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COLLEGIATE AVIATION REVIEW

David C. Ison, Ph.D., Editor

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No juried publication can excel, unless experts in the field 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. 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:

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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 2012 Fall Education Conference of the Association.

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 June 1 (Fall 2012 issue) or December 1 (Spring 2013 issue).

Previous editions of the CAR should also be consulted for formatting guidance. 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 at (727) 403-9903, or may be sent by email to: CARjournal@uaa.aero.

Editor's Commentary

According to Confucius, "by three methods we may learn wisdom: first, by reflection, which is noblest; second, by imitation, which is easiest; and third by experience, which is the bitterest." As anyone who has written or has thought about writing a research article for submission to a peer reviewed journal knows original work is tough to do and comes with the highest personal risk. Putting your work out in the open for a variety of peers to evaluate takes a special drive – one that pushes from within – prompting the desire to share new knowledge with others. There is no magic formula nor do you have to be a skilled wordsmith to become published – you simply must have the ambition to do so.

Although the final product only has two articles, the acceptance rate of this edition of the *CAR* was 40%. This is still higher than most peer-reviewed journal acceptance rates. As the research within our discipline matures, the quality continues to get better. Our reviewers are doing an outstanding job at holding the bar high. Thanks goes out to each UAA member who has taken the time and dedication to review articles. Their hard work is greatly appreciated.

I encourage all faculty to consider writing for the *CAR*. One area in which you may consider to explore is a paper on research methodology. There is a wide, varied range of methods available for aviation researchers to use yet the methods in use among recent articles has been limited. Help enlighten all of us on best practices in methodologies or provide cases as models for unique or versatile designs. We need more tools in our tool boxes. Let's work together to make this happen.

The editors of the journal and the UAA publications committee encourage all types of research – quantitative, qualitative, mixed methods, and methodology articles. There truly is no preference. All that is required is a sound research design, clear methodology, and succinctly reported results. I want to challenge you to produce a journal article to submit for the next edition of the *CAR*. Only through your work can aviation research continue to expand and improve.

Sincerely,

David C. Ison, PhD

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Use of Simulation in Visual Flight Training: The Effect on Time to Solo

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Abstract

The purpose of this study was to determine what effect the use of flight simulation has on the time to solo of student pilots. Participants in this study were first semester flight students at Southern Illinois University Carbondale (SIUC). Twelve participants completed the study and were given three hours of instruction in a Frasca 141 flight training device (FTD) with visual display prior to beginning training in an aircraft. The students were all instructed on the basic sight pictures of a Cessna 172, given instruction on aircraft control, basic maneuvers, and take-off and landing in the FTD. At the completion of first solo, the total flight time and calendar days to the first solo from the starting date were calculated and compared to a historic data group. The experimental group had a mean time to solo of 17.1 hours, mean days to solo of 77.3 days compared to the historic group which had a mean time to solo of 17.4 hours, mean days to solo of 86.1 days. These differences were not significant at the .05 level for hours t (150) = .225, p = .823 (two-tailed), $1 - \beta = .056$, $\eta^2 = .000$; or days t (150) = .784, p = .434 (two tailed), $1 - \beta = .142$, $\eta^2 = .004$.

Introduction

Simulation is used in numerous fields for multiple applications. It can be used to demonstrate difficult concepts to students in a physics classroom (Oss, 2005) or used to train medical practitioners to save lives (Bradley & Postlethwaite, 2003). In many fields mistakes cost time and money but in aviation mistakes can cost lives. This leads to a large amount of simulation training being conducted in the aviation industry. At the primary level, simulation is used to teach basic concepts that are necessary for flight training in a controllable environment where the simulation equipment can change with the needs of the learner (Padfield & White, 2003). In commercial aviation, especially in the airline environment, simulation is used to maintain currency and proficiency. Simulation can be used to experience unusual situations and become accustomed to different crew styles (Foushee, 1984). Simulation allows mistakes to be made in a controlled environment where consequences can be realized and learned from without the fear of loss of life. Aviation simulation also serves the role of reducing the cost of training. Airlines use simulators because it is significantly cheaper to train pilots in a device that consumes only electricity rather than one that consumes large quantities of jet fuel.

Significance of the Problem

Flight training is a rewarding and expensive experience for those who undertake it. Comparing advertised training rates from around the United States (including rental rates and instructor fees) assuming 40 hours of flight time and 40 hours of instructor time, flight schools are charging between $6,000, in the Midwest, and $9,000, on the East and West coasts, for students to earn their private pilot certificate. These costs are for basic certification and not for beginning a career. To reach the point of employability at an airline individuals must obtain a commercial pilot certificate with multiengine and instrument ratings. The minimum training expenditure to obtain these certificates and ratings is between $50,000 and $60,000 (Airfleet Training Systems Inc., n.d.; California Flight Academy, 2003; Mid Island Air Service, 2009; St. Charles Flying Service, 2010; Airline Transport Professionals, n.d.).

When considering the financial burden to a student entering the flight community as a career, a student can expect to spend between $50,000 and $60,000 to reach a minimum level of employability. With the high initial financial obligation from the student, any cost reduction without compromising safety would be welcome. Simulation time tends to cost about half of what aircraft time costs (Airfleet Training systems Inc., n.d.; Mid Island Air Service, 2009). If 10% of the required flight time for employability were changed to allow for simulation, that change would yield about half that cost for those training hours, or about a 5% total reduction in the financial burden to the student.

Monetary considerations are not the only advantages that flight simulation offers; simulation also offers the ability to train students in environments that would be impractical or unsafe in an aircraft. According to the 2009 Nall Report (Deres, Peterson, & Vasconcelos, 2009), the four areas of pilot-related accidents in fixed wing aircraft that have the highest percentage of fatal accidents are: weather, takeoff and climb, maneuvering, and descent and approach. Not only do these have the highest fatal accident percentage of all pilot-related accidents, but they also have the highest lethality percentage. This means that if a pilot is involved in one of these accidents, that pilot and all of their passengers are more likely to have a fatality (Deres, Peterson, & Vasconcelos, 2009). Simulation can help to prevent or mitigate the risks of these types of accidents by demonstrating how the accident chain can begin and how to remove oneself from it while not risking the lives of the student and instructor in the process.

Modern simulation equipment can expose pilots to weather hazards they are likely to encounter that would be unsafe to experience in an aircraft, such as thunderstorms and icing conditions. Simulators can also expose pilots to hazards that cannot be replicated in an aircraft without intentionally rendering the aircraft unairworthy, such as system or equipment failures. If this training were conducted as part of a visual flight curriculum, the accident rate could be reduced (Bürki-Cohen, Soja, & Longridge, 1998; Ratvasky, Ranaudo, Barnhart, Dickes, & Gingras, 2003).

If safety will be improved and flight training costs can be reduced, then simulation will provide a tangible benefit to visual flight training. If this is not the case, then simulation would become a hindrance to the learning process. These issues must be carefully explored through the existing literature before recommendations of adoption can be made.

Research Question

What effect, if any, does the use of flight simulation have the time to solo of student pilots?

Review of the Literature

Solo flight is a rite of passage in the life of an aspiring pilot. This is the first time an individual will be the sole occupant of an aircraft, and truly be the final authority for the flight. The training process that leads a student to their first solo is not terribly long or difficult, relative to total flight training, but it does involve mastery of specific tasks and skills. There have been few studies that directly relate simulation training with the flight experience, measured in flight time required to achieve solo flight, but many studies have examined the effect of simulation on the time required to master the required tasks prior to the first solo.

Ortiz (1994) studied basic maneuver performance with simulation training when compared to aircraft only training. Ortiz found that the group that was given simulation training experienced a significant time savings over the control group. When a transfer effectiveness ratio was calculated, Ortiz found that the simulator training produced a result of 48% transfer.

Dennis and Harris (1998) also studied the effect of simulation on the mastery time of basic flight maneuvers when compared to a control group that did not receive simulation training. They found that those in the control group took longer to master the assigned flight maneuvers and had higher mental workloads while in the aircraft than did either of the two experimental groups that received simulation training before flying. Dennis and Harris (1998) concluded that the benefit of reduced time to master tasks for initial flight training was obvious, but the reason was not. In the experiment, the simulation equipment was not set-up to mimic the training aircraft, and the control inputs were entirely different than what was required in the aircraft. Dennis and Harris (1998) observed the reduced time to maneuver mastery, but could not attribute the time reduction to mechanical learning. Their explanation centered on the reduced workload experienced by the experimental groups when in the aircraft as compared to the control group. Their study argued that the simulation equipment used did not teach the students the mechanics of the maneuvers, but rather the concept and what to expect so that their workload was reduced when they were actually flying the assigned maneuvers.

Several studies have considered what the most vital part of pre-solo flight training is arguably the landing. These studies vary in research focus but all show that simulation can enhance landing training and make it more effective. Lintern and Walker (1991) found that students who were given simulation training in a simulation environment with moderate graphic fidelity performed best when learning to land. Lintern and Koonce (1991) studied the effect of visual magnification of the visual display of flight simulation equipment when related to landing. They found that properly applied magnification enhanced the simulation experience leading to better approaches to land. Lintern, Taylor, Koonce, Kaiser, and Morrison (1997) found that simulation experience with less graphic fidelity improved landing work in an aircraft over higher graphic fidelity systems and over training only in an aircraft. While these three studies have different results, they all reveal that simulation can be used effectively to train students toward landing an aircraft.

Method

Participants

Participants in this study were first semester flight students at Southern Illinois University Carbondale (SIUC), enrolled in a FAR Part 141 private pilot curriculum. Flight instructors from the SIUC instructional staff volunteered to conduct the training required by the study and those instructors approached their primary flight students about participation. Each student was given a letter stating the purpose of the study. Participation in the study was voluntary and approved for both experimentation and data collection by the SIUC Human Subjects Committee. All information collected remained confidential. The study covered three academic semesters: fall semester of 2010, spring semester of 2011, and fall semester of 2011. In all, 20 students participated, with 10 participants from the fall semester 2010, 4 from spring semester 2011, and 6 from the fall semester 2011. Of the 20 total participants, 2 did not solo at all and 6 completed their aircraft training in a Cessna 152 so they were not included in the results of this study.

Research design

Participants were given three hours of instruction in a Frasca 141 flight training device (FTD) with visual display prior to beginning training in an aircraft. Instruction was limited to 3 hours based on the course structure that the experiment was incorporated into and limited resource availability. The training was conducted at the beginning of flight training because the simulation training was intended to be an introduction to all the elements required for a first solo. The majority of the instruction received in the FTD focused on take-off and landing practice. The students received instruction on the basic sight pictures of a Cessna 172, aircraft control, straight-and-level flight, climbs, turns, descents, steep turns, slow flight, power on and off stalls, and take-offs and landings in the FTD. After completing the FTD training, the students completed the normal first semester curriculum of SIUC.

After all participants had completed their first solo, the total flight time in an airplane and calendar time to the first solo from the starting date were calculated and compared a historic data group using descriptive and inferential statistics. The historic data group consisted of all first semester SIUC flight students who reached the level of possibly soloing from the fall semester of 2006 through the fall semester 2011. Inferential statistics were calculated using SPSS version 20 and statistical powers were calculated using the G*Power 3 computer program.

Results

The findings of this study addressed the research question "What effect, if any, does the use of flight simulation have the time to solo of student pilots?" The experimental group (n = 12) overall had a mean time to solo of 17.1 hours, mean days to solo of 77.3 days, median time to solo of 16.0 hours, and median days to solo of 79 days.

The historic group, which included data beginning with the fall 2006 semester, overall had a mean time to solo of 17.4 hours, mean days to solo of 86.1 days, median time to solo of 16.9 hours, and median days to solo of 77 days. The historic data were based on those in the historic group, excluding the experimental participants who successfully completed solo in a Cessna 172 aircraft (n = 134). A more complete representation of the data can be found in table 1.

A two-tailed *t*-test revealed no statistical significance to the findings at the .05 level of hours t (150) = .225, p = .823, 1 – β = .056, η^2 = .000; or days t (150) = .784, p = .434, 1 – β = .142 η^2 = .004. The sample met *t*-test assumptions of independent groups, ratio dependent variables, and similar variances for both flight hours and calendar days to solo. The small sample size made it difficult to determine normality of the dependent variables potentially violating a *t*-test assumption. The small sample size led to low statistical power increasing the chance of a Type II error.

The data were also examined within individual semesters to control for extraneous variables such as weather and aircraft availability. For the three academic semesters of the study, (a) fall 2010, (b) spring 2011, and (c) fall 2011, the experimental group data were as follows: mean time to solo: (a) 15.8 hours, 72.4 days; (b) 15.8 hours, 80.0 days; and (c) 21.3 hours, 89.7 days. For the same three academic semesters of the study, the non-participant group (n = 29), the subset of historic data from the semesters in which the study was conducted, data were as follows: mean time to solo: (a) 17.9 hours, 107.8 days; (b) 19.6 hours, 106.0 days; and (c) 16.5 hours, 83.9 days. A more complete and comprehensive data set is available in table 2.

Table 1

Total Mean, Sample Standard Deviation, and Median Flight Hours and Calendar Days to Solo for Experimental and Historic Groups

		Flight Hours		Calendar Days	
Data Set	*n*	Mean (SD)	Median	Mean (SD)	Median
Participant[a]	12	17.1 (4.2)	16.0	77.3 (37.5)	79.0
Historic[b]	134	17.4 (3.8)	16.9	86.1 (27.2)	77.0

Note. All data presented represents training in Cessna 172 aircraft.
[a]Participant data collected from fall 2010 to fall 2011. [b]Historic data collected from fall 2006 to fall 2011.

Table 2

Mean, Sample Standard Deviation, and Median Flight Hours and Calendar Days to Solo for Experimental and Historic Groups by Academic Semester

		Flight Hours		Calendar Days	
Data Set	*n*	Mean (SD)	Median	Mean (SD)	Median
		Fall semester 2010			
Participant	8	15.8 (2.2)	15.1	72.4 (31.4)	67.0
Non-Participant	9	17.9 (3.4)	17.9	107.8 (41.6)	101.0
		Spring semester 2011			
Participant	1	15.8	15.8	80.0	80.0
Non- Participant	2	19.6 (2.5)	19.6	106.0 (1.4)	106.0
		Fall semester 2011			
Participant	3	21.3 (5.3)	19.0	89.7 (17.0)	99.0
Non- Participant	18	16.5 (2.4)	15.7	83.9 (15.5)	84.0

Note. All data presented represents training in Cessna 172 aircraft.

Using a two-tailed *t*-test to compare the participants' mean times and days to solo did not result in any statistically significant differences at the .05 level for any semester in the study period. In fall 2010, t (15) = 1.551, p = .142, $1 - \beta$ = .313, η^2 = .138 for flight hours; and t (15) = 1.961, p = .069, 1 – β = .457, η^2 = .204 for calendar days to solo. In spring 2011 a *t*-test could not be completed because of the number of data points (n = 3). In fall 2011, t (2.135) = 1.531, p = .258, 1 – β = .423, η^2 = .523 for flight hours; or t (19) = .590, p = .562, 1 – β = .084, η^2 = .018 for calendar days to solo. The sample met *t*-test assumptions of independent groups, ratio dependent variables, and similar variances for both flight hours (except fall 2011) and calendar days to solo. For fall 2011 a *t*-test was calculated with equal variances not assumed. The small sample size makes it difficult to determine normality of the dependent variables potentially violating a *t*-test assumption. The small sample size led to low statistical power increasing the chance of a Type II error.

Discussion

Aviation is a costly industry in many respects with equipment that is costly to acquire, operate, and maintain. The costs of mistakes in aviation can be measured in terms of lives lost and equipment damaged. Proper use of simulation can reduce the overall monetary cost of flight training and recurrent pilot training as well as exposing pilots and flight crews to extraordinary circumstances that could be hazardous or fatal for a person exposed to them.

The question addressed by this study was "What effect, if any, does the use of flight simulation have the time to solo of student pilots?" As can be seen in table 1, there was no indication that flight simulation effects the flight time to solo for this study. The participant group had a lower mean time to solo in hours and days when compared to the historic, but this difference is not shown to be statistically significant at the .05 level through a two tailed *t*-test. This finding may be due to the very small participant sample (n = 12). A larger study may yield results with more statistical significance.

Conclusions and Recommendations

While the results of this study do not show a significant difference between simulation training and traditional training with respect to time to solo, the literature indicates that simulation is a valuable part of flight training. Simulation has a role to play in flight training, and it may even have a role to play in visual flight training. The problem is that there are too many unanswered questions about simulation training that must be addressed before any great strides can be taken in incorporating simulation into visual flight training industry wide. Further study involving a larger participant sample is needed to address what specific aspects of simulation training enhance basic flight maneuver training, the cost and benefit of simulation based visual flight training, the level of graphic fidelity that is adequate for visual flight training, and what role motion plays in enhancing student learning. Once these issues are addressed, there will be a more complete picture of the role that flight simulation can play in visual flight training.

Recommendations for Further Research

1. Further research with an increase in study population is recommended to help determine the benefit of simulation in primary students.
2. Further experimental study is needed to fully understand how simulation training can affect a student's time to solo.
3. Further study is needed to determine what aspect of simulation training enhances basic flight skills so that focus can be placed in those areas during flight training.
4. Further study is needed is on the economics of simulation used in visual flight training to determine if there is a cost benefit to simulation training over traditional aircraft only training.
5. Further research is needed to determine what role motion and increased fidelity play in enhancing student progress in simulation training.
6. Further research is needed to determine the impact of the length of simulation training and the effect of integrating simulator instruction with aircraft training.

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Disparities in Weather Education across Professional Flight Baccalaureate Degree Programs

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Abstract

The required meteorology coursework for 22 accredited professional flight baccalaureate degree programs was examined and compared. Significant differences were noted in both the number of required meteorology courses as well as the number of required meteorology credit hours. While all programs required at least one three-credit meteorology course, not all programs required an *aviation-specific* meteorology course. In addition to the required number of meteorology courses and credit hours, topics within the aviation-specific meteorology courses were also examined. The study showed the topics of "flight hazards" and "aviation weather reports and charts" were identified most frequently in course descriptions, followed third by "weather applications to flight." However, based on the course descriptions alone, it was unclear if the meteorological theory of flight hazards was addressed in the courses or if the courses only addressed the interpretation of weather hazards charts. To improve and standardize aviation-meteorology education in professional flight-degree programs, a recommendation was made to either provide aviation-meteorology curriculum guidelines through the University Aviation Association (UAA) Curriculum Committee or to form a separate UAA Aviation-Meteorology Education Committee.

Introduction

Weather was cited as the primary cause for 3.6% of the 1,181 general-aviation, fixed-wing accidents occurring in 2009; however, these accidents accounted for 11.2% (26 total) of all *fatal* accidents in the same category, making weather-related accidents the most lethal of all general-aviation accidents (AOPA, 2010). Statistically, weather-related general-aviation accidents had a lethality of 62% in 2009, down from an average of 75% over the previous nine years (AOPA, 2010). While these sobering statistics are not directly connected to professional-flight degree programs, they do bring attention to the threat weather continues to pose to general aviation and flight training. The good news is that with proper education in aviation meteorology and flight planning, weather-related aviation accidents are arguably the most avoidable, thus highlighting the importance of aviation-meteorology education to the quality of professional-flight degree programs.

Aviation-meteorology education can be fundamentally broken into two broad categories, *hazard mitigation* and *hazard avoidance*. The first category focuses on piloting techniques to mitigate the impact of weather hazards once encountered by the aircraft. Two examples of this category include: 1) decreasing airspeed below the aircraft's maneuvering speed to reduce the risk of damage during encounters with turbulence or thunderstorms; and 2) maintaining proper aircraft configuration, attitude and airspeed to avoid wing stalls during an icing event. This category of meteorology education focuses primarily on piloting technique *during* the flight rather than flight planning prior to the flight.

This leads us to the second broad category of aviation-meteorology education, *hazard avoidance*, which focuses on both weather theory and weather flight planning. More specifically, this category of meteorological education seeks to improve each pilot's knowledge of the fundamental causes of hazardous weather and the visual cues necessary to identify and avoid hazardous weather. In addition to meteorology theory, hazard avoidance also includes developing an understanding of the weather resources available to the pilot to ensure proper flight planning and to improve aeronautical decision making (ADM). This broad category of aviation-meteorology education is closely related to Lester's (2004) first step in the self-briefing process, "weather awareness." Weather awareness can be viewed as more than merely an understanding of weather for the day. Instead, it should be viewed as a life-long learning process of improving the pilot's individual understanding of meteorology and staying current with available weather products. This includes, for example, an understanding of the strengths and weaknesses of various weather products as well as an understanding of which FAA products are designated primary products, i.e. for operational decision making, and those that are designated as supplementary, i.e., only for enhanced situational awareness (FAA, 2010). This life-long, meteorology-education process begins in the classroom and only ends after a pilot's final flight. This paper focuses on the variability with which this second category of meteorology education, *hazard avoidance*, is addressed in professional-flight degree programs.

Purpose

The FAA weather certification process clearly recognizes weather education as a fundamental aspect of any pilot certificate level. For example, nearly 17% of the Pilot Handbook of Aeronautical Knowledge (PHAK) text is devoted to weather theory and weather services. Likewise, Gleim and Gleim (2010) provided over 800 sample FAA private pilot knowledge exam questions of which 16% pertained directly to aviation weather and aviation-weather services. While the meteorology training information contained in these instructional documents provides some basic theory, the majority of the material focuses on how to access weather data and interpret charts. The meteorology theory is, in many cases, over-simplified and even outdated. Fortunately, meteorology education in professional flight-degree programs typically goes beyond the basic aviation-meteorology certification requirements. However, the extent to which this is accomplished is by no means standard. The quantity and depth of education provided in the areas of aviation-meteorology theory and weather flight planning varies widely across accredited professional flight-degree programs. The purpose of this paper is to provide a comparative analysis of the aviation-meteorology education requirements for accredited professional flight baccalaureate programs. In addition, this paper makes recommendations for future actions that could potentially improve and standardize the quality of aviation-meteorology education as well as prepare students for anticipated changes to weather support and information systems.

Methodology

Professional flight-degree programs were selected from the list of over 200 degree-granting aviation institutions provided in the 2012 Flight Training College Aviation Directory (AOPA, 2011). For consistency, only Aviation Accreditation Board International (AABI) accredited professional flight baccalaureate degree programs, that also required flight as part of their curriculum, were evaluated. In total, 22 degree programs met these criteria. These institutions are identified in Table 1.

Once the degree programs were identified, the degree requirements and meteorology-course descriptions for each were collected from the most current course catalog available on each institution's official web site. Information collected included: required number of meteorology credit hours; course descriptions for all required meteorology courses; prerequisite courses for all required meteorology courses; and a binary determination of the aviation specificity of each required meteorology course (i.e., whether or not the meteorology course was specific to aviation). The course descriptions were then imported into Excel and a simple manual content analysis was performed by searching for key words and phrases to identify the frequency with which common topics appeared in the course descriptions. Since common topics were often described using different phraseology, some subjectivity was required in the binning process.

Results

The analysis results were divided into three separate areas of focus. The first and simplest evaluation was to determine the required meteorology credit hours for each program. Second, the number of required meteorology courses by type (aviation specific or general meteorology) was examined for each degree program.

The type of course was determined from the course description and/or course title depending on the detail provided in the course catalog. Finally, the topics addressed in the aviation-meteorology courses were evaluated and compared to determine common subject content among the various courses.

Table 1: *Professional Flight Baccalaureate Degree Programs Used for the Study*

College/University	State	Degree Title
Auburn University	AL	Professional Flight Management
Arizona State University	AZ	Aeronautical Management Technology (Professional Flight)
ERAU (Daytona Beach)	FL	Aeronautical Science (Professional Pilot)
ERAU (Prescott)	AZ	Aeronautical Science (Professional Pilot)
Florida Institute of Technology	FL	Aeronautical Science - Flight
Jacksonville University	FL	Aviation Science
University of Dubuque	IA	Flight Operations (Professional Aeronautics)
Kansas State University (Salina)	KS	Professional Pilot
LA Tech University	LA	Professional Aviation
Western Michigan University	MI	Aviation Flight Science
St. Cloud State University	MN	Aviation Professional Flight
St. Louis University	MO	Flight Science
University of Central Missouri	MO	Professional Pilot
Rocky Mountain College	MT	Aeronautical Science (Professional Pilot)
University of Nebraska (Omaha)	NE	Professional Flight
University of North Dakota	ND	Commercial Aviation (Fixed wing)
Kent State University	OH	Flight Technology
Oklahoma State University (Stillwater)	OK	Professional Pilot
SE Oklahoma State University	OK	Professional Pilot
University of Oklahoma	OK	Professional Pilot
Middle Tenn. State University	TN	Professional Pilot
Hampton University	VA	Flight Education

Credit-Hour Analysis

Of the 22 professional flight programs evaluated, the credit-hour requirement for meteorology instruction varied between three and eight credit hours. Twelve (55%) programs required only three credit hours of meteorology instruction, while nine (41%) programs required a minimum of six semester credits hours of meteorology instruction. Figure 1 details the number of accredited professional flight baccalaureate programs requiring the specified number of meteorology credit hours. Though not conclusive, the disparity in required meteorology credit hours suggests a wide range in variability in either the quantity of meteorology topics discussed or the depth to which the topics are covered. It should be noted that the AABI accreditation process does not mandate the number of meteorology-instruction credit hours required; it only specifies that the professional-flight curriculum must address outcomes appropriate to meteorology and environmental issues (AABI, 2012).

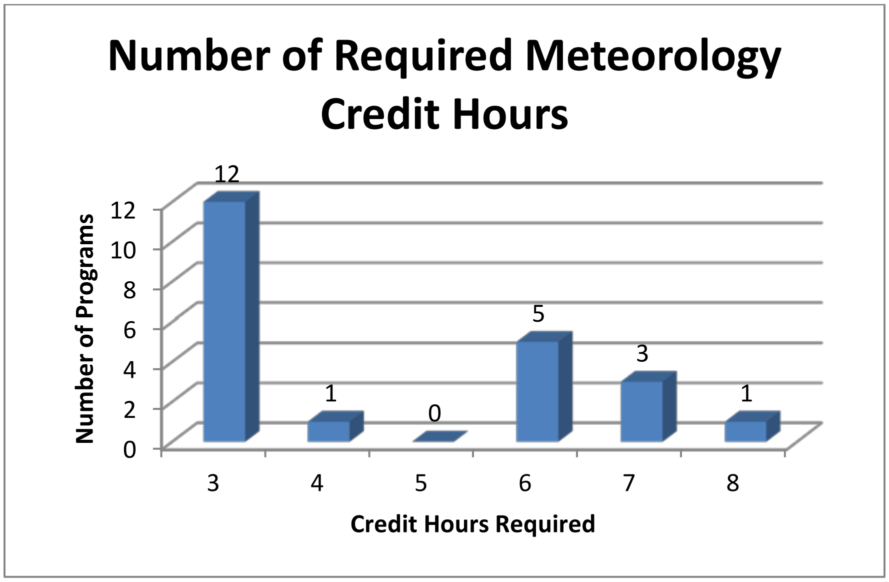

Figure 1. The number of AABI accredited professional-flight baccalaureate programs that require the specified number of meteorology course credit hours.

Meteorology-Course Analysis

As would be expected given the variability in required credit hours, the actual number of meteorology courses also varied widely. Thirteen (59%) programs required four or fewer meteorology credit hours, which were all accomplished in one single-semester course. The remaining nine (41%) programs required six or more meteorology credit hours, which were accomplished in two or more single-semester courses.

Another interesting comparison showed that although all programs in the study required at least one meteorology course, not all programs required an *aviation*-meteorology course; that is, not all required a meteorology course focused on aviation-specific weather hazards and issues. A deeper examination of course descriptions and titles indicated four (18%) programs in the study did not require any aviation-specific meteorology classes, while three (14%) did not offer an aviation-specific meteorology course. Figure 2 shows the analysis of the number of degree programs that required the specified number of meteorology credit hours.

Eleven (50%) of the programs required only a single aviation-specific meteorology course. However, six (27%) degree programs required a two-course meteorology sequence where the first course was a prerequisite general-meteorology course, and the second course in the sequence was an aviation-specific meteorology course. Only one (5%) program offered and required two aviation-specific meteorology courses, while three (14%) programs offered a third non-required advanced aviation-meteorology course beyond the general meteorology and aviation-specific meteorology course sequence. Consistent with the credit-hour analysis, these results also suggest a potentially wide range of variability in either the quantity of aviation-meteorology topics discussed or the depth to which the topics are covered.

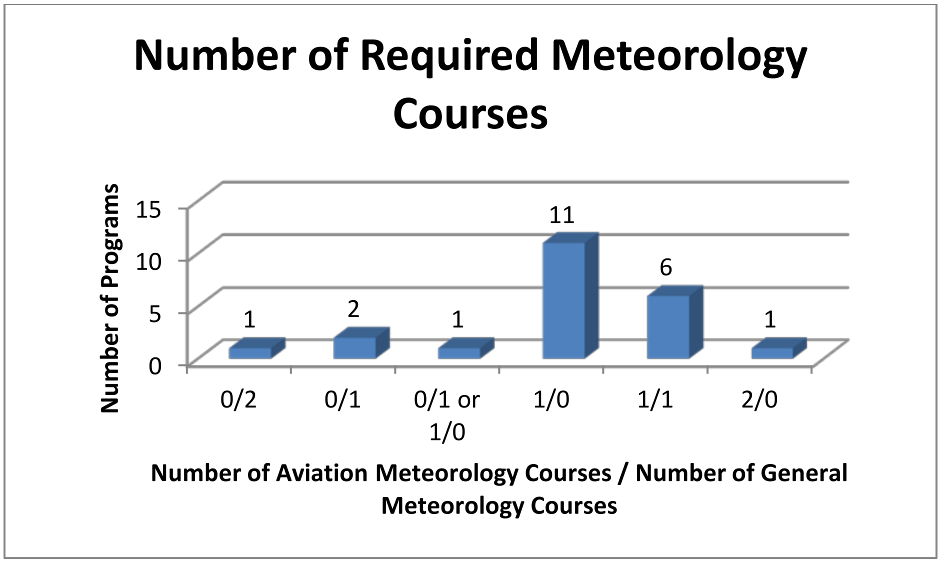

Figure 2. The number of AABI accredited professional-flight baccalaureate programs that require the specified number of meteorology courses. The courses may be either aviation-meteorology courses (left side of the slash) or general-meteorology courses (right side of the slash).

Course-Topic Analysis

Course descriptions taken from each institution's undergraduate catalog were examined to determine the specific topics addressed in each course. For consistency, the course-topic analysis examined *only* those required meteorology courses that were aviation specific, *i.e.*, required general-meteorology course topics were not investigated in this study. In total, 20 aviation-meteorology courses were examined.

Using a simple, manual content-analysis technique, each course description was examined for key phrases to identify the frequency with which various topics occurred among the course descriptions. In total, nineteen common topic areas were identified as shown in the first column of Table 2. The third column of Table 2 shows the frequency with which the topic occurred in the course descriptions. The frequency is given by the number (and percentage) of course descriptions that included the designated topic. To be considered a common topic for this study, at least two course descriptions had to include the topic. Unique topics covered by only one institution are listed in the final row of Table 2. Since common topics often used slightly different phraseology, some judgment had to be made regarding which bin each topic best fit. The list of key words and/or phrases that were applied to the specific topic designator is shown in the second column of Table 2. In some instances, the same phrase was included in two separate categories. For example, the phrase "pressure system structure," which was taken from one of the course descriptions, was counted in both "pressure and winds" and "mid-latitude cyclones/weather systems."

The analysis clearly demonstrated the majority of all examined aviation-specific courses focused on flight hazards and aviation weather charts. This is not surprising since these topics typically distinguish an aviation-meteorology course from a general-meteorology course. What is surprising is that eight (40%) of the aviation-meteorology courses evaluated made no explicit reference to flight hazards in their course descriptions. While the topic of "fight hazards" was clearly identified in twelve (60%) of the twenty aviation-meteorology courses examined, there was no means to determine the extent to which the topic was covered from the descriptions alone. For example, were students merely taught to interpret aviation hazards charts, such as AIRMETS and SIGMETS, or were students introduced to the theory and causal factors of the hazards? This could be a potential area of further study but would require access to actual syllabi and possibly interviews with course instructors.

Tied with "flight hazards," the topic of "aviation weather reports and charts" occurred most frequently in the course descriptions. These included interpreting both meteorological codes (e.g., METARS, TAFS, PIREPS) and aviation weather charts (e.g., Graphical AIRMETs, SIGMETS). While the ability to correctly decode or interpret aviation-weather products is essential to safe flight and therefore necessary for any course in aviation meteorology, this ability is generally technical in nature and provides little theoretical insight regarding the causes of the weather. Thus, the topic of "aviation weather reports and charts" does not promote the development of higher cognitive skills in professional pilots, such as analysis and evaluation. In fact, the topic of "weather analysis" was only explicitly mentioned in three (15%) of the twenty course descriptions examined.

The topic of “weather applications to flight” occurred in seven (35%) of the courses examined. This topic occurred most frequently in course descriptions that were relatively short in length, suggesting the phrase was intended to encompass a wide-range of topics in aviation meteorology. As further evidence of this intent, there only four (20%) course descriptions in the study that did not include a specific reference to either “flight hazards” or “aviation weather reports and charts;” however, all four of these did include the topic of “weather applications to flight.” Thus, all twenty (100%) of the course descriptions examined included at least one of the top three most frequently occurring topics.

Also of interest, the topic of weather “flight planning” was explicitly identified in only five (25%) of the course descriptions examined. It is somewhat surprising this topic was not identified in a greater percentage of course descriptions given its importance. That is, improving weather flight planning is directly tied to improving a pilot’s ADM, which is (or should be) the primary goal of any aviation-meteorology coursework.

With the exception of aviation-weather equipment, the remaining topics were considered general meteorology topics, i.e., topics not specific to aviation. The relatively low number of occurrences of these individual topics in course descriptions can most likely be attributed to differences in the verbosity of the course descriptions themselves. The course descriptions that were significantly more verbose tended to include more general-meteorology topics than those that did not. A second possible reason is that these more general topics were covered in prerequisite meteorology courses.

In summary, a review of topics taken from course descriptions indicated the aviation-meteorology courses examined expectedly placed a strong emphasis on weather flight hazards and aviation-weather products. However, it is unclear as to whether the courses focused only on product interpretation, or if the courses also examined the theoretical underpinnings of the topics. This question is especially pertinent because “aviation meteorology charts and codes” was tied with “flight hazards” as the most frequently occurring topic. While product interpretation and decoding are fundamental to safe flight, professional flight-degree program students should also be exposed to meteorology material that goes beyond basic technical skills to include material that helps them better analyze and evaluate a broad range of weather information.

Discussion

As demonstrated in the analyses above, wide variability potentially exists in both the aviation-specific meteorology topics addressed in accredited professional flight

Table 2. *Consolidated Topic List*

Topic Designator	Other Phrases/Terms Included in Topic	Number (%) of Courses
Flight Hazards	Turbulence; icing; fog; wind shear; thunderstorms; obstructions to visibility; severe weather avoidance	12(60%)
Aviation Weather Reports and Charts	Flight-planning weather information; primary and supplementary aviation weather products; meteorological codes, aviation bulletins; forecasts, prognoses; weather maps; data formats, forecast products; weather products needed to enhance flight safety;	12(60%)
Weather Applications to Flight	Low and high altitude weather from pilots viewpoint; effect of meteorological elements on air operations; meteorology as it applies to flight; effects of meteorological elements on air operations	7(35%)
Mid-latitude Cyclones/ Weather Systems	Pressure system structure; frontal systems; synoptic weather systems	6(40%)
Weather Observations	Observations of weather elements; surface observations; upper-air observations; measurement of meteorological elements; observations of special significance to aviation	5(25%)
Flight Planning	Making informed weather-sensitive decisions	5(25%)
Air Masses and Fronts	Advection, frontal systems; air mass characteristics, frontal weather	5(25%)
Stability/Convection	Weather stability	4(20%)
Pressure and Winds	Pressure system structure	3(15%)
Jet Streams		3(15%)
Weather Services	Weather information systems; navigating today's on-line environment	3(15%)
Weather Analysis	Analysis of atmospheric phenomena; analyzing	3(15%)
Weather Forecasting	Basic prediction techniques	3(15%)
Satellite and Radar		2(10%)
Av. Weather Equip.	Airborne weather radar	2(10%)
Atmos. Circulation.		2(10%)
Atmos. Moisture	Water in the atmosphere	2(10%)
Atmos. Structure		2(10%)
Thermal Wind		2(10%)
Other Topics	Volcanic ash/space weather; baroclinic instability; human factors; thickness; kinematics; winter weather; atmospheric composition; NOTAMS; international weather patterns and information formats; responsibilities of ATC in weather observing and reporting	

baccalaureate degree programs as well as the extent to which they are covered. However, the study results are only suggestive and not necessarily conclusive due to several limiting factors. This section discusses the limitations of the study as well as makes recommendations to address the potential disparities in weather education

Limitations of the Study

The analysis presented here only examined the meteorology courses required by each degree program. However, meteorology topics are often covered in non-meteorology courses. For example, specific meteorology topics, such as meteorological codes, are often addressed in flight courses and even air traffic control courses. This may be especially true for the programs that required no aviation-specific meteorology courses. No attempt was made to evaluate non-meteorology courses in each of the program's curricula to parse out all weather-related topics.

The course-topic analysis was completed using only publicly available data from each institution's official website; that is, no attempts were made to obtain course syllabi for additional details. The official course descriptions varied significantly in the level of detail for each of the institutions. Some course descriptions were very vague, perhaps intentionally, consisting of fewer than fifteen words, while others were significantly more detailed, consisting of over 100 words. Therefore, the topic analysis may not provide a complete picture of the actual topics presented in each of the courses examined.

In addition, the course-topic analysis only examined topics covered in aviation-specific meteorology courses. The general-meteorology courses were not examined. As mentioned earlier, six (30%) degree programs required a general-meteorology course as a prerequisite for the aviation-specific meteorology course. As a result, many of the more basic topic areas, such as atmospheric composition and structure, were likely included in the general-meteorology courses and therefore not duplicated in the aviation-specific meteorology course descriptions. Therefore, while the course-topic analysis is not conclusive, it does nonetheless provide some insight to the potential range of weather topics addressed within accredited professional-flight degree programs.

Recommendations

Currently no professional organizations provide program-specific guidelines for aviation-meteorology education in accredited professional flight-degree programs beyond what the FAA requires for certification. The AABI accreditation criteria do not specify what topics must be covered, only that degree curricula address outcomes appropriate to meteorological and environmental issues (AABI, 2012, criterion 2.4). The AABI Criteria Manual does, however, state the degree program must be developed with advice from appropriate industry associations and professionals in the field (AABI, 2012, paragraph 4.5). The guidance for standardizing aviation-meteorology instruction could, therefore, come from an appropriate professional society, and one logical professional society would be the University Aviation Association (UAA).

The UAA could potentially provide guidance for aviation-meteorology instruction through either their Curriculum Committee or through the creation of a special aviation-meteorology committee. The Curriculum Committee is charged with the task of facilitating the development of model curricula and guidelines, to include learning outcomes and methods of assessment, for both two- and four-year collegiate aviation programs (UAA, 2012). As such, the committee could assist in standardizing weather education by providing guidelines and model curricula for aviation-meteorology coursework in professional flight-degree programs. This would be similar in practice to how the American Meteorological Society (AMS) provides recommended topic areas for meteorology degree programs through a detailed information statement (AMS, 2010) despite not being an accrediting body.

A second option would be the creation of a special Aviation-Meteorology Education Committee. This committee would be similar in function to the UAA special committee on Air Traffic Control (ATC) Education, which serves to: 1) provide a centralized focal point for communication about ATC education issues, techniques and technology; 2) promote and encourage innovation in ATC curriculum and the use of ATC education technology; 3) explore new ATC technology through research and development; and 4) promote involvement of collegiate programs (UAA, 2012). A special committee on aviation-meteorology education could have largely the same goals. That is, the committee could serve to: 1) provide a centralized focal point for communication about aviation-meteorology education issues, techniques and technology; 2) promote and encourage innovation in aviation-meteorology curricula; 3) explore new and developing aviation-meteorology products and information dissemination technology; and 4) promote involvement of collegiate programs

The creation of a UAA special committee on aviation-meteorology education versus the integration of aviation-meteorology education into the UAA Curriculum Committee offers the advantage of being able to address more than curricular issues. The committee could also address current and future advances in weather data, products, and information dissemination systems. For example, over the past 5 years there has been an explosion in the usage of smart phones and computer tablets by flight students. Students now have unprecedented access to weather information through easily accessible applications (i.e., “apps”), not all of which provide weather information that is FAA certified for primary or supplementary use. A special committee on aviation meteorology could provide a means to exchange ideas, from a pedagogical perspective, regarding how best to communicate and exploit the technology in the classroom. Likewise, initiatives such as the Next Generation Air Transportation System (NextGen) will potentially change the way weather data is communicated and accessed (JPDO, 2010). One such change is the anticipated use of objective probability-based weather products in decision-support tools (Guinn and Barry, 2012; JPDO, 2010). The committee could exchange ideas for addressing these anticipated changes in the classroom. Yet another topic of discussion could be the proper use of weather data fed directly to the cockpit. All of these topics would benefit greatly from the exchange of ideas among both meteorology and professional flight instructors. Additionally, by preparing professional flight students for these anticipated technology changes, the committee will likely help make transitions to newer technology smoother and safer for the profession as a whole. Equally important, the committee could aid in promoting the development of life-long learning skills in aviation meteorology within the professional aviation community.

Summary

An evaluation of course requirements and descriptions suggests there are potential disparities in both the amount of required meteorology education as well as the content of the meteorology courses across all AABI-accredited professional flight baccalaureate programs. Professional societies may be able to help minimize these disparities through committees devoted to aviation-meteorology education in professional flight-degree programs. One logical professional society to host these committees would be the UAA.

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