiegmann, Goh, & O'Hare, 2002), which posits that pilots fly into adverse weather because they do not fully realize the situation and they cannot understand the changes in and severity of the weather; and (c) the application of the theory of sunk costs (Arkes & Blummer, 1985), which posits that if pilots encounter adverse weather late, then they are more likely to continue due to the investment made.

O'Hare and Smitheram (1995) applied prospect theory in a study that involved 24 volunteer male pilots from New Zealand. Participants were presented two decision scenarios via a computer-generated cross-country flight within New Zealand. In both scenarios participants were: (a) informed en route that the weather was deteriorating at the destination site, (b) given 5 minutes to acquire all the information they needed to make a decision, and (c) presented with two options: continue with the flight or return to the departure site. They then assessed the confidence they had in their decision on a 7-point scale (1 = confident, 7 = not confident). This was followed by a postdecisional questionnaire in which participants determined the extent to which eight different factors contributed to their decision to continue or divert. These factors, which were assessed on a 7-point scale ranging from very important to not important, included tangible gains and losses for self, tangible gains and losses for others, self-approval/disapproval, and social approval/disapproval.

With respect to the first decision scenario, O'Hare and Smitheram (1995) reported there was no significant relationship between participants' gain or loss preference and their decision to continue the flight. Participants who reported they normally consider the decision to continue a flight in terms of gains were not any more likely to divert, and pilots who reported they normally consider the decision in terms of losses were not any more likely to continue. O'Hare and Smitheram also reported that the background variables they targeted (age, flight hours in various categories, highest certificate, date of most recent rating, and instrument rating) were not significant predictors to whether a participant had a preference for a loss or gain frame. With respect to the second decision scenario, O'Hare and Smitheram reported a significant relationship between the framing manipulation and participants' decision to continue or divert. "Participants in the loss frame were significantly more likely to elect to continue with the flight than participants in the gain frame" (p. 363). There also was no significant difference in the time it took participants to determine whether to continue or divert between the two scenarios, but there was a significant difference in participants' confidence level with respect to their decision. "The pilots' mean confidence rating for the first scenario was significantly lower than their mean rating for the second scenario" (p. 364). Although findings from the first scenario did not support prospect theory, the effect of the framing manipulation in the second scenario provided evidence in support of prospect theory. As useful as O'Hare and Smitheram's study is to understanding the VFR-into-IMC phenomenon, however, a limitation to their findings is that they were based on a simulation and not real-world experiences.

Wiegmann et al. (2002) tested their situation assessment hypothesis by examining pilots' decisions to continue or divert from a VFR-into-IMC flight during a dynamic simulation of a cross-country flight. They predicted that more experienced pilots would divert sooner than less experienced pilots. Thirty-six pilots between the ages of 18 and 62 years old participated in the study. Their total flight time ranged from 63 to 1,983 hours, and their total cross-country flight time ranged from 4 to 550 hours. Twenty-five of the pilots were instrument rated. The participants were divided into two groups: a short group, which experienced degrading weather early after departure, and a long group, which experienced degrading weather later en route.

The results revealed that all pilots continued flight past the point at which the weather began to degrade. Thirty-five pilots ultimately diverted and one pilot crashed while continuing into adverse weather. Results of Mann-Whitney U tests revealed that pilots in the short condition traveled significantly farther and longer into adverse weather. About one third of the pilots accurately estimated visibility and cloud ceiling, and a relatively equal proportion of pilots either overestimated or underestimated weather conditions. Equal portions of pilots from the short and long flight conditions estimated visibility accurately. Wiegmann et al. (2002) indicated that the location at which adverse weather conditions were encountered during a flight affected a pilot's decision to continue with the flight, with the short group of pilots traveling longer into deteriorating weather. As was the case with O'Hare and Smitheram (1995), although Wiegmann et al.'s study brought a new perspective to understanding VFR flight into IMC, their findings are limited because the study was conducted in a simulator and did not involve pilots experiencing an actual VFR-into-IMC flight.

Concluding Statement of Previous Studies

The literature is replete with studies and theories relative to VFR-into-IMC flights. Past studies have examined various databases of archived accident records to determine if there are any common factors relative to: pilot characteristics such as age, flight time, certifications, and licenses; preflight weather briefings such as what weather providers (e.g., FSS) and weather products (e.g., METAR, TAF, ASOS, and AWOS) pilots used; and situation-specific characteristics such as terrain and weather. Past studies also have tested various explanation theories, including prospect theory, situation assessment, and the theory of sunk costs. Although these studies have been beneficial to understanding this phenomenon, findings either have been based on observational studies such as a content analysis of accident reports or involved interventions using simulator or simulation-based exercises. With the exception of Knecht and Lenz (2010) and Shappell et al. (2010), there is a dearth of studies that provide first-person accounts of pilots who personally experienced an inadvertent VFR-into-IMC flight. One limitation of these interview-based studies, though, is that the pilots were identified from archived ASRS or ADAB records. Furthermore, the data acquired from these pilot interviews were mostly quantitative and analyzed from a descriptive statistics perspective with findings being reported via frequencies and percentages. To address the design, sampling, and data analysis limitations of past studies, the literature needs to include studies that (a) are not based on simulations, (b) do not rely on archived records for data mining purposes or to identify and interview pilots who survived a VFR-into-IMC flight, and (c) do not rely on quantitative data analysis procedures. The literature surrounding the VFR-into-IMC phenomenon would benefit from studies that use a qualitative research methodology, which was the approach used for the current study.

Purpose Statement and Research Questions

The purpose of the study was to describe the first-hand experiences of pilots who inadvertently flew VFR-into-IMC. In the context of the current study, pilots were defined as GA pilots involved in "civil aviation operations other than scheduled air services and non-scheduled air transport operations for remuneration or hire" (FAA, 2014, p. G-1). This definition was further restricted to GA pilots who engaged in noncommercial and nonmilitary, fixed-wing flight operations other than gliders. However, no restrictions were placed on the number of licenses and ratings, IFR experience, or age. Three research questions guided the study: (a) In what way do pilots use weather-related information throughout their VFR-into-IMC flight? (b) What are pilots' thoughts and actions when they realize they are in IMC? and (c) What are pilots' retrospective thoughts on their VFR-into-IMC flight experience?

Table 1
Summary of Sample Demographics

		Flight Hours		Age		Type/Number of Licenses[a]				
Sample	***N***	***M***	**Range**	***M***	**Range**	**PPL**	**CPL**	**ATP**	**IR**	**ME**
2014	6	4,627	200–9000	42.5	22–64	6	4	2	4	3
2015	5	411	250–1000	31.4	25–45	5	4	0	5	5
Overall	11	2,519	200–9000	36.9	22–64	11	8	2	9	8

Note. All participants were male GA pilots.
[a]PPL = Private Pilot License, CPL = Commercial Pilot License, ATP = Airline Transport Pilot, IR = Instrument Rated, and ME = Multiengine Rated.

Methodology

Context

The current study was conducted over a 2-year period (2014 and 2015) as a class project for an introductory graduate course in qualitative research design. The course was taught by the major author and consisted of three male students in Spring 2014, and eight students (one female) in Spring 2015, all of whom were part of the research team and are listed as coauthors. The students had diverse backgrounds across a broad spectrum of the aviation industry, including flight instruction, airframe and power plant maintenance, aviation human factors, aviation management and consultant, and aviation analyst. Four students were employed by an international commercial airline, one student was a fulltime flight instructor, four students were fulltime university faculty members or administrators, and two were fulltime students.

Two purposive samples were selected. The 2014 sample consisted of six male pilots denoted as participants P1–P6, and the 2015 sample consisted of five male pilots denoted as participants P7–P11. Participants from both samples previously had flown from VFR-into-IMC inadvertently at some point during their aviation career. As noted in Table 1, which contains an aggregate summary of the participants' demographics, the 2014 participants were older and had more experience with respect to flight time, and 9 of the 11 participants were instrument rated.

Research Design and Data Collection Methods

The current study employed a qualitative research methodology, specifically, phenomenology. This approach was appropriate because the primary purpose was "to describe the essence of a lived phenomenon" (Creswell, 2013, pp. 104–105). In the context of the current study, this "lived phenomenon" was an inadvertent VFR-into-IMC flight, and the unit of analysis was several individuals who shared this experience. In addition to describing pilots' shared experiences, the participants' views also were used to develop a set of conjectures derived inductively from their responses. This grounded theory approach

(Glasser & Strauss, 1967; Strauss & Corbin, 1990) was used to further enhance the answers to the research questions.

Although interviews are the most common data collection approach for both phenomenological and grounded theory studies (Creswell, 2013), an online structured questionnaire was administered to the participants instead. This enabled the participants to respond to the items at a place and time that was convenient for them. The questionnaire consisted of three parts: a set of items related to participants' flight experience, a set of constructed response items related to their VFR-into-IMC experience, and a set of items related to their personal demographics. Prior to implementing the study, the host university's Institutional Review Board reviewed and approved the study and its corresponding protocols.

Each member of the research team targeted a GA pilot whom he or she knew experienced an inadvertent VFR-into-IMC flight, and who would provide rich data. The targeted participants were contacted via a personal e-mail message with information about the study that included a request to participate with a link to the online questionnaire. Each participant who was contacted agreed to participate. Thus, there was no need to pursue any additional solicitations. The data from the questionnaires were collected between March and April 2014, and then again between March and April 2015. Based on the summary statistics provided by the online hosting site, participants averaged between 20 and 25 minutes to complete the 30-item questionnaire.

Standards of Rigor in Qualitative Research

The concept of rigor in qualitative research refers to questions of validity and reliability, which involves making valid inferences from the data and determining the extent to which the data are consistent. Creswell (2013, pp. 244–250) presented many different perspectives about how qualitative researchers could address the concept of rigor in their studies. Of the various perspectives, though, the single most commonly cited one is from Lincoln and Guba (1985), which focused on (quantitative analogs in parentheses): credibility (internal validity), transferability (external validity), dependability (reliability), and confirmability (objectivity).

Credibility was addressed in the current study through structural corroboration, consensus, and interpretive adequacy (Ary, Jacobs, & Sorensen, 2010, p. 498). Structural corroboration was provided in the form of methods triangulation by employing two independent qualitative approaches: phenomenology and grounded theory. The first approach was used to acquire participants' first-hand experiences; the second approach was used to develop inductively a conjecture-based framework, which could be used subsequently for theory building. Consensus was achieved via peer debriefing in which the major author initially assumed the role of "devil's advocate" to challenge the other research team members about the reasonableness of their interpretations and explanations. The research team members also assumed this role as they challenged each other's interpretations of the data. Interpretive adequacy was provided using low-inference descriptors, which included direct quotations to accurately portray participants' views, thoughts, feelings, and experiences. One limitation to credibility, though, was the lack of data triangulation. The study used a single data source, the online questionnaire, which was administered as a one-time event with no follow-up via member checking or with no additional data sources such as face-to-face interviews or e-mail correspondences.

Transferability was addressed through descriptive adequacy and similarity (Ary et al., 2010, p. 502). With respect to the former, accurate, detailed, and complete descriptions of the context and participants were developed; with respect to the latter, the findings of the current study were compared to the current literature, and limitations were identified. Attention to dependability was given via interrater/interobserver agreement relative to the common themes and patterns that emerged from participants' responses. Attention to confirmability was through peer review and methods of triangulation, both of which were discussed in the foregoing paragraph.

Results

Data analysis was conducted in two stages. During the first stage, participants' written responses were carefully reviewed to see if they were commensurate with the research questions. During the second stage, a search for similar comments, common patterns, and themes was conducted. The qualitative software, *Nvivo*, was used for the 2104 data to assist in this search, but because of the larger class size in 2015 (eight students vs. three students in 2014), the 2015 data were analyzed without the aid of any computer software. As the analysis progressed, labels such as preflight, en route, recognition, and lessons learned were assigned to represent the common themes and patterns that emerged. These labels, which were discussed collectively as a group and relative to each research question, underwent several changes until everyone agreed on the final list.

To help categorize the common themes and patterns, Spradley's (1979) domain analysis was applied. Three major domains emerged from the data: Weather Considerations and Expectations, Thoughts and Actions, and Postflight Experiences. These domains were further partitioned into subcategories that Spradley referred to as cover terms and included terms. Several cover terms relative to each domain were identified, but every cover term was not further partitioned into an included term unless the data warranted additional refinement. Tables 2, 3, and 4 contain a summary of this process for each respective domain. Each sequence of "domain-cover term" or "domain-cover term-included term" then led to corresponding conjectures. As an example, consider the sequence associated with Conjecture 2.2 in Table 3 for Domain 2, "Thoughts and Actions." This sequence and corresponding conjecture is read as "GA pilots' *thoughts and actions* during IMC flight *covered* recognition of their situation and *included* their use of various communication resources to assess their current situation"; therefore, "With respect to thoughts and actions during IMC flight: GA pilots who inadvertently fly VFR-into-IMC will use various communication resources to assess their current situation." This data analysis process reflects a grounded theory approach (Glasser & Strauss, 1967) in which theory—or in the context of the current study, conjectures—"is inductively derived from the study of the phenomenon it represents" (Strauss & Corbin, 1990, p. 23). A discussion of the findings relative to each domain follows.

Table 2

GA Pilots' Considerations and Expectations with Respect to Weather

Domain 1	Cover Term	Included Term	**Conjectures** *With respect to weather considerations and expectations: GA pilots who inadvertently fly VFR-into-IMC will …*
Weather Considerations and Expectations	Preflight	—	1.1. consult a weather briefer (human or computer) as part of their preflight actions prior to departure and make their own interpretations of the information they acquire.
			1.2. focus on cloud ceilings and visibility and give little consideration to overall weather conditions or of encountering poor weather conditions.
			1.3. neither expect nor anticipate IMC.
	En Route	—	1.4 use a variety of communications sources such as radio, ATIS, and cell phone to keep current with weather-related issues.

Domain 1: Weather Considerations and Expectations

Domain 1 corresponded to the first research question: In what way do pilots use weather related information throughout their VFR-into-IMC flight? In responding to the questionnaire items related to this question, participants interpreted the phrase "throughout their VFR-into-IMC flight" to mean how they used weather information during both preflight and en route. As a result, their responses led to two separate cover terms: *preflight* and *en route*. Table 2 contains a summary of the major themes and corresponding conjectures associated with Domain 1.

Preflight. Based on their comments, it appeared that the pilots of the current study followed standard preflight protocols with the majority of the participants indicating they received a weather briefing as part of their preflight actions prior to departure. For example: P8 said, "Check the weather as usual and get a standard weather brief"; P9 reported "I checked all the weather sources including FSS"; and P10 said, "Got wx brief, forecasts, NOTAMs, etc. (related to) that flight." So based on these responses, it appears that the participants acquired weather information prior to departure on their own from either human or computer sources and then made their own interpretations.

Although not prevalent throughout, various comments seemed to suggest that some pilots did not consistently give serious consideration to the weather. For example, P1 reported, "I was not anticipating going into IMC..." P1 further qualified this statement as follows:

> We have 2500 to 3000 feet of ceiling (so) there's no need for more consideration of weather so we did not have a lot of weather briefing honestly…just checking the ceiling because it was a local flight…This is the usual habit: just checking the ceiling and surrounding airports and just go fly.

P3's experience accented this preflight weather mindset by indicating that prior to take-off, "I print(ed) all METAR and TAF en route weather (and) … there was no problem for me." However, after take-off P3 reported "I didn't listen to ATIS again from Melbourne airport. Unfortunately, when I was traveling, I was flying from Vero Beach to Melbourne they had issued a special observation and that observation was IMC conditions." Thus, in P3's case, he planned for weather preflight, but was not diligent in following through with a full weather briefing from flight service station.

These comments about what participants' did with respect to preflight weather considerations and expectations led to the following conjecture: GA pilots who experience an inadvertent VFR-into-IMC flight will (a) consult a weather briefer (human or computer) as part of their preflight actions prior to departure and make their own interpretations of the information they acquire, (b) focus on cloud ceilings and visibility and give little consideration to overall weather conditions or of encountering poor weather conditions, and (c) neither expect nor anticipate IMC.

En route. During the en route stage of their flight, participants reported they relied on a variety of communication sources to keep current with weather-related issues. These sources included radio communication, ATIS, and cell phone. For example: P9 reported, "taking ATIS information," and P10 relied on his cell phone for text messages from his instructor and his radio to receive "ATIS, approach and dispatch frequencies." In addition to these communication sources, P8 relied on visual inspection and radio monitoring: "Watch(ed) outside and listened (to) other pilots (on) the radio."

These comments about what participants did with respect to weather considerations and expectations en route led to the following conjecture: GA pilots who experience an inadvertent VFR-into-IMC flight will use a variety of communications sources such as radio, ATIS, and cell phone to keep current with weather-related issues.

Domain 2: Thoughts and Actions

Domain 2 corresponded to the second research question: "What are pilots' thoughts and actions when they realize they are in IMC? Participants' responses to the questionnaire items that were relevant to this second research question led to three major themes: *recognition* that the weather was deteriorating, *reaction* to the situation, and their *thoughts* about their situation either just prior to or during the time they were in IMC. Table 3 contains a summary of the major themes and corresponding conjectures associated with Domain 2.

These comments led to the following conjecture: GA pilots who experience an inadvertent VFR-into-IMC flight will (a) recognize changes in the weather and (b) use various communication resources to assess their current situation.

Reaction. In addition to recognizing the deteriorating weather, and independent of the communication resources they used to assess their situation, several participants also reported what they did either in anticipation of encountering IMC or during IMC. The most prevalent theme was related to the notion of "avoid and escape." As an illustration, consider the respective comments from P7, P10, and P11:

> P7: I saw high clouds in front of me but like a wall and low base so I started to climb. At a point since they were moving towards me I couldn't climb steeper and instead of stalling I went into the clouds. Immediately turned 180 and descended and I got out of it.

> P10: There were scattered clouds that developed into an overcast layer. The sky was scattered when I took off but cloud formation was on progress and ceiling was lowering. It turned to overcast in 1.5 hrs although TAF was saying it would become OVC in 4 hours. I flew to my first destination but couldn't come back to my base so I had to divert to another airport on my way. I did everything what I was taught and told accordingly so I managed to divert safely.

> P11: I searched for a hole in the clouds and tried to remain in the same position because I did not have any radio navigation equipment. I used the knowledge of my present position over the sea and turned to a heading that would keep me over the sea during the descent.

Table 3

GA Pilots' Thoughts and Actions during IMC Flight

Domain 2	**Cover Term**	**Included Term**	**Conjectures** ***With respect to thoughts and actions during IMC flight: GA pilots who inadvertently fly VFR-into-IMC will …***
Thoughts and Actions	Recognition	Observation	recognize changes in the weather.
		Use of Resources	use various communication resources to assess their current situation.
	Reaction	Avoid and Escape	react to change in the weather by using their instruments, climbing steeper, descending, turning 180 degrees, and diverting to another airport to get out of IMC.
	Thoughts	Emotion	have feelings of trepidation about what they should do that span the spectrum of possible scenarios, including whether to continue or divert, or maintain or change altitude.
			express surprise over how the weather they encountered was not what they expected based on the weather information they received and interpreted prior to departure.
		Recollection of training	revert to their training and fly the aircraft, and trust their instruments.

Participants also reported that they focused on their instruments as part of their "avoid and escape" reaction. For example, P7 said he "trusted to the instruments" and used "the attitude indicator and altimeter," and P11 said, "I tried to keep a straight descending flight by monitoring the flight instruments (specifically the airspeed indicator, the heading indicator, altimeter, and the inclinometer)."

These comments about participants' reactions led to the following conjecture: GA pilots who inadvertently experience VFR-into-IMC during the en route stage of their flight will react to changes in the weather by doing whatever they could to get out of IMC, including using their instruments, climbing steeper, descending, turning 180 degrees, and diverting to another airport.

Thoughts. In addition to their recognition of and reaction to the changes in the weather, participants also shared with us what they were thinking when they realized they were going to encounter IMC. Their thought processes included their *emotions* as well as *recollection of their training*. With respect to their emotions, participants' first thoughts appeared to be mental anguish, or trepidation, over what they should do. For example, P6 said:

> I wanted to get home. I knew immediately that once I (flew) into (IMC), but I was hoping to fly out of them so I continued. I was stressed, I was nervous. I knew I was in a situation that was hazardous.

This feeling of trepidation also was echoed by P1 who reported:

> During the beginning of the event, it was a little bit intense because the fear of traffic plus I was flying an airplane that did not have an ADS-B (automatic dependent surveillance broadcast). So I was literally flying blind for the couple of minutes I spent without IFR clearance.

Other participants also expressed a similar emotion as captured by the following remarks:

> P7: (I thought about) turning back to where I came.
>
> P8: Should I continue?
>
> P9: I thought I was in danger (and) I tried to stay calm and started to think about the probability of being in that cumulonimbus cloud.
>
> P10: (I should) descend to an altitude at which I could see visual references and divert to the nearest suitable airport where I can land in VMC conditions.

The participants also expressed an emotion of surprise that the weather had changed. For example, P10 indicated he was expecting poor weather prior to take-off but "the bad wx I was expecting before the flight came 2.5 hours earlier." This earlier than expected bad weather also was reported by P9 who said "It occurred in an hour unexpectedly." Because the participants, as reported in Research Question 1, interpreted their own weather information prior to departure, it appeared that perhaps P9 and P10 did not accurately interpret the data they received given their surprise over how quickly the weather deteriorated en route.

These comments about participants' thoughts led to the following conjecture: GA pilots who experience an inadvertent VFR-into-IMC flight during the en route stage of their flight will (a) have feelings of trepidation about what they should do that span the spectrum of possible scenarios, including whether to continue or divert, or maintain or change altitude; and (b) express surprise over how the weather they encountered was not what they expected based on the weather information they received and interpreted prior to departure.

In addition to their emotions, some participants also seemed to be thinking about their training. For example, P2 said:

> The key to my training is to aviate then navigate then communicate. You have to fly; you don't get distracted. You stay on the gauges; you continue to fly. No matter if you're banging around or losing heading, you still have to focus on your aviation: Fly the aircraft first.

P2 accented his remark by stating, "Steady reliance and trust in your instruments. You have to trust your instruments and so I did that and managed to continue the flight." P1 continued this theme by reporting on the importance of training. "The first (thought) is directly from 'the book,' always trust your instruments and fly according to them." P3's thought was with respect to the "book knowledge" he was receiving via ground training regarding instrument flying:

> The training told me if I enter, I can't enter the clouds (and) I should divert to another VFR airport. But the second part of it, at the same time, I was (taking) my instrument training ground school and the ground school told me if you are in the clouds just rely on your instruments, and I did. Honestly, when I was in the clouds, I didn't look outside so I didn't have any spatial disorientation because of the clouds…I was just looking (at) my instruments.

Lastly, P5 said, "I recognized the situation and (my thought was to) follow my training and immediately (went) into instruments and stabilized the aircraft."

These comments about participants' recollection of their training led to the following conjecture: GA pilots who experience an inadvertent VFR-into-IMC flight during the en route stage of their flight will revert to their training and fly the aircraft, and trust their instruments.

Table 4

GA Pilots' Retrospective Thoughts on VFR-into-IMC Flight

Domain 3	Cover Term	Included Term	**Conjectures** ***With respect to pilots' retrospective thoughts: GA Pilots who inadvertently fly VFR-into-IMC will…***
Postflight Experiences	Postflight Actions	—	3.1. have postflight actions that range from doing nothing to filing a report to NASA's Aviation Safety Reporting System (ASRS).
	Lessons Learned Overall	—	3.2. have a heightened sense of situational awareness.
			3.3. recognize they need to do a better job in alternative planning.
	Lessons Learned about the Weather	—	3.4. have a heightened appreciation for the weather.

Domain 3: Postflight Experiences

Domain 3 corresponded to the third research question: "What are pilots' retrospective thoughts on their VFR-into-IMC flight experiences?" Participants' responses to the questionnaire items that were relevant to this third research question led to three major themes: *postflight actions*, *lessons learned overall*, and *lessons learned about the weather*. Table 4 contains a summary of the major themes and corresponding conjectures associated with Domain 3.

Postflight actions. Participants' postflight actions ranged from doing nothing to filing a report with NASA's ASRS. For example, P8 reported doing "nothing" and P9 said, "There wasn't any need for doing anything." On the other hand, P10 reported that he "Informed every related person about the situation and spent the night in a hotel in another city," and P11 said, "I told my instructor, but I did not report the incident." Of all of the participants, only P7 said he "filed a NASA report."

These comments about participants' postflight actions led to the following conjecture: GA pilots who experience an inadvertent VFR-into-IMC flight during the en route stage of their flight will range from doing nothing to filing a report to NASA's ASRS.

Lessons learned overall. The participants reported learning several lessons from their experiences. These ranged from engaging in alternative planning to situational awareness to informing the tower of their actions to diverting. For example:

> P2: I believe I would have diverted.

> P3: Absolutely! I would redirect to Okeechobee because I knew Okeechobee (had) VFR conditions that day.

P6: I would have turned around and landed in Gainesville or some other airport that was VFR. I would have gotten an updated weather briefing and proceeded much more cautiously. I would have waited for the weather to move until I had VFR conditions to my destination.

P7: (I learned) how and when to take action in case of similar situation.

P8: I would return to base or divert to a suitable airport.

P9: (I learned that) alternate planning must be made carefully (and I would do a) much better (job at) alternate planning.

P10: Stay awake, be aware and evaluate the situation by asking yourself "what is next?"

P11: I would have done the same actions, but I would have contacted the tower and told them what I planned to do.

Unlike the 2015 sample, the 2014 participants also reported they considered their VFR-into-IMC experience as a worthwhile training event that they never could have received from formal training. For example, P3 said, "After this flight, I think my risk demand is a little bit weakened compared to the past. I mean, this is not the stock exchange anymore; this is life." P4 also described how his VFR-into-IMC flight changed his perspective of flight training:

> I attribute the change to having the realization that flying is actually dangerous. Before I was young and dumb and felt invincible, and that the system was so safe in the U.S. and that nothing bad could happen. After that (this experience) I kind of had a reality check. I am a far safer pilot now.

Finally, P1 commented, "Definitely. I learned to have the bigger picture; even for small flights in the area."

These comments about what participants' learned overall from their VFR-into-IMC experience led to the following conjecture: GA pilots who experience an inadvertent VFR-into-IMC flight will have a heightened sense of situational awareness and recognize they need to do a better job in alternative planning.

Lessons learned about weather. Independent of lessons learned overall, participants also reported learning several lessons about weather. For example, P7 reported he needs to "Read the weather chart better" and that "After this situation I choose to fly over (the) coast mostly since there are less clouds." P1 said, "The only thing that changed is my weather briefing. For local flights, I do not only look for METARs and TAFs, I check everything now to prevent going into IMC." Other comments relative to lessons learned about the weather included:

P8: Do not risk the weather (if it) is marginal.

P10: Never trust wx forecasts totally, get as much information as you can get, always observe the environment about the changes.

P11: Check the weather forecast before flight, and be sure to assess the weather continuously during flight.

These comments about what participants' learned about the weather from their VFR-into-IMC experience led to the following conjecture: GA pilots who experience an inadvertent VFR-into-IMC flight will have a heightened appreciation for the weather.

Summary and Discussion

With respect to Domain 1, Weather Considerations and Expectations (Table 2), although all participants received a weather briefing as part of their preflight actions, they still encountered VFR-into-IMC during the en route phase of their flight. This finding is consistent with those of Knecht and Lenz (2010), Ison (2014), and Shappell et al. (2010). As noted earlier, Knecht and Lenz reported that of the 100 VFR-into-IMC ASRS incident reports they analyzed, pilots in 95 of them indicated they received preflight weather briefings. Ison (2014) also reported that pilots who were involved in a fatal accident that was classified as VFR-into-IMC were "19 times more likely to have received a weather briefing" (p. 17). Shappell et al. reported, "All pilots had obtained some type of weather information prior to departure on the day of the weather encounter, and most (76.0%) accessed weather information less than 30 minutes before departure" (p. 6). The participants in the current study also indicated that based on their preflight weather briefing they neither expected nor anticipated IMC en route. This finding provides support to Goh and Wiegmann's (2001) speculation that "…erroneous assessment of weather conditions may cause…some pilots to fly into IMC unwittingly" (p. 5) as well as Ison who surmised that pilots do not seem to be grasping the required knowledge to evaluate weather reports (p. 22).

When the findings associated with Domain 1 are considered collectively, it appears that the participants of the current study relied on their own interpretation of the weather briefing information they received and did not give sufficient attention to the possibility that they might encounter deteriorating weather conditions. This also suggests that the participants might be relying too heavily on forecasts and/or they do not truly understand the difference between a forecast and reality. One plausible reason for this is that many flight schools train pilots to base their go/no-go preflight decision on cloud ceilings and visibility, which could lead pilots to overemphasize these areas in their preflight weather forecasting. The findings related to Domain 1 also could be due to the participants' relative inexperience, particularly with the 2015 sample, which had a mean age of 31.4 years old and a mean of 411 flight hours (Table 1). In light of the FAA's (2013a) 1500-hour rule, which increased the minimum number of hours required to be a first officer from 250 hours to 1500 hours, it is possible that the participants did not have enough weather experience.

Although what might appear to be a blasé preflight attitude about the weather, this seemed to be mitigated somewhat en route because the participants indicated they kept current with the weather. Nevertheless, given that the trend for preflight weather briefing is toward pilot self-briefing (Casner, Murphy, Neville, & Neville, 2012; FAA, 2013b), the findings related to Conjectures 1.1 and 1.3 of the current study raise a red flag about GA pilots' ability to correctly interpret weather information.

With respect to Domain 2, Thoughts and Actions (Table 3), because participants kept current with the weather en route, they were able to recognize changes in the weather, assess their current situation relative to the weather, and take action to either avoid or escape IMC. As noted in Conjecture 2.3 (Table 3), the actions participants took involved climbing steeper, descending, turning 180 degrees, and diverting to another airport to get out of IMC. These findings are consistent with those of Knecht and Lenz (2010) and Shappell et al. (2010). Knecht and Lenz reported that the three most frequently used recovery strategies cited by non-IR pilots were descend to stay below the weather, perform a 180-degree turn, and land at an alternative site. Shappell et al. reported

> …the majority of pilots (92.0%) deviated at some point from their planned route or altitude…(and)…the majority who deviated (73.9%) did so after encountering the weather. Even though a majority of the participants deviated, 87.5% were aware of where they were relative to their course and location. (pp. 7-8)

Concomitant with participants' actions were various emotions they experienced, including feelings of apprehensiveness and worry about what specific actions they should take, and feelings of surprise over how the weather was not what they expected preflight. This finding seems to support Csikszentmihalyi's (1990, 2014) flow theory, which posits a relationship between a person's perceived skill level and his/her perceived understanding of the challenge level of a task. As an example, consider a GA pilot who perceives a particular challenge as being relatively low such as a cross-country trip on a clear day the pilot has made several times before. As the pilot's skill level varies from low to moderate to high, his or her mental state would also change commensurately from apathy to boredom to relaxation. However, as the challenge level increases (e.g., encountering IMC en route unexpectedly), and the perceived skill level is low-to-moderate, then the pilot will experience states of worry and anxiety. This appears to be exactly what the participants reported. They perceived their flight as not being challenging, and they were neither expecting nor anticipating deteriorating weather conditions en route. Once they encountered IMC, though, they entered a state of worry.

Ultimately the participants gathered their thoughts and relied on their training experiences to help resolve their situation. This latter finding underscores the importance of training, particularly instrument training. This finding also gives credibility to the current emphasis in VFR training, which is to require basic instrument flying. This finding also provides support for a new, separate rating called the En route Instrument Rating (EIR), which is now available in the United Kingdom and permits holders of an EIR to conduct flights by day under IFR during the en route phase of flight (Civil Aviation

Authority, 2014, p. 1). Holders of an EIR, however, are prohibited from accepting "an IFR clearance to fly a departure, arrival or approach procedure" (p. 2).

With respect to Domain 3, Postflight Experiences (Table 4), the only postflight action that emerged was whether or not the participants reported their VFR-into-IMC experience. Some opted to not report what happened whereas others did so. This suggests that some GA pilots might be apprehensive in documenting any irregularities they experienced en route. Nevertheless, the participants indicated that their VFR-into-IMC experience made them more sensitive to maintaining situational awareness, and it alerted them to the need for alternative planning. Taken separately, the former provides partial support to Wiegmann et al.'s (2002) situation assessment explanation theory; the latter strengthens Knecht and Lenz's (2010) position that non-IR and unseasoned IR pilots need to consider and develop alternative actions about what to do in the event they encounter adverse weather before they are needed and not wait until the last minute (p. 22).

One manifestation of the participants' surviving an inadvertent VFR-into-IMC flight was a much greater appreciation and respect for the weather. What is most pronounced is the juxtaposition of Conjectures 1.1, 1.3, and 3.4. When viewed as a single entity, this juxtaposition implies that GA pilots have an incorrect perception of their weather knowledge. The participants clearly articulated that although they did their due diligence with respect to acquiring a preflight weather briefing, they were surprised by the change in weather, neither expected nor anticipated IMC, and now have a greater appreciation for the weather as a result of their VFR-into-IMC experience. This revelation supports the findings reported by Burian (2002) who administered a weather knowledge test to 1005 GA pilots with a PPL rating and PIC certificate for at least visual meteorological conditions (VMC). Burian found that the participants performed poorly on the test and concluded that "Many pilots apparently lack operationally relevant weather knowledge and/or have difficulty recalling what was once learned" and that "VFR-only pilots performed significantly worse than" IR pilots, CFIs, and ATPs (p. iv). The implication from juxtaposing Conjectures 1.1, 1.3, and 3.4 also is consistent with some of Wiegmann, Talleur, and Johnson's (2008) explanations of why pilots fly into adverse weather: lack of knowledge and experience, limited weather evaluation skills, and poor in-flight planning. This implication also supports Shappell et al.'s (2010) concluding comment: "Contrary to what the accident record seems to suggest, flight into adverse weather seems to be primarily due to the lack of appreciation/understanding of the hazards associated with adverse weather" (p. 12).

Limitations and Recommendations

Limitations

Given the nature of the current study, several limitations are warranted. First, it should be noted that we had no control over participants' flight experiences or personological characteristics as reported in Table 1. Second, we chose to focus on *inadvertent* VFR-into-IMC flights. Third, data collection was restricted to a one-time event and was conducted via an online survey-hosting site with no face-to-face interviews, follow-up, or member checking. Fourth, the questionnaire items were prepared collectively by the research team and served as the only data source. Fifth, the majority of participants' inadvertent VFR-into-IMC flights occurred in Florida, which many within the aviation community regard as "airport-friendly" because there are many airports located within close proximity of each other.

Recommendations

The findings of the current study led to a set of recommendations for practice as well as to a set of recommendations for future research. With respect to practice, we recommend:

1. The flight instruction curriculum should increase its coverage of weather and consider adding more emphasis to weather training.

2. The flight instruction curriculum should include VFR-into-IMC simulation training.

3. The flight instruction curriculum should continue training on how to escape inadvertent VFR-into-IMC situations.

4. GA pilots should be encouraged to document their experience of any irregularities en route, including encountering inadvertent IMC during a VFR flight, so others can learn from their experiences.

5. The FAA should consider applying the United Kingdom's En route Instrument Rating (EIR) to the GA flight training curriculum.

With respect to future research, we recommend:

1. Future studies should include data triangulation by incorporating face-to-face interviews and e-mail correspondence as supplemental data sources to increase the credibility of the study.

2. Future studies should include female pilots.

3. Future studies should include pilots who experienced inadvertent VFR-into-IMC flights outside the state of Florida.

4. Future studies might consider including a mixed methods approach by measuring pilots' hazardous attitudes and then mapping them to pilots' responses to the questionnaire items and interview responses.

5. Future studies should investigate the deficiencies in weather training for GA pilots.

Lastly, we encourage replication studies be conducted to validate the findings of the current study as well as confirm the conjectures that emerged as outlined in Tables 2, 3, and 4. We also encourage researchers who analyze VFR-into-IMC incident/accident reports from

NTSB, FAA, or ASRS databases to determine if their findings support or refute these conjectures, or if they require further modifications.

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The Effect of Public Law 111-216 on Collegiate Flight Programs: Perceptions of Aviation Faculty and Flight Center Personnel

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Abstract

In response to the 2009 Colgan 3407 airline crash and ensuing public concern, Public Law 111-216: The Airline Safety and Federal Aviation Administration Extension Act of 2010 was signed into law on August 1, 2010. This legislation mandated significant changes to the aviation and airline industries. Among these changes, an increase in pilot qualification standards was enforced for pilots seeking employment with US air carriers. This study explores the perceptions of aviation faculty members and flight center personnel at four-year collegiate flight training programs in the US regarding the effect of PL 111-216. Results of this national study indicate the majority of respondents believe PL 111-216 will have an adverse effect on collegiate aviation flight students, collegiate aviation flight training programs and the US air carrier industry. This study also revealed the perception that collegiate flight students will begin to pursue flight careers (non-US airline or corporate aviation) that are not directly impacted by PL 111-216.

Introduction

Any air carrier accident resulting in passenger or crew fatalities receives a high volume of attention from media and flying public. Each air carrier accident is closely analyzed and reviewed in an effort to mitigate the risk of repetition of the same type of accident. After investigation, regulatory modifications are often made related to specific events that contributed to the accident. In the name of safety, all shareholders strive to ensure that flying passengers will safely arrive at their destinations. These changes are intended to improve the safety of flight but rarely do they have sweeping affects across the industry. However, the aftermath of the 2009 crash of Colgan Air Flight 3407 was different.

In February of 2009, Colgan Air Flight 3407 crashed in Buffalo, New York. This tragic end to flight 3407 resulted in the death of 45 passengers, four crew members and one person on the ground (Pasztor, 2009). This crash resulted in an unusually high level of scrutiny from the media due to the National Transportation Safety Board's (NTSB) report, which in part, focused on failed flight checks, challenging living arrangements that require crew to commute across the country, and low pay for the flight crew (Garrison, 2010). This tragedy triggered a massive overhaul of airline safety and pilot qualifications that now affects the entire US air carrier industry. The magnitude of these changes are evident in the comments of Collins (2014) "the crash of Colgan 3407 brought on the all-time most egregious case of smoke and flames rulemaking by the FAA, among other things, establishing new standards for first officers" (para. 1). President Obama, on August 1, 2010, signed into law Public Law 111-216: The Airline Safety and Federal Aviation

Administration Extension Act of 2010 (Airline Safety and Federal Aviation Administration Extension Act of 2010, 2012).

Particularly concerning to current and aspiring pilots and pilot training organizations, these new standards would drastically change the expectations and progression of pilots seeking employment from US air carriers. These new standards would require pilots that occupy the flight deck of a commercial airliner to hold an Airline Transport Pilot (ATP) Certificate, the highest attainable airmen certificate requiring 1,500 hours of flight time. This represents more than 1,000 hours of additional flight time than previous standards that pilots must hold a commercial certificate and 250 hours of total flight time (Blair & Freye, 2012; Collins, 2014). These new standards went into effect on August 1, 2013, three years after the law was enacted (Airline Safety and Federal Aviation Administration Extension Act of 2010, 2012).

As a result of PL 111-216, a new pilot qualification, Restricted ATP (R-ATP) was created to assist aspiring airline pilots to be eligible to operate in a commercial airliner before earning the 1,500 flight hours in certain circumstances. These options and circumstances for the R-ATP are (Radtke, 2015):

- 750 flight hours for military pilots
- 1,000 flight hours for graduates holding a bachelor's degree with an aviation major from an approved school
- 1,250 flight hours for graduates holding an associate degree with an aviation major from an approved school

Under this new qualification, pilots are now able to acquire pilot certification from approved organizations or institutions with slightly less pilot flight time requirements than the ATP Certificate or 1,500 hours.

Since enactment of PL 111-216 in 2010, pilot training organizations have been closely following the details in an effort to stay informed and adjust so they may offer their students and prospective students the best flight training opportunities possible. Collegiate flight training programs have been particularly concerned with these new standards and the potential effects to their institution's pilot training. Many collegiate flight training programs have voiced concern that increasing the pilot qualification standards will force student pilots to acquire many more flight hours that are not typically included in their academic flight training programs (University Aviation Association, 2012). Furthermore, to be eligible to offer the R-ATP, collegiate flight training programs must seek approval from the FAA by an R-ATP application process.

Recent academic research studies regarding PL 111-216 have all expressed significant concern regarding the application of these new standards, the potential negative effect to collegiate flight program current and prospective students, alterations to the career path for aspirating pilots and the long term effects collegiate flight training programs (Bjerke E. & Malott, 2011; Christensen C. & Card. K. A., 2014; Depperschmidt, C. L., 2013). Additionally, many individuals from industry have voiced concern that long-term effects of PL 111-216 may have negative effects to the aviation industry (contributing to a looming pilot shortage, discouraging future generations from considering commercial pilot as a career choice) or that the intended purpose of the legislation to create a safer industry with more capable pilots by requiring additional certification with increased total flight time is misguided and ineffective (Garfield, 2014; Romero, 2013; Schneider, 2013).

As with any change, there is a possibility for unknown or unintended consequences. PL 111-216 is no exception. As this new legislation is enforced, it is important for all stakeholders of the US aviation industry to closely follow the effects and possible consequences. Collegiate flight training programs represent a significant portion of supporters to the early stages of the pilot training cycle. Members of these programs (aviation faculty and flight center personnel) are well positioned to quickly interpret and identify the effects and trends related to PL 111-216, especially as they directly relate to collegiate flight training programs.

PL 111-216 created significant change and challenges for collegiate flight training programs. As collegiate flight training programs, it is important to understand these challenges so they may collectively and individually adapt to offer the best flight training opportunities possible for their students. In an effort to better understand how PL 111-216 is affecting collegiate flight training programs, this study explores the perceptions of aviation faculty members and flight center personnel regarding the effect and challenges five years after enactment and two years after enforcement of PL 111-216.

Methodology

To better understand the effects and challenges of PL 111-216 to collegiate flight training programs, the following research questions were used to guide this study:

1. What effect has PL 111-216 had on collegiate flight programs?
2. What effect has PL 111-216, specifically the R-ATP requirement, had on collegiate flight students and their career aspiration of professional flight?

Research Population

To answer these questions, this study sought the perceptions of aviation faculty and flight center personnel (director, manager, chief flight instructor, assistant chief flight instructor) of four-year collegiate flight training programs in the United States that offer flight training for academic credit of a bachelor's degree in aviation.

Potential participants for this study were identified by several different measures. First, all educational institutions who are 2015 institutional members of the University Aviation Association (UAA) were considered for this study. This represented a total of 96 institutional members. Of these 96 institutional members, the authors conducted an internet search of each institution's website to determine if they offered flight training associated to earning a bachelor's degree in professional pilot, or flight. Of these 96 original institutional members, 41 institutions offered flight training related to a bachelor's degree in professional pilot, or flight. The authors reviewed the faculty/staff websites of these 41 institutions to identify aviation faculty and flight center personnel. This final measure resulted in this study's population of 262 individual aviation faculty or flight center personnel.

The authors sent the 262 identified aviation faculty members and flight center personnel a solicitation email inviting them to complete a voluntary electronic research instrument with a provided electronic survey link. After approximately two weeks, a second reminder solicitation email was sent to all 262 potential participants. After approximately one month, the survey was deactivated and results were processed for this study. Of the 262 potential participants, 122 completed all questions of the survey. In addition to the 122 respondents, one participant chose to not participate and 10 did not complete all questions. In an effort to standardize respondent results, these 11 participants responses (not to participate and partial responses) were not included in the analysis or results of this study. The final response rate for this study was 122 participants (46.5%) of 262 potential participants.

Research Instrument

Developed by the authors, the research instrument was created to solicit demographic, perception and comment information from the respondents regarding issues related to the effect of PL 111-216. Demographic questions sought information regarding enrollment trends, size of program, type of employment and if institutions were approved to offer the R-ATP. Perception questions were offered in Likert-scale statements in an ordinal measurement pattern that offered respondents the options of: Strongly Agree, Agree, Disagree, or Strongly Disagree. For this study, the authors used a 0-4, forced-response, Likert-Scale. The forced-response Likert-scale does not offer a central or neutral choice and forces the respondents to agree or disagree with the statement (Trochim, 2006). The last section of the research instrument was an open text box where respondents were asked to include any comments or concerns they had regarding PL 111-216 and its effect on their collegiate flight program and/or students. Permission to conduct this study and solicit this research instrument was approved by the Institutional Review Board at Oklahoma State University (approval # ED-15-71).

Limitations of Study

Limiting to this study was the volunteer participation of the respondents. Results of this study reflect the 122 participating respondents who were available and willing to complete the electronic research instrument. Further, results to this study are limited to the perceptions of faculty and flight center personnel of UAA member institutions.

Analysis

The Likert-scale statements were analyzed using Cronbach's alpha (α) reliability test to measure internal consistency. To measure internal consistency, Cronbach's α determines how all items on a test are related to all other items and the total test (Gay, Mills, & Airasian, 2006). George and Mallery (2003) established the following Cronbach's α acceptance scale: " ≥ .9 – Excellent; ≥ .8 – Good; ≥ .7 – Acceptable; ≥ .6 – Questionable; ≥ .5 – Poor; and ≥ .5 – Unacceptable" (p. 231). To analyze the results of this study, all data was inputted into an Excel spreadsheet and then imported into SPSS version 21.0. This resulted in an overall Cronbach's alpha value of .801 representing a level of good based on the George and Mallery scale. This study also applied descriptive statistics in analysis of the data. Standard Deviation, a type of descriptive statistic, is used as a measure of variability in data analysis (Fraenkel & Wallen, 2006; Gay, Mills, & Airasian, 2006). In the results section of this study, standard deviation is indicated as SD for the demographic and Likert-statement results.

Results

Demographic

Respondents were asked to identify their position of academic employment at their educational institution. Choices for this question were Aviation Faculty or Flight Center Personnel (Director, Manager, Chief/Assistant Chief Flight Instructor). Table 1 indicates that the majority of respondents were aviation faculty (71%).

Table 1
Respondent Academic Employment

	Responses	Percentage	SD
Aviation Faculty	87	71%	0.45
Flight Center Personnel	35	29%	0.45
Total	*122*	*100%*	

In addition, the research instrument asked respondents to identify the approximate number of student pilots enrolled in their collegiate flight program and what enrollment trends they have experienced since enforcement of PL 111-216 in 2013. Tables 2 and 3 detail the respondents' answers to these two questions.

Table 2
Student Pilot Enrollments

Enrollments	Responses	Percentage	SD
1-50	8	7%	
51-100	34	28%	1.63
101-150	25	20%	1.63
151-200	21	18%	1.63
201-250	9	7%	1.63
251 or more	25	20%	1.63
Total	*122*	*100%*	

Table 3
Enrollment Trends since Enforcement of PL 111-216

Enrollment Trend	Responses	Percentage	SD
Increasing	36	29%	0.86
Decreasing	30	25%	0.86
Unchanged	56	46%	0.86
Total	*122*	*100%*	

The last demographic question asked respondents if their collegiate flight training program was approved by the FAA to offer the R-ATP certification. Table 4 indicates a strong majority, 77%, of respondents are from a collegiate flight program that is approved for the R-ATP certificate.

Table 4
Programs Approved for R-ATP

R-ATP Approval	Responses	Percentage	SD
Yes	94	77%	0.51
No	24	20%	0.51
Under Review	4	3%	0.51
Total	*122*	*100%*	

Likert-Scale Statements

To explore the perceptions of aviation faculty and flight center personnel, the survey instrument solicited responses to 13 Likert-scale statements regarding PL 111-216 and its potential effect on collegiate flight students, collegiate flight training programs and the US air carrier industry. Table 5 lists the results of the Likert statements related to the effect of PL 111-216 on collegiate flight students.

Table 5

Perceptions of Effect Regarding Students

Likert Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
Our current flight students have expressed concerns regarding the effect PL 111-216 will have on their career goal of aviation flight.	64 (52%)	47 (39%)	8 (6%)	3 (3%)
The required R-ATP certificate (minimum of 1,000 flight hours) will discourage some of our current flight students to continue/complete their four-year collegiate flight degree due to the financial obligation of additional flight costs.	25 (20%)	67 (55%)	28 (23%)	2 (2%)
Since implementation of PL 111-216 (August 2013), our flight students have increasingly pursued other undergraduate aviation degree options other than flight/professional pilot.	13 (11%)	59 (48%)	45 (37%)	5 (4%)
Our collegiate aviation flight program's aviation faculty and/or flight center personnel believe that PL 111-216 requirement of the R-ATP certificate will effectively produce a more experienced and employable collegiate pilot.	1 (1%)	13 (13%)	55 (45%)	50 (41%)

As indicated by Table 5 responses, the majority of respondents expressed concern that PL 111-216 will have an adverse effect on students. More than 90% of respondents indicate students have expressed concern regarding their career goals, and 75% of respondents believe PL 111-216 will discourage students to complete or continue their collegiate flight degree. While the majority of respondents indicated students are concerned or challenged to continue their academic pursuit and career goals, they also strongly indicated that new pilot standard will not produce a more experienced or employable pilot. When asked to respond to the following statement; *Our collegiate aviation flight program's aviation faculty and/or flight center personnel believe that PL 111-216 requirement of the R-ATP certificate will effectively produce a more experienced and employable collegiate pilot*, 86% of respondents disagreed or strongly disagreed.

To examine potential effects to collegiate flight training programs, respondents were asked to respond to several Likert statements that addressed the potential effect of PL 111-216 on their collegiate flight training program. Results of the responses to these statements are listed in Table 6.

Table 6 further expresses concerns by the respondents regarding the effect of PL 111-216 on their collegiate flight training program. The majority of respondents were concerned that retention of current students and recruitment of potential students would be negatively affected by PL 111-216. Respondents strongly agreed or agreed (84%) that their aviation faculty and flight center personnel have concerns regarding the effect PL 111-216 will have on their flight program and 82% of respondents strongly agreed or agreed that PL 111-216 will have a negative effect on their flight students and their collegiate flight program.

Table 6
Perceptions of Effect Regarding Collegiate Flight Training Programs

Likert Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
Our collegiate aviation flight program has concerns that PL 111-216 will negatively affect the retention rate of our current flight/professional pilot students.	21 (17%)	64 (52%)	36 (30%)	1 (1%)
Our collegiate aviation flight program has concerns that PL 111-216 will negatively affect the recruitment of prospective flight/professional pilot students.	67 (55%)	31 (25%)	21 (17%)	3 (3%)
Our collegiate aviation flight program's aviation faculty and/or flight center personnel have concerns regarding the effect PL 111-216 will have on our flight program.	40 (33%)	63 (51%)	16 (13%)	3 (3%)
Overall, PL 111-216 will have a negative effect on our flight students and our collegiate flight program.	31 (25%)	57 (47%)	33 (27%)	1 (1%)
As a result of PL 111-216 implementation, our college/university administration has expressed concern regarding the future viability of our collegiate flight program.	13 (11%)	50 (41%)	48 (39%)	11 (9%)

The last set of Likert statements were intended to investigate the potential effect of PL 111-216 on the US air carrier industry. Results of the responses to these statements are provided in Table 7. Outcomes of respondent's perceptions regarding the industry were similar to those regarding students and collegiate flight training programs by a strong majority concern for an adverse effect as a result of PL 111-216. When asked if PL 111-216 will improve the overall safety of the US air carrier industry, 92% of respondents disagreed or strongly disagreed that their students have stated that PL 111-216 will improve the overall safety of the US air carrier industry; and 93% of respondents indicated that aviation faculty or flight center personnel disagreed or strongly disagreed that PL 111-216 will improve the overall safety of the US air carrier industry. The majority of respondents (87%) also believe that PL 111-216 will contribute to a pilot shortage and 88% strongly agree or agree that overall, PL 111-216 will have a negative effect on the US air carrier industry.

Table 7
Perceptions of Effect Regarding the US Air Carrier Industry

Likert Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
Our current flight students have stated that PL 111-216 (required R-ATP certificate) will improve the overall safety of the US air carrier industry.	2 (2%)	7 (6%)	65 (53%)	48 (39%)
Our collegiate aviation flight program's aviation faculty and/or flight center personnel believe that PL 111-216 (required R-ATP certificate) will improve the overall safety of the US air carrier industry.	1 (1%)	8 (6%)	57 (47%)	56 (46%)
Our collegiate aviation flight program's aviation faculty and/or flight center personnel believe that PL 111-216 (required R-ATP certificate) will reduce the number of employable pilots available to the US air carrier industry; contributing to the concern of a projected US pilot shortage.	57 (47%)	49 (40%)	16 (13%)	0 (0%)
Overall, PL 111-216 will have a negative effect on the US air carrier industry.	47 (38%)	61 (50%)	12 (10%)	2 (2%)

Discussion

It is probable that many stakeholders in the US aviation industry, especially in collegiate flight training programs, will not be overly surprised by the findings of this study. Many have continually voiced concern over recent legislation, increased standards and the potential effect to collegiate flight training and the aviation industry. This was especially true as collegiate aviation training programs speculated the outcome of this legislation prior to the release of the Notice of Proposed Rulemaking (NPRM) of The Airline Safety and Federal Aviation Administration Extension Act of 2010. However, five years after enactment and two years after enforcement of PL 111-216, these concerns remain very strong. As indicated by the results of this study, there are significant concerns for current and prospective flight students, collegiate flight training and the US air carrier industry as a result of PL 111-216.

PL 111-216 remains a passionate issue that continues to be a concern for aviation faculty and flight center personnel of collegiate flight training programs. The last section of the research instrument for this study offered respondents the opportunity to offer personal comments or concerns regarding PL 111-216. Many respondents expressed very strong opinions and reiterated many themes explored by the research instrument. However, several new themes emerged as points of concern or interest regarding PL 111-216.

Several respondents indicated that while student pilot enrollment since enforcement of PL 111-216 had increased, this was due to a significant increase in flight students of non-US citizenship. One respondent indicated concern that collegiate flight training programs who do not have a means to train non-US citizens will suffer competitively after enforcement of PL 111-216. This indicates that in a new climate after PL 111-216, collegiate flight training programs could find a competitive advantage to pursue and train students that seek professional flight careers outside the US that are not affected by PL 111-216. Several also indicated that while enrollment of non-US citizen students have increased, they do not expect US student enrollment to increase due to PL 111-216. Related to this issue, respondents indicated that US student pilots will increasingly seek career opportunities outside of the US as a result of PL 111-216. Also related to this, many respondents indicated an increasing interest of students to seek pilot careers in corporate aviation or Part 135 operators that are not affected by the increased pilot standards of PL 111-216.

It was also recognized by several respondents that a root cause of this issue is related to pilot pay. It was indicated that this problem could be largely solved by increasing the starting salary range of regional pilots and/or decreasing the flight students' financial investment regarding their collegiate flight training costs.

There were also several positive reflections offered by respondents related to the impact of PL 111-216. These were related to two different aspects. Several respondents indicated that approval from the FAA to offer the R-ATP gave them a competitive flight training advantage over most or all competing flight training options in their area. Secondly, several respondents indicated the enforcement of increased pilot standards has resulted in a dramatic increase of the longevity of their CFI's tenure as they seek to acquire additional flight hours. This reduction in CFI turnover and increase in flight training consistency was a welcomed change to several respondents.

Finally, many respondents questioned the effectiveness of the increased standards and challenged that an increase in flight hours at this stage of a student pilot's training would not improve piloting skill. The continued question of "quality vs. quantity" was also expressed. Respondents indicated that the new legislation was misguided in its application since the fault of Colgan 3407 was not as a result of fewer than 1,500 flight hours or lack of an ATP certification from either pilot.

It will take many years to conclude the final effect of PL 111-216 on collegiate flight training programs and the US air carrier industry. However, continued interest and caution is necessary from collegiate aviation stakeholders. In order to offer their flight students the best professional pilot employment opportunities and the US air carrier industry the best qualified pilot applicants, it is vital that collegiate aviation stakeholders continue to voice concern and be involved in the regulatory processes. This would include proposes for necessary regulatory change or active involvement in any legislation that may further affect this issue. Perhaps collegiate aviation stakeholders will see continued change or adjustment regarding PL 111-216 in the future. As several respondents indicated, Congress will eventually be forced to fix their mistake and retract or adjust the legislation related to the increase of pilot certification standards of PL 111-216.

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Overcoming Gender Barriers in Aircraft Maintenance: Women's Perceptions in the United States

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Abstract

The Federal Aviation Administration's 2014 annual airman certificate demographics report revealed that women comprise roughly 23% of the non-pilot certificated airman in the United States; however, only 2.3% of the certified aircraft mechanic workforce are women. The problem explored in this mixed-methods concurrent triangulation study was the literature gap regarding factors that impact the demographic disparity between men and women in the aircraft maintenance technician field. The purpose of the study was to understand why most women choose not to become aircraft mechanics. A total of 431 female participants completed a 13-question survey containing 5-point Likert and open-ended questions to collect quantitative and qualitative data that addressed the research question. Results indicated that neither motherhood nor marriage were factors that impacted a woman's interest in a career as an aircraft maintenance technician. Furthermore, there was a relationship between a woman's perception of physical limitations as a mechanic, career appropriateness, work environment safety, social acceptance, and advancement opportunities. Finally, the qualitative analysis yielded a substantial amount of informative themes and nodes that illuminated a general lack of women's knowledge regarding the field and a perception of sexual discrimination if one were to start such a career.

Introduction

While women comprise almost half of the workforce in the United States, women continue to be underrepresented in many technical fields. In fact, despite the fact that number of women attending college has exceeded men, only about 19-21 percent of undergraduate science, technology, engineering, and math (STEM) majors are women (Ma, 2011). The significant underrepresentation of women in STEM fields is not a new problem. Jacobs (1995) highlighted the problem and noted that it was fundamentally connected to gender segregation. There are very few women in aviation and aerospace fields, and fewer still in aviation maintenance. There may be significant factors affecting the number of women who choose aviation maintenance careers. No aviation career field reflects the level of disparity as seen among aircraft maintenance technicians.

Problem Statement

The Federal Aviation Administration's (FAA, 2014) annual airman certificate demographics report revealed that women comprise roughly 23%—or a total of 162,284—of the nonpilot certificated airman in the United States (see Appendix A). Of those women nonpilot airmen, 87% hold certificates as flight attendants. Aircraft mechanics are the next largest population and consist of only 5% of the total female workforce—or about 7,746—and comprise 2.29% of the of larger 338,844-person aircraft mechanic workforce (FAA, 2014). Several studies that explored relationships between gender and career choices attribute selection to a number of factors, to include; (a) marriage, (b) motherhood, (c) sexual discrimination, and (d) fair competition (Buser, Niederle, & Oosterbeek, 2014; Chynoweth, 2014; Dubey & Tiwari, 2014). The specific problem explored in this study was the gap in the literature surrounding factors that create the gross imbalance between men and women in the aircraft maintenance technician workforce.

Purpose Statement

The purpose of this mixed-methods concurrent triangulation study was to examine and explore the factors that impact career selection as it pertains to women in aircraft maintenance. This study attempted to identify some of the attitudes and influential factors that steer women away from the aircraft maintenance technician career.

Literature Review

The following review of professional and academic literature formed the foundation of the research question. To fully understand the factors and reasons that lead women to choose fields other than aircraft maintenance, we had to explore the role of women in STEM fields, women in the aviation industry, and women in aircraft maintenance. Upon completion of the foregoing, we were postured appropriately to develop and address the research question.

Women in STEM

To examine the lack of women in aviation maintenance, we should start with the lack of women in technical fields. There is a great body of evidence that indicates a disproportionate number of women in so-called science, technology, engineering and mathematics (STEM) career fields. Despite significant increases in the numbers of women in management, professional and related occupations since the 1980s, women still only represent less than 25% of those employed in fields which fall under the STEM umbrella (Bureau of Labor Statistics, 2014; Beede et al., 2011). These studies point to some common findings and statistics on the number of women in these fields, and generally remain constant, especially in the last five years. What is surprising is this finding: the number of women going into certain STEM fields including computer science and mathematics has actually decreased (Corbett, Hill, & St. Rose, 2010). Even more surprising is that women are beginning to outnumber men among college-educated workers with STEM degrees in these very areas (Beede et al., 2011). Chen and Moons (2015) explored the foregoing and discovered that many women were disinterested in male-dominated fields, such as STEM fields, because they felt that they would not be socially accepted or have influence in those positions. That might explain why there is such a shortage in the aviation fields, which are also predominantly male.

Women in Aviation

From the days of Lillian Todd, the first woman to build an aircraft in 1906, to Lt. Col. Eileen Collins, the first woman Space Shuttle Commander, women have been involved in all facets of aviation (Women in Aviation International, 2013). In WWII women not only flew military aircraft but also worked in the factories building aircraft for the war effort (Texas Women's University, 2014). The iconic 'Rosie the Riveter" poster and magazine cover is a well-known portrayal of women who left the home to work in the factories during WWII. In fact, in 1943, more than 310,000 women worked in the aircraft industry and comprised more than 65% of the total workforce (Rosie the Riveter, n.d.). However, most women returned back to the home and family after the end of the war even though women had demonstrated they could perform the jobs as well as their male counterparts. The question is, did women return to aviation careers?

Goyer (2014) examined data from 1960 to 2010 to understand whether the numbers of women in aviation had significantly increased. Goyer found that the numbers of women entering aviation from 1960 to 1980 was significant but since that time, little progress has been made. In 1960 less than 1% of women in the labor force worked in the pilot or aircraft mechanic aviation fields. By 2010, the numbers had only increased to 4.3% and 2.17% respectively (Goyer). Conversely, in 1960 women accounted for approximately 4% of lawyers and 6% of doctors and surgeons. By 2010, women lawyers accounted for 38.3% of the workforce and 31.8% of the total number of doctors and surgeons in the U.S. (Goyer).

To examine the numbers more in depth, as of 2013 a total 205,915 women held FAA Airmen Certificates in pilot and non-pilot categories (FAA, 2014). In 2005, the FAA included flight attendants for the first time and in 2013 of the 205,915 women with FAA certificates 143,701 were flight attendants (FAA). The remaining 62,214 accounted for the entire population of women holding airmen certificates. Breaking the numbers down further, 39,621 women held pilot certificates and 22,593 were non-pilots. The largest non-pilot population is mechanics at 7,917 (FAA).

Admittedly, the numbers from the FAA include only women with actual certifications. According to the U.S. Bureau of Labor Statistics (BLS), the total labor pool for airline pilots, copilots and flight engineers is 73,030 and for aircraft maintenance technicians the number is 115,410 (2013a, 2013b). These figures represent the number of people actually working in these aviation career areas. Comparing the BLS statistics to the numbers reported by the FAA, the results are similar with women making up approximately 5.5%

of the aircraft pilot and flight engineer workforce and 2.2% of the aircraft mechanic and service technicians (U.S. Department of Labor, Women's Bureau [DOL], 2013). The predominant aviation career area with the largest number of women continues to be the flight attendant category, at 80.9% of the labor force (DOL, 2013). At the end of over a century of aviation progress, it seems the composition of the overall aviation workforce is still predominantly male.

Women in Aircraft Maintenance

Today, several aviation-related career fields are experiencing shortages and even greater numbers of workers will be needed in the future. Experts at Boeing and Airbus forecast a labor shortage in the aviation industry and predict a need of up to 600,000 aircraft maintenance technicians by 2031 (Boeing, 2014). Currently, the average aircraft maintenance technician salary is approximately $50,000 per year (U.S. Bureau of Labor Statistics, 2013b). In recent years heavy maintenance, also known as Maintenance, Repair and Overhaul (MRO) activities, were outsourced to foreign companies to save costs. Experts predict a return of MRO work to the U.S. in the coming years, and that need should increase the pay for aircraft maintenance technicians (Team SAI Consulting Services, 2014). The commercial aircraft or air transport segment is the largest of the MRO markets and forecasted to be $57.7 billion in 2014 with forecasted growth to $87.8 billion by 2024 (as cited in Holland, 2013). With a compound annual growth rate (CAGR) of 4.2%, the commercial aircraft sector is one of the more healthy indicators for the future of the aviation industry. Yet, in the wake of the forecasted labor needs, market growth and fair compensation, few women still appear to enter or stay in the aircraft maintenance career field.

According to the latest figures available from the FAA, women make up just 2.5% of licensed aircraft mechanics. Arguably, the numbers for aircraft mechanics are representative of only those women who hold FAA Airframe and Powerplant (A&P) certificates (FAA, 2014). However, in a U.S. workforce of 314,622 a total of 7,746 certificated women airmen is a low number by any measurement standard.

What actions are needed to attract more women into the aircraft maintenance career field? Is it a matter of women not understanding the work or simply being uninformed of the career field and need? Or is the aircraft maintenance career field not attractive to women, i.e. perceived as *dirty work*? Research has found that women choose careers that have an impact and make the world a better place (Zimovan, 2014). How do we inform women of the contributions that aircraft maintenance improvements and practices have made to the world of aviation as well as other transportation sectors? If we can find ways to answer these questions then the path to solving the issue may be clearer.

Research Question

The central research question for the study was: *What factors contribute to the majority of women being disinterested in aircraft maintenance careers? Why?*

To address the research question, we used quantitative analysis to examine the factors identified in the related literature that typically serve as barriers for women entering male-dominated fields. We simultaneously conducted a qualitative exploration of each factor to better understand the responses. The following factors served as the pillars for the research: (a) marriage, (b) motherhood, (c) sexual discrimination, and (d) fair competition. We assessed these factors via the following tests and supported the results with related qualitative findings.

Hypotheses

a) Marriage and maintenance career interest:

H_0: Marital status has no significant impact on a woman's interest in a career as an aircraft maintenance technician.

H_a: Marital status significantly impacts a woman's interest in a career as an aircraft maintenance technician.

b) Motherhood and maintenance career interest:

H_0: Parental status has no significant impact on a woman's interest in a career as an aircraft maintenance technician.

H_a: Parental status significantly impacts a woman's interest in a career as an aircraft maintenance technician.

c) Career interest, career appropriateness for women, advancement opportunity, physical limitations, and work environment safety.

H_0: There is no correlation among career interest, career appropriateness for women, advancement opportunity, physical limitations, and work environment safety.

H_a: There is a correlation among career interest, career appropriateness for women, advancement opportunity, physical limitations, and work environment safety.

Method and Design

The goal of this mixed-methods concurrent triangulation study was to examine and explore the factors that impact career selection as it pertains to women in aircraft maintenance via collection of data from a 13-question survey. The chosen method was most appropriate because it afforded us the quantitative data to accept/reject hypotheses, and the qualitative data to provide depth of scholarship regarding the aforementioned tests (Creswell, 2009). Given the size of the sample and convenience of collecting all of the data at one time, the concurrent triangulation design allowed us to collect simultaneously quantitative and supporting qualitative data (Creswell).

Population and Sampling

The population consisted of adult women distributed across the U.S. for which the sample ($n = 431$) was taken. Amazon's MTurk™ served as the conduit for accessing the population given its popular use in the U.S. and distributed and diverse user demographics. The cross-sectional study covered a three-day data collection period, during which time the active link to the survey was open and confirmation codes were rotated to avoid fraudulent responses.

Validity

To ensure valid data, it was important for us to confirm that the data collection device measured the appropriate criteria (Lameck, 2013). We guided the planning of our investigation and tested our collection procures and instrument via a pilot study—or feasibility study—using MTurk^{TM} participants (n=53) from the target population; the pilot participants' *Worker ID*s were excluded from the full study. The pilot confirmed the effectiveness of the sampling strategy and that the $0.50 per survey incentive was sufficient. The results of the Likert questions in the pilot provided insight on areas for improvement, such as question clarity, survey length, and balancing the participant incentive against the time it took to complete the survey. Following the five Likert questions, pilot participants were afforded a comment box to provide qualitative feedback for suggested survey improvements. We used the foregoing to improve the survey and improve validity of the findings (Dolnicar, 2013).

Reliability

Reliability is paramount to assessing the quality of the collected data (Tavakol & Dennick, 2011). We conducted a split-half coefficient expressed as a Spearman-Brown corrected correlation to assess the reliability of the survey data. We divided the scale into two equivalent halves. While splitting the items, we accounted for sequencing of items and balance. The general guidelines for alpha values: 0.90 to 1.0 are excellent, 0.80 to 0.89 are good, 0.70 to 0.79 are acceptable, 0.60 to 0.69 are questionable, 0.50 to 0.59 are poor, and below .50 are unacceptable (George & Mallery, 2003). The value of the split-half coefficient met *acceptable* reliability standards with a score of 0.698 (or 0.70).

Results

Hypothesis A: Marriage and maintenance career interest

Hypothesis:

H_0: Marital status has no significant impact on a woman's interest in a career as an aircraft maintenance technician.

H_a: Marital status significantly impacts a woman's interest in a career as an aircraft maintenance technician.

An independent-samples *t* test was conducted to evaluate the hypothesis that a woman's marital status impacts her interest in a career as an aircraft maintenance technician. The independent variable was the respondent's marital status and the dependent variable was the interest in aircraft maintenance as a career. The test was not significant $t(429) = -.525$, $p = .60$, therefore we accepted the null hypothesis that marital status had no significant impact on a woman's interest in a career as an aircraft maintenance technician. Table 1 depicts the results.

Table 1
Independent-Samples t Test for Hypothesis A (n = 431)

		Marital Status					
Group	*t*	*df*	*p*	*M*	*SD*	LL	UL
Single	-.525	429	.600	-1.48	.812	-.194	.112
Married	-.524	405.8	.601	-1.44	.796	-.194	.113

Hypothesis B: Motherhood and maintenance career interest

Hypothesis:

H_0: Parental status has no significant impact on a woman's interest in a career as an aircraft maintenance technician.

H_a: Parental status significantly impacts a woman's interest in a career as an aircraft maintenance technician.

An independent-samples *t* test was conducted to evaluate the hypothesis that a woman's parental status impacts her interest in a career as an aircraft maintenance technician. The independent variable was the respondent's parental status and the dependent variable was the interest in aircraft maintenance as a career. The test was not significant $t(429) = -.439$, $p = .66$, therefore we accepted the null hypothesis that parental status had no significant impact on a woman's interest in a career as an aircraft maintenance technician. Table 2 depicts the results.

Table 2
Independent-Samples t Test for Hypothesis B (n = 431)

		Parental Status					
Group	*t*	*df*	*p*	*M*	*SD*	LL	UL
No Children	-.439	429	.661	-1.48	.862	-.190	.121
Children	-.428	335	.669	-1.45	.763	-.194	.125

Hypothesis C: Career interest, career appropriateness for women, advancement opportunity, physical limitations, and work environment safety

Hypothesis:

H_0: There is no correlation among career interest, career appropriateness for women, advancement opportunity, physical limitations, and work environment safety.

H_a: There is a correlation among career interest, career appropriateness for women, advancement opportunity, physical limitations, and work environment safety.

We calculated correlation coefficients among the elements of hypothesis C. By using the Bonferroni approach to control for Type I error across the 16 correlations, we required a *p* value of less than .005 (.05/10 = .005). The correlation results presented in Table 3 identify that 6 out of 10 correlations were statistically significant. With the exception of career interest, each element had at least two significant relationships with the other five elements. If a woman felt the aircraft maintenance technician's work environment was safe, she also agreed the job was appropriate, there were advancement opportunities, that women would be socially accepted, and that women were not physically limited from performing AMT functions.

Table 3
Correlations among the Ten Elements of Hypothesis C (n = 431)

	Career Interest	Appropriate for Women	Advancement Opportunity	Physical Limitations	Safe Environment
Appropriate for Women	-.022				
Advancement Opportunity	.085	.121			
Physical Limitations	.010	-0.429*	-.089		
Safe Environment	.108	0.227*	0.378*	-0.135*	
Social Acceptance	.080	.098	0.461*	-.067	0.418*

* = Significant at the .003 (.05/10 = .005) to account for Type I error.

Women's Overall Perspectives

To support our discussion, and ultimately our conclusions, we conducted a one-sample t-test to determine if women had a significant, overall opinion regarding career interest, career appropriateness for women, advancement opportunity, physical limitations, and work environment safety. The test value was 0, representing an absolute neutral perspective. Using the Bonferroni method, we calculated the required *p* value to be .008 (.05/6 = .008). *Table 4* displays the 5 out of 6 factors with means that are statistically different than the absolute neutral test value of 0. Figure 1 depicts a boxplot that shows the general rating of women for each item.

Table 4
Significance of Means

	Test Value = 0					
	t	*df*	*p*	*M*	LL	UL
Career Interest	-37.80	430	0.00*	-1.46	-1.54	-1.39
Appropriate for Women	30.02	430	0.00*	1.30	1.21	1.38
Advancement Opportunity	2.83	430	0.00*	0.13	0.04	0.22
Physical Limitations	-21.00	430	0.00*	-1.02	-1.11	-0.92
Safe Environment	8.85	430	0.00*	0.42	0.33	0.51
Social Acceptance	-1.16	430	0.25	-0.05	-0.14	0.04

* = Significant at the .006 (.05/6 = .008) to account for Type I error.

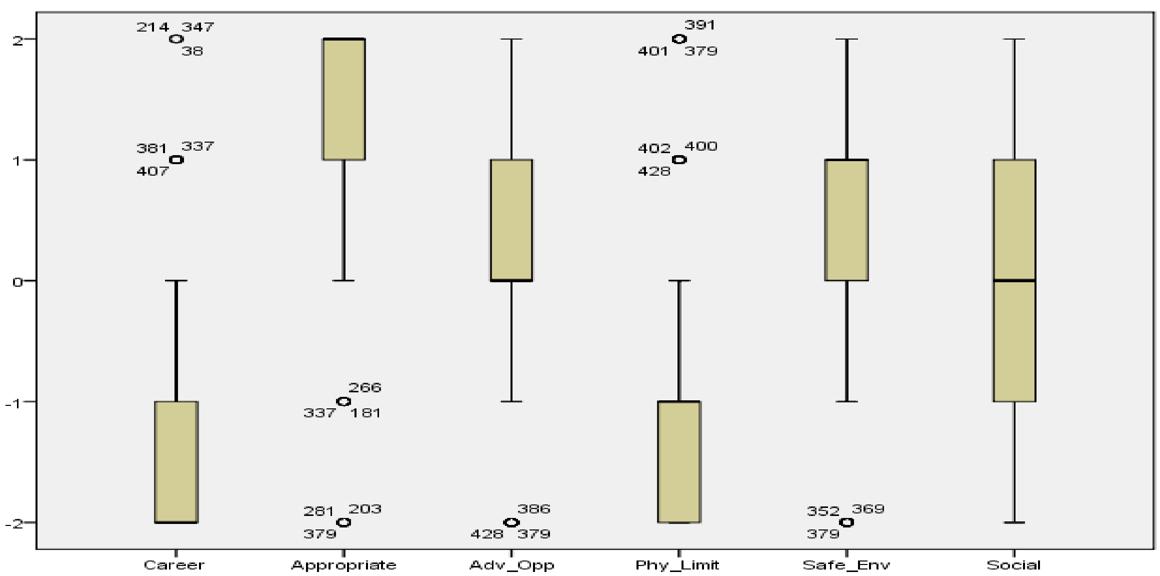

Figure 1. A boxplot representing the response distribution for each survey question.

Qualitative Exploration

The items in Figure 1 represent the overall opinions of women in the U.S. regarding aircraft maintenance. To understand the distribution of the data, each Likert question in the survey contained a mandatory short response question where participants were asked to—in one or two sentences—explain why they selected their answer. Table 5 lists the coded themes and frequency for each theme that was relevant to addressing the research question. Themes that appear more often are believed to hold more value.

Discussion

Motherhood and Marriage

Contrary to the expectations derived from the literature, we discovered that neither parental nor marital status had a significant impact on the desire to participate in a career as an aircraft maintenance technician. Although unexpected, the implications of the findings are significant to the aircraft maintenance industry. From an operational and retention standpoint, it does not appear likely, from a woman's perspective, that the introduction of family in the form of a spouse or child will impact a current or potential aircraft maintenance technician's decision to enter or stay in the field. Because these findings conflict with literature, we can assume that they are not transferable beyond the field of aircraft maintenance.

Relationships among career interest, appropriateness for women, advancement opportunity, physical limitations, and work environment safety

We found that among our survey respondents, women who felt physical limitations were either non-existent or did not exclude a career in aircraft maintenance responded favorably to the other areas in the survey. In other words, if a woman felt she was physically able to accomplish tasks in an aircraft maintenance field, she also likely felt the field was appropriate and offered a safe working environment. If a woman felt that the field was a safe environment, she likely felt the field offered advancement opportunities and social acceptance for women. The overall consistency of the results suggest an *all-in* or *all-out* perspective of women towards the career field. Again, these inferences are significant to industry from a marketing and recruitment perspective. Marketing efforts concentrating on the actual aircraft maintenance work environment, available career paths, and any physical strength requirements will likely be well-received by women.

Depth of Understanding

The distribution of responses was expected, in most cases, based on the data provided by the FAA (2014) regarding the grossly low number of certificated women mechanics. However, the reasons explaining why the majority of women do not choose careers in aircraft maintenance remained a gap in the literature. The following sections discuss the results of the qualitative analysis in Table 5 and illuminate some of the primary reasons women chose their respective responses.

Table 5
Qualitative Nodes and Frequencies

	Disagree		Neutral		Agree	
	Nodes	*f*	Nodes	*f*	Nodes	*f*
Career	Not mechanically inclined	103	Not appealing	18	Sounds exciting or interesting	40
	Prefer white collar work	68	Never considered it	12	Mechanically Inclined	25
	Responsible for lives	39	Other interests	7	Passion for aviation	23
	Other interests	29	Not mechanically inclined	6	Good pay and benefits	18
Appropriate	Appropriate for Men	8	Assume the career is Appropriate	23	Women are just as capable	111
	Physical Limitations for Women	6	Not Familiar with Career	5	Appropriate Career Choice	133
			Women Are Not Interested	5	Not Gender specific	17
					With Correct Skills/knowledge	11
Advancement	Discrimination/sexism	49	Unfamiliar with career field	83	Equal opportunity to advance	82
	Male oriented/controlled	18	Not sure	55	Hurdles/bias/barriers	11
	Women not exposed to career	8	Assume it is harder to advance/bias	45	Unfamiliar with career field	6
	Unfamiliar with career field	6	There should be equal opportunity	31	Women just do not choose	5
Limitations	Women should not be limited	129	I do not know	14	Women are not as strong as men	14
	Heavy lifting may not be required	41	Depends on the person	7	Women can be physically strong	7
	Women can be physically strong	37	Women can be physically strong	4	Not all women are strong enough	4
	Women can bridge physical gaps	34	Heavy lifting may not be required	2	Not physically suited	2
Safe	Sexual harassment/discrimination	29	Depends on the people/culture	60	Equally safe for women and men	76
	Men are threatened by women	17	It should be safe	47	Predominantly male, but safe	50
	Unsafe environment	13	Some harassment present	12	Generally believe it is safe	41
	No work environment is safe	3	Unsure	5	Men respect women as equals	11
Acceptance	Many men are still not accepting	41	Don't know	76	Gender discrimination is uncommon	32
	Not sure, but doubtful	30	Not sure but hopeful	37	Men/Women fit in equally	25
	Women unwelcome in male field	17	Many men are still not accepting	23	No gender discrimination	17
	Cultural perceptions barrier	15	Making progress but not there	19	Women work just as hard as men	14

Career interest. Several reasons emerged from the data as to why women are not interested in careers as aircraft maintenance technicians. Most of the women who responded to the survey were not interested due to a perceived lack of mechanical or technical skills. Simply put, they did not feel they had the technical or mechanical ability to perform the tasks required in aircraft maintenance. Many women also felt more closely aligned with white-collar jobs than blue-collar jobs. This information might partially explain why 87% of the non-pilot certificated airmen who are women are flight attendants (FAA, 2014). For those women who were interested, it was largely due to the expectation of an exciting career, demonstrated mechanical ability, or a personal passion for the aviation industry.

Career appropriateness for women. Nearly all women who felt that the aircraft maintenance technician field was appropriate for women also felt that women were just as capable as men in the performance of all of the related tasks. Women who were neutral also assumed the foregoing but were not sure, with a small majority who just were not sure. Very few women disagreed that the career was appropriate for women and their responses were divided between responses that indicated the aircraft maintenance field was a "man's world" or that women were not physically suited for the job.

Advancement opportunities. Although more women indicated in the Likert responses that they were neutral or agree that women have equal advancement opportunities, the qualitative data provided sufficient depth to understanding the distribution of data. For example, many of the respondents who selected neutral as an answer were unsure of the existence of discrimination, but felt the bias against women would be present in the work place. It is important to note that bias or discrimination was among the top four frequencies in each coded response category. The qualitative data suggests a patent lack of knowledge regarding the advancement opportunities women have as aircraft maintenance technicians and highlights the predominant feeling of the existence of discrimination or male dominance in the career field.

Physical limitations. To understand the distribution of responses in this category it is important to note that—unlike the other questions—this question had a negative statement for agreement (i.e. "women do have physical limitations…") versus the other questions that had a positive statement for agreement (i.e. "women have equal advancement opportunities…"). Given the foregoing information, the data for this question was skewed to the right. This information translates to a majority of *disagree* and *strongly disagree* answers, as opposed to the contrary. For those women who felt there were no physical limitations, most of them felt women were no more limited than men, especially given all of the equipment available to assist with the more strenuous technician tasks. For the women who agreed that physical limitations existed, they felt men were more physically suited for the job. As with many of the categories in Table 5, the majority of neutral selections were due to a lack of knowledge surrounding the career field.

Safe environment. The perception of physical environmental safety for women largely favored the perception that, although men dominate the field, women would be respected and generally safe in such a work environment. Of the neutral responses regarding safe working environments, most felt physical safety was dependent on the culture and people at the specific location, but overall, a safe environment should not be a concern. Discrimination and sexual harassment in the work environment were the top perceptions for those who felt the environment was unsafe for women.

Social acceptance. The qualitative views regarding social acceptance of women in an aircraft maintenance environment were primarily neutral due to a lack of knowledge regarding the work environment of aircraft maintenance technicians. Although some respondents were hopeful that an accepting culture exists (or is developing), there were more women with an opinion that women would not be socially accepted, than those who felt they would be accepted. The distribution between agreement and disagreement responses was not significantly different from zero and the overall qualitative responses reinforced the statistical finding.

Assumptions, Limitations, and Delimitations

Assumptions

The succeeding assumptions underlay the research:

- During the pilot study, all participants noted that the questions did not make them feel uncomfortable and that they answered honestly; it was reasonable to assume the same for the main study.
- The aggregate data represents the general position of the larger population.
- Study results are generalizable and researchers will be able to replicate them.

Limitations

The preceding research faced a number of internal and external challenges—most of which were generated by the geographic separation of the research team members from each other and from the participants. Skype™ served as the platform for virtual communication and there were no apparent negative impacts to the study as a result of the medium by which the team communicated. Because the survey instrument was electronically distributed and taken online via SurveyMonkey™, the physical location of the participant was irrelevant with respect to the location of each member of the research team.

Another limitation was MTurk's™ inability to target/filter workers—or participants—by gender. As a result, we expanded the questions of the survey and redeveloped it to be neutral to both men and women. Although the foregoing required us to collect three times as much data to reach power sample of at least 384, we were able to store the combined male and female responses (n = 1,118) and associated questions for future research projects.

Delimitations

This study was the first in a larger series covering the topic and not all data were presented in the study. Because of the size of the instrument, massive amount of data collected, and concern for only female responses for this particular project, we restricted the information presented. Given the foregoing, responses to survey questions not related to this study, as well as, all male respondent data were excluded.

Recommendations

It is obvious that the aviation maintenance technician career field is not well known to women in the U.S. Institutions of higher learning and industry must not only reach out to women, but also work collaboratively to educate women on the AMT career path. Internships, marketing collaborations, expansion of and commitment to women-focused aviation groups are possible ways to increase gender diversity in the AMT field. We recommend more women-focused marketing using non-traditional methods such as social media, publications that target women, and special interest groups. The fact that neither motherhood nor marriage are deterrents to women pursuing aviation maintenance technician careers means that academic institutions can use similar marketing strategies to target single and married women with and without families.

The relationships among career interest, appropriateness for women, advancement opportunity, physical limitations, and work environment safety areas of the study told us that women either believe aviation maintenance is a suitable career for women or it is not. The perception of bias indicates a need for modified diversity marketing in such a way that the industry markets not only to diverse races of men, but also women. The aforementioned suggestion brings up an interesting research question for consideration by future researchers: *With the aircraft maintenance field being male-dominated at a rate of 49 to 1, do men even consider women appropriate for the work? Why or why not?* The foregoing is important, because nearly every level of work—from management to the line mechanic—will be predominantly controlled by men and their perceptions on women in *their* workforce will have a significant impact on women's entry.

Additional research might delineate the depth or breadth of these findings. Are certain age groups of women more informed about the aviation maintenance career than other groups? Are the bias or discrimination feelings aligned with age or ethnic groups or both? Do women outside the U.S. mirror the perspectives highlighted in this study? In cultures where women are just entering the workforce in large numbers, can education and communication mitigate the unawareness of the career and improve participation?

Conclusions

In the end, the study provided corroboration to the low numbers of women participating in the aviation maintenance career field in the U.S. However, we also found that while anonymity of the career field was a predominant finding, the *all in* or *all out* is the basis or key to correcting the issue. Some women in the U.S general population do believe that the aircraft maintenance technician career field is appropriate for women. The women who answered positively predominantly did so by association or knowledge of a woman involved in aviation maintenance. This finding rings true to the lack of knowledge about the career field. Now the effort needs to begin on improving communication and disseminating information at all levels to make the career more attractive to women. While this is a huge challenge, through university and industry collaboration and partnerships, we believe desired results can be achieved.

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Appendix A

FAA 2014 Nonpilot Airmen Certificate Gender Demographics

	Non Pilot Airmen	%	Ground Instructor	%	Flight Engineer	%
Women	162,284	100.00%	5,568	3.43%	1,685	1.04%
Men	544,871	100.00%	66,925	12.28%	43,632	8.01%
Total	707,155	100.00%	72,493	10.25%	45,317	6.41%
Women %	22.95%		7.68%		3.72%	
Men %	77.05%		92.32%		96.28%	

	Dispatcher	%	Flight Navigator	%	Flight Attendant	%
Women	3,480	2.14%	1	0.00%	140,870	86.80%
Men	18,921	3.47%	125	0.02%	38,661	7.10%
Total	22,401	3.17%	126	0.02%	179,531	25.39%
Women %	15.54%		0.79%		78.47%	
Men %	84.46%		99.21%		21.53%	

	Mechanic	%	Repairmen	%	Parachute Rigger	%
Women	7,746	4.77%	2,285	1.41%	649	0.40%
Men	331,098	60.77%	37,667	6.91%	7,842	1.44%
Total	338,844	47.92%	39,952	5.65%	8,491	1.20%
Women %	2.29%		5.72%		7.64%	
Men %	97.71%		94.28%		92.36%	