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COLLEGIATE AVIATION REVIEW

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Cover Image: A Boeing 767 taking the top off a small cumulus cloud on approach at London Heathrow, June 16th, 2007.

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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.

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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 2008 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.
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for the

2009 UAA Fall Education Conference

and the

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Both qualitative and quantitative research manuscripts are acceptable. All submissions must be accompanied by a statement that the manuscript has not been previously published and is not under consideration for publication elsewhere.

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 University Aviation Association (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.

Authors should email an electronic version of their manuscript to the editor, conforming to the guidelines contained in the *Publication Manual of the American Psychological Association*, 5th Ed. (APA). The UAA review process incorporates editorial input and recommendations from "blind" peer reviewers. A list of all reviewers is available from the ***CAR*** editor and is published annually in the ***CAR.*** If the manuscript is accepted for the 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. *Authors should use the previous year's CAR for guidance in format and page layout.*

All manuscripts must be emailed no later than December 1 (Spring Issue) or June 1 (Fall Issue), and should be sent to the editor, at CARjournal@purdue.edu.

Questions regarding the submission or publication process may be directed to the editor at (765) 494-5782, or may be sent by email to: CARjournal@purdue.edu.

Students are encouraged to submit manuscripts to the ***CAR***. A travel stipend up to $500 is available for successful student submissions. Please contact the editor or UAA for additional information.

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ABSTRACT

This 3-year qualitative case study of service learning in undergraduate aviation classes measures the affective domain learning outcomes of required service learning projects vs. optional service learning projects. A literature review on democratic citizenship suggests a gap in learning materials available to help students become responsible and engaged citizens. Development of the service learning component is described, including critical thinking, problem solving, and developing a clear connection between the course objectives and service activities. The study details three measured outcomes of the affective domain: receiving, responding and valuing. Three semesters of required service learning activities are compared with three semesters of optional service learning activities using descriptive statistics and chi-square analysis. Findings indicate that when service learning is required, students respond at a significantly higher rate than when the service learning is optional. However, students who voluntarily completed the optional activities were found to value the experience to a greater extent than students who were required to complete the projects.

INTRODUCTION TO SERVICE LEARNING

In 1938, John Dewey wrote a treatise on what he called the theory of experience. Dewey maintained that the goal of education was to help people become effective members of a democratic society. Students, he believed, needed real-life, outside-the-classroom experiences rather than just a unidirectional, authoritarian education in order to become respected and conscientious members of society. Following Dewey's logic, this paper discusses the definition of service learning, reviews the current literature on service learning and discusses an action research project conducted on incorporating service learning into the collegiate aviation curriculum. On a small scale, the study seeks to reaffirm the idea that civic responsibility is learned through service and that students gain knowledge of citizenship, politics, and government through valuing their participation (Colby, Ehrlich, Beaumount & Stephens, 2003).

Dewey's theory of citizenship and service learning states that experience arises from two principles: continuity and interaction. Continuity dictates that each event a person experiences will influence his or her future, for better or worse. The idea of interaction relates to the situational influence on one's experiences, where experience serves as a function of the interaction between one's prior experiences and the present situation. Furthering this thought, Mendel-Reyes (1972) discusses how service learning connects personal and political transformation. Through involvement in their community, students transform themselves into citizens, and their society becomes one that welcomes and promotes active citizenship (Benson & Harkavy, 1998).

Service learning provides a mechanism for students to become acclimated into their ultimate roles as citizens and leaders of tomorrow. There are several definitions of service learning and for the purposes of this discussion, the following definition will be employed: Service learning is a form of experiential learning where students and faculty collaborate with communities to address problems and issues, simultaneously gaining knowledge and skills and advancing personal development. There is an equal emphasis on helping communities and providing valid learning experiences to students (Astin & Sax, 1998; Bounous, 1986; Eyler & Giles, 1997, 1999; Batchelder & Root, 1994; Keen & Keen, 1998; Daloz, Keen, & Keen, 1998).

LITERATURE REVIEW: SIGNIFICANCE AND PURPOSE

A Disconnected Nation

Current writings on the teaching of democratic citizenship present the critical issue of the "troubling gap in the materials available to help students become responsible and engaged citizens of their communities" (Gerston, 2002, p. xiii). Writing to future educators, policy makers, and leaders, Gerston asks the question, "Where are the passions that drive young people into the political process? What is keeping them out?" (p. 15). In his experience as a senior scholar with the Carnegie Foundation for the Advancement of Teaching, Thomas Ehrlich attributes today's lack of passion as a student-community disconnect. Students fail to see how policies are created and communities are formed, through the act of service (as cited in Gerston, 2002, page ii).

Researchers state that service-learning has the following positive affects:

1. Increased student personal development such as sense of personal efficacy, personal identity, spiritual growth, and moral development (Astin & Sax, 1998; Astin, Sax & Avalos, 1999; Rockquemore & Schaffer, 2000);
2. Increased interpersonal development and the ability to work well with others to facilitate cultural and racial understanding (Astin & Sax, 1998; Keen & Keen, 1998; Driscoll, Holland, Gelmon, & Kerrigan, 1996; and Vogelgesang & Astin, 2000);
3. Increased development of leadership and communication skills (Astin & Sax, 1998; Dalton & Petrie, 1997; Eyler & Giles, 1999; Freidus, 1997; Rhoads, 1997, 2003 ; Sledge, Shelburne & Jones, 1993; Peterson, 1998, Vogelgesang & Astin, 2000; Wade &Yarborough, 1996);
4. Increases students' sense of social responsibility and citizenship skills (Astin & Sax, 1998; Astin, Sax & Avalos, 1999; Batchelder & Root, 1994; Dalton & Petrie, 1997; Driscoll, Holland, Gelmon & Kerrigan, 1995; Eyler & Giles, 1999; Eyler, Giles & Braxton, 1997; Fenzel & Leary, 1997; Giles & Eyler, 1999);
5. Participation in service learning impacts academic outcomes as shown through demonstrating the complexity of understanding, problem analysis, critical thinking, and cognitive development (Batchelder & Root, 1994; Eyler & Giles, 1999; Eyler, Root & Giles, 1998; Osborne, Hammerich & Hensley, 1998);
6. Service-learning experiences contribute to career growth (Astin & Sax, 1998; Astin, Sax & Avalos, 1999; Driscoll, Holland, Gelmon & Kerrigan, 1996).

These six effects support the impact of service learning on students' civic experience and identify a missing piece in the growing knowledge about service learning: universities and faculty must play a greater role in engendering the civic mission of society (AASCU, 2004; Eyler & Giles, 1999).

Role of the University

Universities as employers within a community are powerful social, political, and economic units whose decisions directly impact their surrounding communities (Altbach, Berdahl & Gumport, 2005). Ramalay (2000) examines higher education's relationship and responsibility to the community, focusing on the comprehensive university and advocating the replacement of the traditional concept of research, teaching, and service with the "richer and more multidimensional terms of discovery, learning, and engagement" (p. 233).

To prepare students to meet the responsibilities of living in a democratic society, institutes of higher education teach the importance of voting, participating in local governance, and staying informed about social and political issues (Jacoby, 2003). Staying informed of these responsibilities helps students develop a sense of personal responsibility to their community and nation. Astin (1999, 2000) challenges the academy to an institutional commitment to revitalize democratic education, asserting collaborative partnerships between universities and communities helps to engage students in academically-linked service and restores student connections to knowledge and understanding of civic affairs. Effective introduction of a service-learning component into any curriculum necessitates careful preplanning and a thorough follow-up to ensure that as educators, we are not defining the community's need for the community, but rather defining it with the community (Stanton, Giles & Cruz, 1999). Jacoby (2003) recommend that when planning community events for students, the service component can be tied to tangible learning objectives in the classroom and can be equally effective if the learning objectives evolve from the service event itself (Rhoads, 1997). Students need to understand that educators and community leaders place a high value on community service and expect individuals to participate.

DISCUSSION

Service Learning: A Trend for Higher Education?

Recent discussion of the importance of service learning is gaining momentum in the classroom and on campuses nationwide. The American Project for Civic Engagement and the American Democracy Project are two of the major service-learning initiatives that have won widespread recognition and are helping to affirm the university's responsibility to the community by responding to social issues and educating students to be lifelong learners and citizens for community and democracy. Faculty, students, university administrators, and community partners alike have shown increased interest and support for service learning. Specifically, the Campus Compact organization, which promotes service learning, has grown from fewer than 20 universities in 1985 to over 900 member universities in 2005 (Rose, Rose & Norman, 2005), a trend that shows no sign of abatement (Smith-Paríolá, 2006). Some universities have gone so far as to provide incentives for faculty to implement service learning in their courses (St. Cloud State University, 2006). The service learning component should not be presented as an additional component to the course (i.e., more work for the instructor and students) but should be integrated into the course as a tool to teach course, department, college and university goals and programmatic learning outcomes (Feather-Gannon, 2004).

Developing the Service Learning Component

Research conducted on the outcomes of service learning in an aviation classroom employed systematic instructional design (SID), which employs three distinct steps: learner/contextual analysis, task analysis, and identifying the learning domains (Bloom, 1956; Bloom, Krathwohl, & Masia, 1956; Morrison, Ross & Kemp, 2004). In the first step, the learner, and contextual analysis, the learner's characteristics are identified. Aviation students, like those in other science and engineering disciplines, differ from students majoring in the humanities, social science, and education in that they tend to want to know facts and figures, and how the aircraft operates. Students do not always understand the relevance of learning citizenship and volunteerism from their aviation courses. When creating a social-skills component in the hard sciences, the first thing faculty must do is understand their audience's personality characteristics and learning styles. Are your students traditional-aged or non-traditional? Are they male or female, or both? What are their academic and work backgrounds? Taking stock of, and recording, your student demographics is important in designing the service-learning component before moving into the next phase, task analysis.

Task analysis, according to Morrison, Ross, and Kemp (2004) is perhaps the most important step in the instructional design process. In designing a service-learning objective however, there are not specific tasks, rules, or procedures that are followed because the students are not learning cognitive or psychomotor skills, but rather learning within the affective domain. The critical incident method therefore is used to analyze attitudes, which will be assessed before and after the service learning experience. Survey students on the following factors: a) if, and how often, the student has participated in community service or volunteer activities, b) what the activity involved, c) how well the student liked the experience, and d) why the student did or did not like the experience. Compile the results in conjunction with the demographic data and move on to the next phase, identifying the learning domains to be associated with the learning activity.

Bloom's taxonomy indicates that the three learning domains: cognitive, affective, and psychomotor, can be found in any and all learning objectives (Bloom 1956; Anderson, 2001; Morrison, Ross, & Kemp, 2004). The objectives of service learning for our aviation students fall into the affective domain, but could also include a psychomotor domain if a specific skill is also being learned (marshalling on the flight line, for example).

Three major areas comprise the measurement dimensions: self report, record, and observation. The learning outcomes for this study are stated as: The student will observe, record, and self- report their service learning experiences, leadership potential, sense of belonging, and civic responsibility through involvement in meaningful community service.

In the aviation courses used in this case study, the objective was to have students receive the message about the service learning project, respond to the requirement through participation, and value the experience (as measured before and after the event/s).

Assessing Service Learning

The process of learning is a multi-faceted activity and can be accomplished through reading, writing, listening, talking, thinking, and doing. Educators unfamiliar with civic learning might question how the learning is assessed. Bresciani and Sabourin (2002) indicate that assessments for service learning components should include the following student learning outcomes: critical thinking, problem solving, and developing a clear connection between the course objectives and service activities. Additionally, the student development aspect (in this case, civic responsibility) is also assessable (using pre-and post-tests) by determining the student's commitment to service, understanding of civic responsibility, and development of self esteem and personal reflection. In this study, the specific outcomes sought were to develop the connection between the course objectives (knowledge base in aviation fundamentals) and the service activities (an activity linked to the aviation community, giving the student greater exposure to the industry). Additionally, the student's level of commitment to service, understanding of civic responsibility, and personal reflection were measured through the affective domain in their written assignments.

To better understand the measured outcomes, the definitions of the learning activities taking place within the affective domain are defined. *Receiving* refers to the student's awareness of the service learning component in the class and to the student's willingness to attend the service learning activity. *Responding* refers to active participation on the part of the student. At this level the student chooses whether or not to respond to the assignment by submitting a written proposal for their service learning project. In this case study *valuing* is defined as the worth or value a student attaches to the service project. The essential element characterizing the learner's attitude is a result of their appreciation of the service learning project. *Valuing* can be shown in terms of acceptance of the value, where the student attaches a value to the service learning component, and a preference for a value, where the student presents a commitment towards the service learning project.

RESEARCH METHODOLOGY

The two research questions explored in this case study were: 1) How many students achieved each of the stated learning outcomes (receiving, responding, valuing)? 2) To what extent does required vs. optional service learning activities play in the differences in the learning outcomes? In this research, measurement of the affective domain of the service-learning component of the aviation courses was conducted using quantitative, descriptive statistics and chi-square analysis. The dependent variable is considered to be the service learning activity and the independent variables are the required and optional activity. The Chi square statistic is appropriate for determining significance between categorical variables, and in this case, the categories were required vs. optional. The null hypothesis for this study would indicate that no difference in the levels of participation or learning outcomes would be expected. Each of the affective domain variables is assessed and then measured. The first assessment, measuring the receiving component, was a multiple choice quiz covering the content of the course syllabus, administered at the beginning of the term. In order to proceed with any other assignments in the class, students must complete the syllabus quiz. While this measurement is not awarded points, it is required, and confirms that the students have received the information. After having read the syllabus and taken the quiz on the content of the syllabus, students should be fully aware of the requirements of the course and the expectation regarding the service-learning component. All students should score 100% on the receiving component.

The second measurement taken in this course is assessment of the student proposal (responding). The service learning proposal requires the student to respond to the course requirement by writing a 1-page proposal describing the activity they plan to undertake and detailing how it meets the course requirements. The guidelines for the service learning projects allow flexibility for the selection of the project location and emphasis, provided there is a link to aviation. The instructor provides suggestions on possible service learning opportunities including volunteering at fly-ins, aviation pancake breakfasts, FOD-walks (foreign object debris collection, or roadside/runway trash pickup); air shows, reading aviation stories to grade-school children, etc. Once the possibilities are presented to the students, they must indicate in writing to the instructor their preferred activity, where, and when. No grades are given at this point, but proposals are evaluated in two areas: Does the proposed project serve a need identified by an aviation community partner? And, is the proposed project addressing an organizationally-defined or community-defined need rather than a student-defined need? If the answer is 'no' the proposal is returned to the student for revision, if the answer is 'yes' the requirement is noted as successfully completed.

The third measurement is the reflection paper (valuing), describing the service learning project's personal value and outcomes. This paper is a recorded reflection of the student's attitude of the completed project, a written evaluation of the activity in terms of how they valued the experience. Students are asked to provide an affective description of how valuable the experience was in terms of how they value the project as it relates to their future in aviation or their career, how they felt about themselves and their experience performing the project, and the likeliness of their voluntarily participating again. Students who complete the reflection paper are awarded the full points for the project. It is important to note that this assessment is not graded based on whether or not the student valued the experience, but whether or not they completed the project and completed the reflection paper. For the purposes of this research, the reflection papers were scored on whether or not the student made value-laden statements, for example:

Respond statements: students are simply reporting the activity they participated in—value statements are not clearly defined. An example of a *respond* statement:

"On September 30, at the airport we did a FOD walk to clean up the runways and the taxiways it was fun. The majority of the garbage was small rocks and pieces of garbage that had blown onto the airport."

Value statements: students are reporting about the activity they participated in, and value statements are evident and might include statements indicating a high level of personal enjoyment of the activity, feelings of time well-spent, feeling that the experience was valuable to the community and his/her future in the industry, and the student's perception of the learning experience, etc. This variable is more difficult to determine but when each student's answers to these questions examined, the differences in valuing becomes more apparent. Examples of valuing statements have included:

> "I accomplished a lot from this experience. I've made many friends; I was involved in every step to make the event possible. During the process I feel that have gain a lot of people skills, I felt that I came out as a leader in this event because my effort made a difference for this event."

> "First of all, it was a great possibility to get in contact with the real stuff (airplanes) compared to the theoretical background, which is taught in the lecture. And furthermore a good example

what can happen if the airplane hits a foreign object."

"What I enjoyed the most about this volunteer activity was being surrounded by aviation people with the same interests as me. Many of them had already reached their aviation goals, and it was great to hear how they accomplished them."

"Next time I volunteer in an aviation setting I would like to take a more active role in actually helping to plan and run the event. This would give me an opportunity to see the real world side of the industry."

Statistical Analysis

To understand the impact of the service learning curriculum's effectiveness, descriptive statistics are used to answer the research questions. The dependent variable is defined as the learning activity itself and the independent variable is whether the activity was optional or required for the course. The results answer the questions: How many students achieved each of the stated learning outcomes (receiving, responding, valuing)? Which approach (required service learning vs. optional service learning) was most successful in producing said outcomes? Chi square analysis was used to determine whether there was any significant difference between the student learning outcomes in the required activities and the optional activities.

The data was collected over six semesters in two courses, Introduction to Aeronautics and Introduction to Air Transportation. Both of these courses are 100-level general education courses. Approximately 80% of students enrolled in either course are aviation majors, 20% are non-aviation majors taking the course to fulfill general education requirements. The author taught Introduction to Aeronautics each semester and Introduction to Air Transportation once a year.

Two teaching methods were utilized in this research: requiring students to complete the service-learning project and making the service-learning project optional (extra credit). The data (see Table 1) was analyzed as course and teaching method vs. learning outcomes. Descriptive statistics were used (frequency, percentage) to indicate the numbers of students receiving, responding, and valuing (as determined by the assessments described previously). The number of students receiving equals the number of students in the course section since students must complete the syllabus quiz before moving on to any other coursework.

FINDINGS

The frequency and percentage of students who received and responded are shown in columns 2 and 3. The frequency and percentage of students who responded and indicated value statements in their reflection papers are shown in columns 4 and 5. The means for responding and valuing were calculated as well to show at-a-glance the differences in means of responding/valuing in the required and optional sections.

The non-parametric statistic, chi-square was calculated for this data for two reasons: the data is categorical (the assessments were conducted on the basis of whether or not students responded and whether or not they indicated that they valued the experience) and the data contains two independent groups (required project and optional projects). As shown in Table 1, a chi-square analysis was performed on the sample of students in Introduction to Aeronautics (required vs. optional) as well as Introduction to Air Transportation (required vs. optional).

The results of the first chi-square calculation ($p>.01$, $df=2$) suggest that the students in Introduction to Aeronautics who were required to participate in the service learning project responded to and valued the experience significantly more often than those students whose service learning projects were optional. The same held true for the students in the Introduction to Air Transportation courses ($p>.05$, $df=1$): students who were required to participate responded and valued significantly more often than those students for whom the project was optional.

Significance to Our Teaching

What do these results mean in terms of teaching a service-learning component in aviation? In the sections of each course

(Introduction to Aeronautics and Introduction to Air Transportation), the chi square results were significant in the category *responding*: Introduction to Aeronautics, $\chi^2 = 26.73$, which was significant at $p<.01$, and Introduction to Air Transportation, $\chi^2 = 5.96$, which was significant at $p <.05$. Not surprisingly, the chi-square values and significance in the valuing category were not significant: Introduction to Aeronautics $\chi^2=1.38$ and Introduction to Air Transportation $\chi^2=1.20$. These numbers suggest that in the course sections where the service learning component is required, students respond at a significantly higher rate than when the service learning component is optional. The numbers also suggest that when a teacher can get the students to respond, students will correspondingly value the experience. The literature tells us that moving students to this mode of learning is more difficult than teaching them facts and figures—in many cases, it requires them moving outside of their comfort zone. Requiring the service learning project in these aviation courses is essential to having more students value the experience—if left to their own choice, students will opt-out of doing something that they are unfamiliar with and which puts them outside their zone of comfort. If we are to change our institutions and communities, it is essential that we require our students to complete these components in our courses.

The second notable result from this research is that those students who are not required to complete the service-learning component show 100% valuing rates across-the-board, as compared with those students who are required to do the projects (while significantly high, it is not 100%). This is to be expected—not all students who are required to complete service learning projects are going to value them, whereas those students who voluntarily complete the projects are likely to value the experience.

What Students Have Said About Their Experiences

The service learning activity allows students to combine their love of aviation and flying with a civic activity that promotes aviation, and sometimes inspires others in the community toward a love of aviation (teaching young children the basic concepts of aerodynamics using paper airplanes, or reading stories of the first female and minority aviators). The single negative response received from a student participating in this activity was a speeding ticket received while traveling to the service learning site!

In three years and over 1,400 documented hours of aviation service-learning, there have been several success stories worth noting. One freshman aviation major chose to volunteer at a large regional air show, and was given the name of the air-show director. After indicating his willingness to provide time and service to promoting aviation to the community, he was offered the opportunity to 'shadow' the air show director for the entire weekend event, which involved meeting and greeting VIPs from the community, the military, and even meeting the Blue Angels flight team pilots. He learned about the busy and complex job of an air show director, and was invited back again the next year, as a paid intern.

A group of female students contacted an elementary school and offered to spend time reading aviation stories to first-grade children. They researched a variety of age-appropriate books that would represent the history of aviation as well as the achievements of women in aviation. The story time was a success and the children asked questions of the young female pilots about when and how they knew they wanted to be pilots, and what they loved about flying. The young women were so moved by the children's inquisitiveness, that they scheduled time to read to other classes. In both of these examples, the true nature of service learning was experienced by all parties involved; rather than just volunteering in order to earn a grade, the students and community shared and developed a civic-minded approach to learning.

Table 1. *Service Learning Project Assessment/Learning Outcome Res*ults

Group: Teaching method/sample sections	# Students Received	# Students Responded	% Students Responding	# Students Valued	% Students Who Valued
SL Project is Required (3 sections)					
Introduction to Aeronautics	35	34	97.14%	32	94.11%
Introduction to Aeronautics	19	16	84.21%	16	100%
Introduction to Aeronautics	59	47	79.66%	45	95.74%
Mean		32.33		31	
SL Project is Optional (3 sections)					
Introduction to Aeronautics	10	5	50.00%	5	100%
Introduction to Aeronautics	31	14	45.16%	14	100%
Introduction to Aeronautics	15	8	53.30%	8	100%
Mean		9		9	
Chi Square (p>.01) (df=2)	na	26.73		1.38	
SL Project is Required (2 sections)					
Introduction to Air Transportation	22	20	90.90%	20	100%
Introduction to Air Transportation	35	31	88.57%	30	96.77%
Mean		25.5		25	
SL Project is Optional (2 sections)					
Introduction to Air Transportation	27	25	92.95%	25	100%
Introduction to Air Transportation	21	8	38.09%	8	100%
Mean =		16.5		16.5	
Chi Square (p>.05) (df=1)	na	5.96		1.20	

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

First and foremost, students need real-life, outside-the-classroom experiences in order to fulfill the needs of the industry. With service learning, students link personal and social development with academic and cognitive development. Eyler and Giles (1999) affirm that in service-learning models, the student experience enhances understanding and this understanding leads to more effective action. In the aviation industry, the future of service learning is exemplified by Southwest Airlines' *Share the Spirit* program in which employees reach out to individuals, families, and entire communities, providing help where it is needed, through programs like: *Trunk or Treat* – Southwest Airlines Corporate Communications office works with local church organizers and offers a safe trick-or-treat experience for nearly 600 local children; *Guts and Glory* –the airline donates roundtrip tickets to the annual Crohns & Colitis Foundation of America's Walks and Runs, to raise funds for research of Crohn's disease and ulcerative colitis; *Sharing the Back* *to School Spirit* – During the "Back to School Action Day" at the Alice Griffith Community of Opportunity in South San Francisco, Southwest Airlines provided school supplies for backpack giveaways, goody bags for the residents, and more than 60 Southwest employees worked in the community garden, cleaned up the housing development and played games with the neighborhood kids; or Southwest's *Operation Phone Home* that partnered with the USO and its Operation Phone Home program, to provide phone cards for the troops, donating more than $50,000, which translated into a million units of call time for our troops (Southwest Airlines, 2007). When our students have already demonstrated their responsiveness and valuing of service learning, employers like Southwest Airlines will stand up and take notice (Freitag, 200; Freiberg & Frieberg, 1996).

Second, aviation education programs need to adopt and implement a core philosophy that our students as young aviation professionals need real-life outside-the-airport experiences in addition to their classroom learning. Service learning has and will continue to play an important role in preparing aviators for the 21st century.

Additional research needs to be conducted in this area of aviation education, measuring whether the service learning experience is valued by the community—are the recipients finding the same level of value and satisfaction with the activities as are the students? When this question is answered, the service learning experience can be evaluated from a 360-degree perspective and our faculty will have the data needed to further support the need for and value of service learning in the aviation classroom. Until then, we do know that students who are compelled to complete service-learning projects overwhelmingly value their experiences and even begin to characterize service to others as a lifelong activity.

Finally, creating a successful service learning experience for the student involves planning and designing a learning component that both the student and the community can value. As this research has shown, when the instructor cares about designing and requiring a meaningful activity, the students will in turn care about the activity by responding and valuing the experience. Instructors who value service learning will make it a required component of their courses and students who value service learning will complete the project whether it is required or optional.

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APPENDIX A

A list of service learning projects that students participated in throughout the case study include:

FOD walks

Airport fly-in support

Air show support

Community Aviation Day activities

Aviation Expos in a variety of capacities (around the state and region)

Washing the University airplane fleet

Fundraising for the University Aero Club

Reading aviation stories to elementary school children (the stories and theme of stories is chosen by the university student)

Paper-airplane folding and flying contests with school children (teaching aerodynamics)

Young Eagles program

POW hot-air balloon rides

Road clean up (around the airport)

Operation Santa rides (C-130)

Visits to old high schools to talk about aviation to high school students

ATC Tower tours

Aviation banquets

Civil Air Patrol activities

Moving FITS Training from the Laboratory to the Flight Line

Wendy S. Beckman, Mark N. Callender, Steve Gossett,
Wayne A. Dornan and Paul A. Craig

ABSTRACT

In 2004, Middle Tennessee State University (MTSU) first conducted training on an experimental basis using a FAA-Industry Training Standards (FITS) accepted Private/Instrument curriculum. Based on the results of that and subsequent studies, the decision was made to move to full-scale implementation of this Private/Instrument curriculum beginning in January of 2007. Before this course of action was chosen, a number of issues were resolved including flight school preparation, development of a Commercial FITS approved syllabus, aircraft scheduling and training time considerations, and changes to the original syllabus. Since implementation as the standard MTSU flight school curriculum, sixteen students have completed the course. The mean flight times and number of setbacks experienced by students during training continue to compare favorably to traditional training methods.

INTRODUCTION

In 1998, the FAA announced a "SAFER SKIES" initiative to achieve significant reductions in the number of General Aviation (GA) fatal accidents by 2007 (United States General Accounting Office, 2000). As part of this initiative, the General Aviation Joint Steering Committee (GAJSC) focused on the leading causes of GA accidents. In order to assess what new safety challenges occur with the advent of the Technically Advanced Aircraft (TAA), the GAJSC established a TAA study team to investigate safety issues with TAA aircraft (Dornan, Beckman, Gossett, & Craig, 2007b; Fiduccia et al, 2003). Part of the impetus for this was an observed increase in fatal accidents with the next generation TAA's in the early to mid-90's (AOPA Air Safety Foundation, 2005; National Transportation Safety Board (NTSB), 1990). A major recommendation in this report was that the current training format in the industry was insufficient to exploit the additional safety features of TAA, and that there was a critical need to develop a TAA training program in the GA community (Fiduccia et al, 2003). As a result of these recommendations, the FAA implemented the FAA-Industry Training Standards (FITS) program (Federal Aviation Administration, 2004; Glista, 2003). This program emphasizes the importance of "real world" training exercises in the form of scenario training. This approach had proven successful in the air carrier industry, but had not been attempted in the GA community. This training places a major emphasis on: aeronautical decision making skills, risk management, situational awareness, and single pilot resource management using real-time flight scenarios (Ayers, 2006; Glista, 2003). Studies from Embry-Riddle Aeronautical University (ERAU), the University of North Dakota (UND), and Middle Tennessee State University (MTSU) on the effectiveness of the FITS curriculum have resulted in the FAA accepting the FITS training approach as the industry standard for all future flight training in General Aviation (Glista, 2003).

In 2004, MTSU received the first FAA acceptance to train students for a combined Private Certificate/Instrument rating in TAA using the FITS training program. This was a novel approach, as traditionally, a student pilot is required to first complete training for a Private Certificate, then complete additional training for an Instrument rating. This FITS curriculum was developed by ERAU and UND through the FAA Air Transportation Center of Excellence for General Aviation (CGAR). The FITS curriculum was first tested at MTSU in 2004-05 in a NASA funded project called "SAFER." Over the last three years, the MTSU SAFER research team has published and presented the results of several studies that have indicated the effectiveness of the FITS approach for not just TAA, but for use in all aircraft (Craig, Bertrand, Dornan, Gossett, & Thorsby, 2005a, 2005b; Dornan, Beckman, Gossett, & Craig, 2007a; Dornan, Beckman, Gossett et al., 2007b;

Dornan, Beckman, Gossett, Craig, & Mosey, 2007; Dornan, Craig, Beckman, & Gossett, 2007; Dornan, Craig, Gossett, & Beckman, 2006; Dornan, Craig, Gossett, Beckman, & Mosey, 2007; Dornan, Gossett, Craig, & Beckman, 2006). Each of these studies was conducted in a somewhat controlled environment, in that small sub-sets of the entire population of Professional Pilot students at MTSU were utilized. Given the success of these experimental groups, the decision was made to move forward with full scale implementation of the FITS Private/Instrument curriculum for all students at the MTSU flight school. For several decades, the MTSU flight program had used a traditional training approach in which students obtained the Private Pilot Certificate first, followed by a semester gaining VFR cross country experience, followed by a semester earning the Instrument Rating. In January 2007, the MTSU Aerospace Department changed this conventional, maneuver-based methodology to a combined Private and Instrument syllabus that has received FITS acceptance. The decision to implement the FITS curriculum for all students in the program required a great deal of decision making, implementation planning, and flight instructor training (Dornan, Beckman, Gossett, Craig et al., 2007). There were five significant issues that were addressed before the implementation decision was made: Flight school preparation, the availability of a FITS Commercial Pilot syllabus, the use of both TAA and conventional aircraft, the length of time required for course completion, and the changes to be made to the original syllabus used in the NASA SAFER project.

Flight School Preparation

It had been hoped that the MTSU flight program would be ready to implement the FITS Private/Instrument syllabus as the standard training methodology in August of 2006, but ultimately the changeover was delayed until January 2007. This delay allowed the flight school staff the necessary time to address the issues that the FITS syllabus would create. These issues have been described in a previous publication (Dornan, Beckman, Gossett, Craig et al., 2007), but were in large part flight instructor training, development of ground school curriculum, and aircraft scheduling.

Development of a FITS Commercial Syllabus

The students who participated in the experimental FITS groups were all enrolled in the MTSU Professional Pilot program, which requires students to obtain the FAA Commercial Pilot Certificate and Multiengine Rating prior to graduation. Therefore, the students who completed the FITS Private/Instrument syllabus then utilized a traditional Commercial Pilot course to complete the Commercial Certificate and to meet graduation requirements. It was frustrating for students who had learned with scenario-based training to have to revert to maneuver-based training, especially when a number of the Commercial maneuvers (chandelles, lazy 8's) seemed to have little relevance to actual commercial operations. In addition, any reductions achieved in flight hours required in Private/Instrument training were quickly lost when the students went back to a syllabus requiring minimum flight times. Thus, it was decided that the Private/Instrument syllabus would not be used as the standard curriculum until there was available a FITS Commercial syllabus as a complement. This would allow the students to complete their entire training requirement using the FITS methodology, therefore maintaining all the benefits produce by FITS. In early 2007, MTSU was tasked by CGAR to write a FITS Commercial Syllabus. In the summer of 2007 the syllabus was reviewed by a national review team and ultimately awarded FITS acceptance (Federal Aviation Administration, 2007a, 2007b). It was then possible to link the FITS Private/Instrument syllabus with the FITS Commercial syllabus so that students could go from their very first flight lesson through Commercial Pilot using the FITS methodology.

Use of Both TAA and Conventional Aircraft

The students in the SAFER project trained exclusively in TAA. Since MTSU's training fleet is only 20% TAA, to use the FITS syllabus for the entire program it became necessary to use the FITS syllabus with both TAA and conventional aircraft. Some lessons contained within the syllabus were designated as "TAA lessons" which required use of a TAA. Most lessons however, did not designate TAA and those lessons could be completed in either a TAA or conventional aircraft. The decision to use both TAA and non-TAA interchangeably was a matter of necessity, not a research question. The flight school needed to utilize 100% of the fleet to accommodate the schedule, so to implement the FITS syllabus for all students; every airplane had to be used.

Length of Training Time

The students in the original SAFER project found it difficult to complete the Private/Instrument syllabus in a single semester. While there were several students who did complete in one semester, on average more time was needed. Therefore the decision was made to allow students two semesters to complete the FITS Private/Instrument syllabus. This produces some challenges when students begin the curriculum in the spring semester, and then are not able to stay for the summer semester. For those unable to remain in school during the summer, an undesirable gap in the middle of training occurs. There is no easy solution to this problem, beyond encouraging students entering the program to either begin training in the fall semester or to plan on staying for the summer semester, so that their training will be continuous.

Improvements to the Original Syllabus

MTSU was the first to use the syllabus produced by CGAR, and as a result became the beneficiary of a number of "lessons learned." Before the decision was made to use the FITS syllabus as the standard training curriculum several changes were made to the syllabus that reflected these lessons learned. It was found that there was not enough landing practice experienced by students by performing only a landing at a scenario destination and a landing when returning to the home airport. Provisions were made in the syllabi for lessons to contain multiple landings at both the destination and home airport on several lessons. It was also discovered that students who only experienced an instrument approach at the end of a relatively long cruise portion of flight, with abundant time for approach set up, had difficulty when expected to prepare for an approach on short notice. Thus, guidance was given to instructors to include scenarios where the expected approach was changed at the last minute, due to ATC needs or weather changes, in order to increase student proficiency in dealing with such changes. Greater emphasis was also placed on conducting GPS approaches, while references to NDB approaches were removed, as the aircraft in use were not ADF-equipped.

While the number of lessons remained the same as in the original, on some lessons the flexibility to conduct the training in either a Flight Training Device (FTD), a DA-20, a conventional DA-40, or a G-1000 equipped DA-40 was added. This allowed instructors the flexibility to move between equipment types as availability allowed, and enhanced students learning by exposing them to a variety of equipment. In addition, instead of providing a detailed listing of all tasks to be completed on a flight, the task listing was shortened to those tasks being stressed in that particular lesson. For instance, items such as engine start up, taxiing, and the pre-takeoff check are key tasks in the early lessons, but by a point mid-way through the curriculum, those tasks should have already been mastered. While these tasks are still important, other skills are the focus of later lessons. This revision was necessary as the sheer amount of text on each lesson page was overwhelming to flight instructors, and they had difficulty determining the intent of a particular lesson.

RESULTS

There were sixteen students who started the FITS syllabi in January of 2007, and who had completed the FITS syllabi by October 2007. As indicated in the Introduction, the curriculum was designed to take two semesters, so only students who were willing to stay at school and fly during the summer were expected to be completed. There were two students who came very close to completing the syllabus in one semester, as they only required a few days after the spring semester to complete their training. The remainder of the students completed during the summer months.

To determine the effectiveness of the full-scale implementation, the average flight times and setbacks of these 16 students was compared to both the original SAFER project experimental group and to a group of conventional syllabus students which were used for comparison purposes in the first MTSU FITS study (Craig et al., 2005a). There were fifteen students in the original SAFER group, and sixteen students in the conventional syllabus group. As can be seen in Figure 1, the mean flight time for the full-scale implementation group to obtain the Private/Instrument was 95 hours. This compares to a mean of 88 hours for the SAFER experimental group, and a mean of 135 hours for the conventional syllabus students.

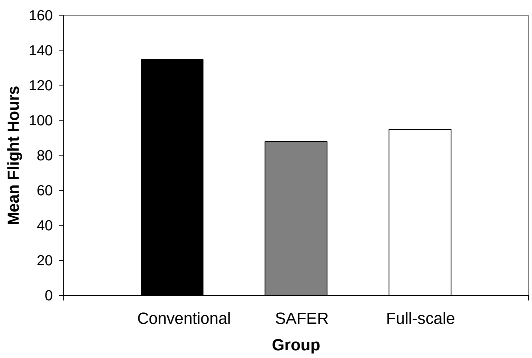

Figure 1: Mean hours to complete the Private Certificate with Instrument Rating for each of the three groups

A setback was defined as a lesson that a student had to repeat to obtain proficiency. As can be seen in Figure 2, the mean number of setbacks experienced by each group prior to obtaining the Private/Instrument were examined. For the full-scale implementation group, a mean of 12 setbacks was found. For the SAFER experimental group a mean of 6.91 setbacks was found, while the conventional syllabus group experienced a mean of 22.45 setbacks.

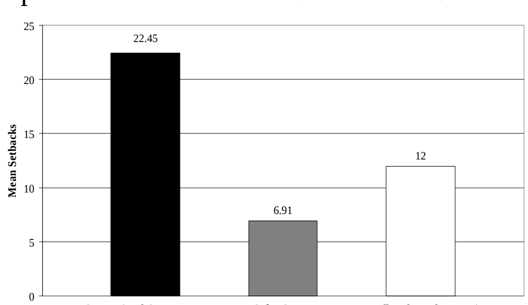

Figure 2: Mean number of setbacks experienced during training for each of the three groups

The setbacks were further examined to determine if there was a significant difference between pre-solo training setbacks and post-solo training setbacks. As can be seen in Figure 3, a 2X3 ANOVA revealed a significant interaction of training group versus pre-solo and post-solo setbacks ($F=10.38$, $p < 0.01$).

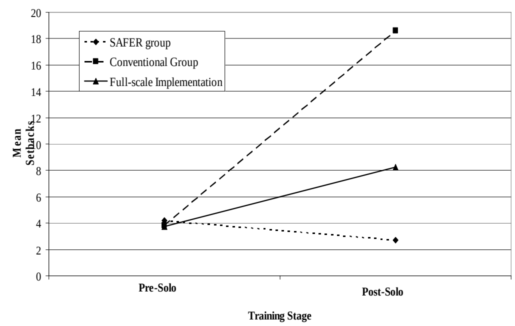

Figure 3: Mean number of setbacks for each group both pre-solo and post-solo

As can been seen from this figure the average number of pre-solo setbacks were not statistically different (X=3.85 for the conventional syllabus group, X=4.21 for the SAFER group, and X=3.75 for the full scale implementation group). However, post-solo setbacks increased significantly in the conventional syllabus group (X= 18.6) and in the full implementation group (X=8.25), versus the SAFER group (X=2.71). A post hoc analysis revealed an overall significant difference in the conventional syllabus group compared to both FITS groups. Interestingly, with a post-solo setback mean of 8.25, the full implementation group had a mean midway between the conventional syllabus group and the SAFER experimental group. Lastly, post hoc analysis revealed that the SAFER experimental group had significantly fewer post-solo setbacks compared to the other groups.

DISCUSSION

Based on the results above, it is evident that the students who have completed training thus far as part of the full-scale MTSU flight school implementation have experienced fewer setbacks and attained their private pilot certificate and instrument rating in fewer hours than the traditionally trained students that were used for comparison purposes. This outcome agrees with the results of the highly controlled

SAFER project, which implemented FITS in a more research oriented environment. If the results of the SAFER project are used for comparison as the "ideal" situation, the full implementation comes very close to being ideal, although the mean number of setbacks and flight hours were slightly higher. This did not come as a surprise, in light of the challenges associated with implementing any program on a larger scale. Although it has been shown that the FITS syllabus and not simply training in a TAA is the source of improvements among students (Dornan et. al., 2006), SAFER students did experience the benefit of training solely in TAAs. Full implementation necessitated the use of both two conventional (DA-20 and DA-40) and TAA (DA-40 with G-1000) aircraft for training. The lack of a common aircraft from flight to flight is a confounding and likely detrimental variable.

Also, the SAFER project employed a small group of experienced and FITS trained instructors. The full implementation required the services of all flight school instructors who, although qualified, did not have a high experience level upon which to draw for scenario-based training. Along with low experience levels, they also were largely traditionally trained and so had not experienced the benefits of FITS training themselves. It is believed that as FITS trained pilots enter the instructor ranks in the near future, they will be both more prepared for and more comfortable with scenario-based training. It must be recognized that the full implementation did reduce the average number of pre-solo setbacks when compared to the SAFER project, although not by a statistically significant amount. The average pre-solo setbacks in the SAFER project was X=4.21, while the average pre-solo setbacks in the full implementation group was X= 3.75. This improvement is believed to be the result of increasing the number of landings conducted in the pre-solo lessons, thereby providing more practice of the maneuver-based landing skills. The analysis of the mean setbacks experienced both pre-solo and post-solo was undertaken to assist in scrutinizing the syllabus for possible future revisions. It was found that many students in the full implementation group experienced setbacks just prior to the IFR stage check (Lesson 19), when all of the instrument skills previously learned were being consolidated. This could indicate the need for an additional lesson prior to this point in the curriculum.

CONCLUSION

In closing, the first full implementation of the FITS private/instrument combined training course provided significant improvements with regards to both mean flight time and mean setbacks experienced versus traditional training methods. When coupled with rising training costs, this translates to savings for students. It should be noted that at the time of this writing, the sample size of students who have completed the curriculum is very small, which is a significant limitation of the study. However, this project is continuing, and data will continue to be collected as more students enroll in and complete the Private/ Instrument FITS syllabus. Data collection will also begin as students enter the Commercial FITS curriculum, to assist in determination of the effectiveness of that training course. This data will be made available in future articles.

Finally, reductions in setbacks, hours, and costs should not overshadow the original purpose for scenario-based/FITS training. The development of these curricula was motivated and driven by the desire to make flight training more effective in terms of producing a pilot who is better able to make safe decisions. Previous studies have shown that FITS trained pilots "make better decisions", are "more comfortable in the IFR environment", and are "more cautious" than traditionally trained pilots (Dornan et. al., 2006). It is primarily for these reasons that the FITS methodology should be considered, while the reduction in training costs are a secondary benefit.

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Transfer and Cost Effectiveness as Guides to Simulator/Flight Training Device Use

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ABSTRACT

As fuel prices climb and aircraft operating expenses follow suit, the training costs incurred by aviation students continue to rise. Responsible aviation programs must seek ways to provide safe and effective training while minimizing their students' training costs. To accomplish this, many aviation programs utilize flight simulation of some form as a complement to training in the aircraft. Simulation can be offered at greatly reduced per hour costs when compared to the aircraft, and as studies have shown, provides positive transfer of training from the simulated environment to the aircraft. Positive transfer of training implies that students will benefit from training in the simulated environment. This is only the case when the transfer effectiveness ratio (TER) is above a given value. It is the purpose of this paper to demonstrate a method of evaluating the cost effectiveness of a training device by using the TER and the cost effectiveness ratio (CER.) By using these tools, the use of simulation will be of maximum benefit, i.e. reduced training costs, to aviation programs and their students.

INTRODUCTION

Training is "the act, process, or method of one that trains" (Merriam-Webster's Collegiate Dictionary, 2005, p. 1326). In aviation, as in all other endeavors, training ideally should take place in the same conditions and environment as the circumstances for which one is being trained. This translates into conducting pilot training in an actual aircraft while in flight. While this form of training may be ideal, it is also very expensive. With the current Federal Aviation Administration's (FAA) mandated 40 flight hours necessary to apply for the private pilot certificate under Part 61 (Code of Federal Regulations [CFR], 2007, Part 61), a small aircraft renting for $100 per hour (including averaged instructor's fee) will cost the student $4000 to receive the required time/training. This is the minimum number of hours necessary; however, the FAA indicates that the average number of hours actually received by applicants for the private pilot certificate extends upwards to 75 hours (Federal Aviation Administration [FAA], 2006), thereby increasing the hypothetical cost to $7500. Rising fuel and aircraft acquisition costs will also affect the cost of training by rapidly inflating the per hour cost of operating the aircraft.

For the student of a collegiate aviation training program requiring students to complete at least the commercial pilot's certificate, these costs are substantial given the 190 hour FAA minimum flight hours necessary to apply for the commercial pilot certificate under Part 141 (CFR, 2007, Part 141) and the added expense of tuition and fees for their college education. In light of this, ground-based trainers provide a training environment similar to the actual aircraft while at a reduced per hour cost.

TRANSFER EFFECTIVENESS RATIO

The transfer effectiveness ratio (TER) (Roscoe & Williges, 1980) is a means by which the benefit of training in a simulated environment can be measured by recognizing the positive effects seen when transitioning to the actual environment. The method by which the TER is calculated is as follows:

$$TER = \frac{Y_O - Y_X}{X}$$

Where:

- Y_O = iterations for a control group to meet a standard in the aircraft
- Y_X = iterations for an experimental group to meet a standard in the aircraft after having received prior training in a simulated environment
- X = iterations for an experimental group to meet a standard in a simulated environment prior to training in the aircraft

The numerator in the TER represents the relative benefit or detriment of prior training in a simulated environment. Positive numerators indicate less airplane iterations were required of a student who had prior training in a simulated environment than were required by a student who only trained in the actual environment, i.e. the simulated experience positively transferred to the actual environment. On the other hand, negative numerators indicate more iterations were required of a student who had prior simulated experience, i.e. bad habits gained in the simulated environment required extra iterations in the actual environment to overcome their negative effect, so a negative transfer. Numerators equal to zero represent a situation where prior simulated experience neither adds to nor takes away from a student's experience, or no transfer. Obviously the only acceptable option is that of positive transfer if simulation is to be used; however, the amount of time spent in simulation to achieve positive transfer is critical. For example, if simulator training reduced the iterations to reach proficiency in a given task by five iterations, the transfer would be positive.

$$Y_O - Y_X = 5$$

If five simulator iterations were required to do so, the TER would equal one.

$$TER = \frac{Y_O - Y_X}{X} = \frac{5}{5} = 1$$

If twenty simulator iterations were required, the TER would still be positive, but the transfer effectiveness would be much lower.

$$TER = \frac{Y_O - Y_X}{X} = \frac{5}{20} = 0.25$$

SIMULATION IN AVIATION

In aviation, the actual environment refers to an aircraft in flight. The simulated environment consists of any ground-based system which seeks to represent in some way an aircraft in flight. The personal computer-based aviation training device (PCATD) is a relatively inexpensive (several thousand dollars) system driven by a laptop or desktop computer running a flight simulation program (FAA, 1997). An onscreen representation of a cockpit with instrumentation is interfaced by means of flight, avionics, and other cockpit controls connected to the computer. A more accurate representation of an aircraft's cockpit, whether of a general or specific aircraft, is achieved by using a flight training device (FTD) or a flight simulator. FTDs and flight simulators represent full sized cockpit environments and typically have visual systems (CFR, 2007, Part 61). Flight simulators have the added benefit of force cueing, to further envelope the student in a more realistic training environment by giving the sensation of motion. FTDs are many times more expensive than PCATDs, hundreds of thousands of dollars, while full motion flight simulators reach into the millions of dollars.

No matter which level of these devices is used, the owner of the device must charge a per hour fee in order to offset the cost of the device, the cost of maintaining the device, and any other costs associated with the device's operation. This fee may be minimal for a PCATD, but can be substantial for the FTD or flight simulator. This fee must be considered, in conjunction with the transfer effectiveness of the simulation device, when incorporating simulation into a training program.

COST EFFECTIVENESS RATIO

TERs have been calculated and reported in many studies, the majority of which show positive transfer (Orlansky & String, 1977; Rantanen & Talleur, 2005; Taylor et al., 1999). Although positive TERs are a necessary consideration when evaluating the benefits of a particular simulation device and training methodology, positive *TER* values don't necessarily mean that the simulation device should be used. When considering the most directed and beneficial use of simulation devices, the TER is only the beginning. Another way of looking at the TER is as follows:

$$TER = \frac{\begin{array}{c} aircraft\ \ iterations\ \ saved \\ by\ \ prior\ \ simulation \end{array}}{\begin{array}{c} simlation\ \ iterations\ \ used \\ prior\ \ to\ \ aircraft\ \ iterations \end{array}}$$

In other words, this is a ratio of aircraft iterations to simulation iterations. This ratio can be transformed from a ratio of iterations to a ratio of time as follows:

$$TER \cdot \theta = \frac{\dfrac{aircraft \;\; time \;\; saved \;\; by}{prior \;\; simulation}}{\dfrac{simlation \;\; time \;\; used}{prior \;\; to \;\; time \;\; in \;\; aircraft}}$$

Where:

$$\theta = \frac{t_O}{t_X}$$

t_O = average time per iteration to perform a particular task in the aircraft

t_X = average time per iteration to perform a particular task in the simulation device

With the ratio now consisting of times, the per hour fees associated with the aircraft and simulation device can be applied as follows:

$$TER \cdot \theta \cdot \phi = \frac{\dfrac{aircraft \;\; fees \;\; saved \;\; by}{prior \;\; simulation}}{\dfrac{simlation \;\; fees \;\; spent}{prior \;\; to \;\; aircraft \;\; iterations}}$$

Where:

$$\phi = \frac{f_O}{f_X}$$

f_O = Per hour operating fee for the aircraft

f_X = Per hour operating fee for the simulation device

This new ratio of money saved in the aircraft to money spent in the simulation device provides a very useful metric for evaluating when simulation is or is not cost effective in a training program. This becomes the cost effectiveness ratio (CER) and is represented by the following equation.

$$CER = TER \cdot \theta \cdot \phi$$

The CER, unlike the TER, cannot simply be a positive number for favorable simulation cost effectiveness to occur. Since the numerator indicates the amount of money saved in the aircraft, and the denominator indicates the money spent in simulation, CER values greater than one represent more aircraft fees saved than simulation dollars spent. This represents a net savings to the student. For CER values less than one but greater than zero, money was saved in the aircraft; however, the money spent in simulation outweighed the money saved, thereby imparting more cost to the student than if the student had trained in the aircraft alone. CER values equal to one represent equal amounts of aircraft fees saved and simulation fees spent. In this situation, no difference as far as cost is concerned is apparent between aircraft only training and aircraft/simulation combined training. Therefore, only CER values greater than one represent positive cost effectiveness.

To further develop the usefulness of cost effectiveness, the components which compose the CER must be examined. As stated previously, the CER is the product of the TER, the time ratio, and fee ratio, and must be greater than one for positive cost effectiveness. This is shown in the following equation.

$$CER = TER \cdot \theta \cdot \phi > 1$$

Solving the inequality on the right for the *TER* yields:

$$TER > \frac{1}{\theta \cdot \phi}$$

This inequality reveals a minimum value of the TER necessary to provide a positive CER. As seen above, this TER value must be greater than the reciprocal of the product of the time and fee ratios. At this point a simplifying assumption will be introduced. For FTDs and flight simulators with realistic cockpits and controls, it will be assumed that the average time per iteration in the FTD/flight simulator will be the same as the average time per iteration in the aircraft. With this assumption, $\theta = 1$, the minimum TER necessary for positive cost effectiveness is found as follows:

$$TER > \frac{1}{\phi}$$

The TER for any particular task need only be greater than the reciprocal of the fee ratio, ϕ, in order for FTD/flight simulator use to be cost effective.

DISCUSSION

The value of ϕ is readily available for an aviation program with a set fee schedule. For example, if a program charges $100 per hour (including instructor's fee) for an aircraft and $50 per hour (also including instructor's fee) for an FTD, $\phi = 2$, and the corresponding TER for each task trained in the FTD must be greater than 0.5 in order to maximize the cost savings to a student. At this point an aviation program would need to know the TER for each task to be trained in order to make this evaluation. Studies such as that by Macchiarella, Arban, and Doherty (2006) have evaluated the transfer effectiveness from an FTD to an airplane for a given set of standard required pilot tasks (FAA, 2002.) While the overwhelming majority of the TERs in this study were positive, over half were less than 0.5. If the hypothetical value of $\phi = 2$ were to be used for this case, the aviation program could remove all non-cost effective tasks from FTD lessons thereby reducing the training costs to students.

It is apparent that the larger the value of ϕ, the lower the TER may be and still deliver positive cost effectiveness. Large ϕ values will arise when the difference in cost of the airplane versus the simulation device are large. This large difference will be realized for relatively expensive aircraft and/or inexpensive simulation devices. Accordingly, the use of simulation devices will most certainly be cost effective when training pilots to operate large, costly turbine-powered aircraft. For operators of such aircraft, even full-motion flight simulators may be many times less expensive to operate than the aircraft. For operators of small, reciprocating-engine aircraft, PCATDs will most likely provide positive cost effectiveness due to their very low operating costs. It is for the operators of small, reciprocating-engine aircraft using FTDs or flight simulators that the determination must be made as to the cost effectiveness of the device.

CONCLUSION AND RECOMENDATIONS

Positive TERs are necessary to justify the use of any simulation device. Taken one step further, the TERs must also be greater than the reciprocal of the fee ratio, ϕ, to provide positive cost effectiveness as given by the CER. It is the recommendation of the author that aviation programs should seek to determine the TERs for tasks to be trained in their FTDs/flight simulators, and only those tasks which provide positive cost effectiveness should be trained in a simulation device. In this way, aviation programs can provide more cost effective training for their students.

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Theoretical Mechanics of Judgment Training in Aviation: Using Set Theory and Probability Statements in Instructional Design

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ABSTRACT

Aeronautical Decision Making (ADM) in student pilots has been governed by Advisory Circular 60-22 since 1991, and theoretically supported by studies conducted in the 1980s. What has been missing in some of these studies is direct access to the nature of judgment within decision-making. Judgment has always been the by-product of decision-making, not the chief focus. This essay concentrated on the response type and headwork portions of the ADM process, the first four steps of Jensen's (1995) detailed decision model, and the rational judgment portion of the Theory of Signal Detectability (TSD) (Jensen, 1995). Venn diagrams were used to express a new concept known as tensional meaningfulness and to express in theoretical terms how phenomena within the Venn diagrams related to each other. Orasanu's (1993) three types of decisions provided the backdrop for these Venn visualizations. These theoretical relationships were then translated into practical guidance for instruction in the classroom, instruction in the simulator, and testing strategies.

INTRODUCTION

For professional pilots, an accurate or situationally relevant decision is based on a sound foundation of judgment, accrued over years of experience and much regulation. If pilot judgment is faulty, who is to know? If decision-making is faulty, it seems that everyone knows. Poor simulator performance, in-flight incidents or accidents might provide evidence of poor judgment, but in the crew environment, some poor judgment can be mitigated by good crew resource management. In other words, poor judgment is bypassed, not dealt with.

In Jensen's (1995) view, the reason why bad decisions are made is because there is no concerted effort to develop judgment in student pilots, other than what is naturally acquired in the course of pilot training. Although Jensen's views appear to be dated, there is a logical assumption being made here. Pilot judgment can be built, one scenario at a time, and this training should commence the very first day of pilot training, no matter where that training is conducted (military or civilian). Jensen's insistence on a concerted effort for judgment training can be equated with what Clark (2005) described as intentional learning.

It is important to note that in the 1980s several studies were commissioned by the Federal Aviation Administration and Embry-Riddle Aeronautical University to determine if judgment training reduced the number of judgment-related errors in student, not commercial airline pilots (Berlin et al., 1982; Diehl & Lester, 1987). The outcome showed a significant advantage in judgment-trained participants over those receiving conventional training, without a specific emphasis on judgment. Berlin et al. (1982) found that judgment-trained student pilots made 16% fewer judgment errors.

Judgment and Decision-Making in the Airlines

For a moment, the course of this paper diverts to commercial airline pilot judgment, but only to make a point about how judgment training is conducted, and then the attention will be brought back to student pilots in collegiate programs. Airline pilots pore over volumes of NTSB aircraft accident reports, to find out what went wrong and then to determine how in the future these same mistakes could be averted. In U.S. air carrier training departments, studying aircraft accident reports is just one way to stay ahead of errors. Other programs such as Line Oriented Flight Training (LOFT), Line Operations Safety Audits (LOSA), the Aviation Safety Action Program (ASAP), and the Advance Qualification Program (AQP) are used as quality enhancement tools to ensure a broader margin of safety and to improve judgment in an environment where the lack of judgment will not hurt anyone (Mulqueen, Baker, & Dismukes, 2002). Over 30,000 pilots believed that these training programs were useful and that they made a difference in how they behaved as a crewmember (Beaubien & Baker, 2002). If thousands of pilots think these programs are useful, then judgment training should begin sooner, not later.

Beaubien and Baker (2002) claimed that if CRM training were part of pilot training, one should see an improvement in judgment and decision-making, because judgment and decision-making are integral parts of the training curriculum: it is intentional and it has government attention (Department of Transportation [DOT], 2004). In practice, the success of judgment training within CRM courses is due in large part to the mix of classroom, simulator, and flight contexts of learning (Cook, Beneigh, & Clark, 2001; Hoover & Russ-Eft, 2005; Lofaro & Smith, 2001). CRM courses that do not integrate training devices with the classroom experience are less effective and they do not assess judgment within the context of flight. This point was made by many individuals who attended the 2007 CRM Vectors conference and their recent input seems to echo what has been said in past (Beneigh & Hubbard, 2007).

Judgment and Decision-Making in Collegiate Programs

The following comments are perceptions drawn from flight training in collegiate programs, on the flight line and in the classroom. The citations are old, but the findings are still on track. Flight examiners, Certified Flight Instructors, and professors supporting collegiate professional pilot programs have many ways of developing judgment in student pilots (Diehl & Lester, 1987). The means by which judgment is built are also the means by which judgment is assessed. On the flight line student pilots take paper and pencil tests and computer-based tests; they orally communicate resolutions to situational problems posed by their flight instructors, they complete training sessions in the simulator, and they complete flights in the aircraft. If the training curriculum does not specifically include a section on judgment, then one can assume that judgment is only the byproduct of training and is not an intentionally emphasized and tested part of that training.

Professors who educate professional pilot students through theory-based courses, such as Ethics, Law, CRM or Human Factors, build judgment in their students through the lens of other's experience in the real world—the world outside of the classroom. Reviewing NTSB accident reports is one method of integrating actual experiences of pilots, and is perhaps one of the oldest ways to introduce pilots to judgment and decision-making. Supported by simulator sessions, perhaps a better way forward is to use texts that go beyond the accident report, into the psyche of the pilot and the psyche of the pilot's airline company, such as *The Limits of Expertise*, by Dismukes, Berman, and Loukopoulos (2007). Students are asked to go beyond the obvious or the reported proximate cause and find other clues for poor performance, which expands classroom discussion to include issues of judgment. Given the assumption that a pilot does not intend to make bad decisions and bring harm on him or her and the passengers on board, there might be other reasons for the mistakes. This is the point being made in *Limits of Expertise*.

Judgment training post 1980s has been built on the foundational principles found in Advisory Circular (AC) 60-22 (DOT, 1991). These principles are distillations of studies conducted by Jensen, Adrion, and Maresh with the U.S. Air Force (Jensen, 1995) and other studies such as those by Berlin et al., (1982) and Diehl and Lester (1987). Therefore, to understand the theoretical underpinnings of AC 60-22, *Aeronautical Decision Making* (ADM) is to understand the theoretical underpinnings of the aforementioned studies.

The FAA, even in its regulatory role, is reluctant to write an advisory circular if it is not based on dozens of corroborating studies, in a way similar to how AC 60-22 was created. A case in point is the June 18, 1996 study on *The Interfaces Between Flightcrews and Modern Flight Deck Systems*. In the preface of the co-chairpersons, the FAA listed those who contributed to the study. Besides the FAA, the European Joint Aviation Authorities, and "technical advisors" from The Ohio State University, the University of Illinois, and the University of Texas participated. Those tracking automation studies would have guessed the names of those contributing from each university. Nadine Sarter, the University of Illinois representative, has academic and professional connections to the Ohio State University through Richard Jensen and David Woods. Bob Helmreich, the University of Texas

(Austin) representative, was the most recognizable name in human factors at UT in the 1980s and 90s, particularly in the area of CRM. And David Woods, the Ohio State University representative, is interconnected as stated earlier. The FAA had commissioned studies through these universities, and it was these universities that established the theoretical approach used by the FAA, and perhaps the European JAA.

Wherever judgment and decision-making training occurs today, it is marked by the findings of those earlier studies—funded by the FAA—that established the theoretical basis on which training would be conducted and the outcomes assessed. If theory and practice are bookends between which pilot instructors build better pilots, then paper and pencil tests are the tools used to assess the student's knowledge of theory and simulator scenario training is the tool used to assess both judgment and decision-making (DOT, 1991; Jensen, 1995).

Special Focus and Limited View

Having completed a concise history of the foundational elements of judgment and decision-making training and the pivotal studies that first influenced this type of training, there is now a shift toward the theoretical underpinnings of judgment itself. Since this paper is more akin to an essay on theoretical methodology, gone are the very familiar figures depicting the entire decision cycle for pilots. This paper does not address the entire decision cycle, as depicted and described in AC 60-22 (DOT, 1991). This paper instead focuses only on the *response type* and *headwork* portions of the aeronautical decision making process, as depicted in Figure 2 of AC 60-22 (not appearing herein). In terms of JAMJET (Jensen, Adrion and Maresh, Judgment Assessment Technique), this paper focuses on problem vigil, recognition, diagnosis, and alternative generation from within the detailed judgment model in Jensen (1995, p. 37). Regarding the Theory of Signal Detectability (TSD), this paper is only interested in the rational judgment part of the theory, which coincides with at least four of the steps in the detailed judgment model (listed above).

This paper provides insights into how judgment training can be developed for collegiate aviation programs within this narrow focus. Throughout the paper, the reader will see illustrations of how students can be prepared to receive judgment training, how instructors should proceed when building judgment scenarios for student pilots, and how instructional designers can use the logical forms in Venn diagrams to construct meaningful curricula. As a means to keep the paper relevant to current thinking about judgment and decision-making, work by the following persons was analyzed (Bass & Radzio; 2003; Jensen, 1995; Mauro, Barshi, Pederson, & Bruinicks, 2001; O'Hare, 2003; Orasanu, 1993). It is important to note here that even though work by Orasanu and Jensen date back to the 1990s, and that many of the other references are hedging on being old news, their combined work continues to challenge and inform scholars in the 21st century. What follows are parts of a broader discussion on the theory of judgment.

PART 1: THE THEORETICAL MECHANICS OF JUDGMENT AND DECISIONS

Keeping in mind that the chief aim of this paper is to provide a bridge between theory and practice in judgment training, it is important to separate theory from practice and then knit it back together by the end. First, the reader will be treated to a section on the proposed theory of tensional meaningfulness as it relates to the valuation of decisions made while solving problems. To do this, brain biology, probability judgments (Venn diagrams), and the mechanics of attention and inhibition must be explained, at least partly. It is beyond the reach of this paper to thoroughly inform the reader of all that can be known about judgment and decisions within the purview of cognitive psychology, but some exposure is necessary if the end goal is to be attained. Second, the theoretical must be balanced with the experiential. Practical tips on how to design judgment training and how to properly assess judgment after training will be described and illustrated. As a start to this process, we need a skeletal framework upon which we can build theory and later practice. Orasanu (1993) and Mauro et al. (2001) have provided this framework.

In a chapter by Orasanu (1993), she listed three categories of decisions made by pilots in the cockpit as knowledge-based (ill-defined problems), knowledge-based (well-defined problems), and rule-based (condition-action rules)

(p. 138). Mauro et al. (2001) presented an alternative list some years later (analytical, associative, and codified).

There are some obvious pairings or logically intuitive agreements between the two lists. For example, analytical decisions can be paired with knowledge-based (ill-defined problems), associative decisions can be paired with knowledge-based (well-defined problems), and codified decisions are naturally paired to Orasanu's rule-based decisions. These pairings, put in display form, would look like Figure 1.

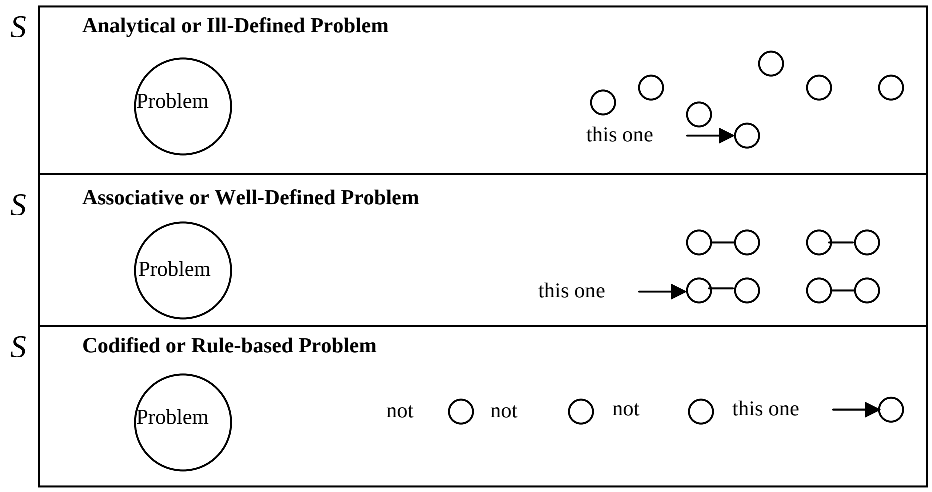

Figure 1. Category Pairings of Decision Types

Figure 1 is divided into three parts, separating each decisional category. On the left side of each division an *S* appears. *S* is the space within each rectangle. On the right of each rectangle there is a depiction of the logical induction; however, it is not a depiction of how an individual processes information or makes decisions based on judgment. It merely illustrates the three types of decisions that pilots make.

Judgment Development Though Tensional Meaningfulness

Pilot training in collegiate aviation programs has matured over the decades. Many of the enhancements made in pilot training have been the result of studies by behavioral and cognitive psychologists who have had a special interest in aviation and pilot training. They use a special vocabulary to explain phenomena that describe specific qualities or characteristics of each phenomenon. These phenomena have simpler names outside the scientific community, but in keeping with the protocols of technical writing, the use of special terms ensures accuracy. These special terms will be described in reader appropriate language to help prevent frustration.

One of these special terms is tension. Engineers appreciate the term as a means to describe load. Artists use it to describe balance within a painting. Sociologists use tension to describe effects of group interaction. But in this essay the term takes on a new meaning: one not found in textbooks.

Tensional meaningfulness is an invented term, and although it was not derived from studies in cognitive psychology, it can be explained by use of cognitive psychology. Without going into too much detail just yet, an illustration of tensional meaningfulness will have to suffice for now. Picture a flat surface upon which there is a thin layer of iron filings. Imagine laying a bar magnet on that layer of iron filings, such that the negative end of the magnet faces away from an opposing positive end of the magnet. If the experiment is done correctly, you should see what is depicted in Figure 2. What had been invisible becomes visible in the presence of the magnets. What had been a disorganized layer of iron filings, took on shape and significance when the magnet was placed on the filings. Tensional meaningfulness is what is between and around the bipolar magnet after it is placed on the iron filings.

Perhaps not so surprisingly, some diagrams of how judgment and decisions interact look like a magnetic field. Cooksey's Lens Decomposition Judgment model, displayed in a study by Bass and Radzio (2003) illustrates this point (Figure 3).

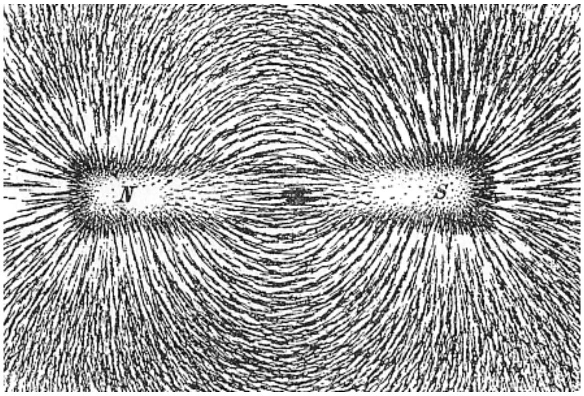

Figure 2. Magnetic Field Illustrated

It is interesting to note that the intervening cue utilizations and ecological validities have no meaningfulness unless put in relation to criterion and cues or judgment and cues, just like gender variables remain hidden until put in relationship to the opposition of the ideal masculine and ideal feminine.

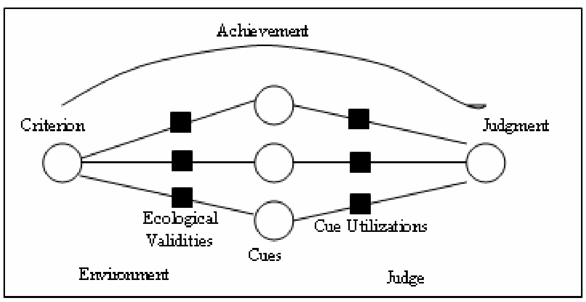

Figure 3. Lens Decomposition Model (adapted from Bass & Radzio, 2005, p. 76)

In tensional meaningfulness terms, judgment is what lies between two points in opposition: the decision to do something and the decision not to do something. Using the tensional meaningfulness expressed in the magnet illustration, suppose instead of iron filings there is a layer of knowledge laid to rest on the flat surface without organization. Suppose a problem is introduced, which Jensen(1995) described as problem vigil and recognition. Ultimately, the problem will be resolved correctly when it is properly diagnosed and when one decision can be distilled from all other possibilities. Put in opposition to each other, the tensional field is that which operates around and between two poles, which for the present can be represented as A and ~A. All things having to do with the problem can be found between A—the pole representing the one decision that is the very best decision—and ~A—the pole representing a decision that has nothing to do with any accurate solution of the problem, but which is just outside possibility. In tensional terms, A is the polar opposite of ~A (read “not” A). All that resides around and in between these poles are possible solutions, without any ordering as to effectiveness. Only judgment can differentiate between one possible solution and another possible solution. In terms of the detailed judgment model, this is the stage where alternatives are identified and risks assessed (Jensen, 1995, p. 37). If using the TSD model, all the steps having to do with rational judgment have been energized (Jensen, 1995).

Perhaps one of the most significant statements that will be made and supported in this paper is the statement that judgment is not decision. Judgment is the knowledge and ability that allows a person to intervene in the decision cycle and make a selection from all possible alternatives, as defined by A and ~A, with an apparent belief that this, and not another, possibility is the best for the moment. This theoretical approach will be explained further.

Quick Review of the Cognitive Process

Judgment development depends to a large extent on the raw materials in each student pilot: his or her intellectual ability in particular. Intellectual ability is not something one can change. One can *gild the lily*, with all sorts of academic achievement, but one’s intellectual ability remains steadfast (Gardner, 1999). Gardner believed, and still does believe that there are several types of intelligence, some being more conducive to careers in science and technology and others more conducive to careers in public service. However, no matter what a person’s intelligence is called, the unifying factor for all student pilots is brain biology, to include brain chemistry.

Based on neuroscience, the biological center of decision-making is largely controlled by the frontal lobe, just behind the forehead (Barkley & Grodzinsky, 1994). It has been called the executive control center by some, because incoming information from other parts of the brain eventually gets sorted out in the frontal lobe. Brain research examined by Goleman (1995) indicated that higher functions of the brain are engaged very quickly after initial excitation, when in the presence of an emotionally significant event.

For example, if a child falls into a backyard swimming pool, adults will jump in the water to save the child. The fight or flight mechanism in our brains causes immediate action. Save the child. Forget about how wet you will get or that your billfold is in your pants pocket. An individual can react immediately or pause long enough to shift to a higher reasoning ability. In the case of the drowning child, thinking about whether to jump in or not to jump in causes a delay in action and puts the child at more risk.

This also happens with pilots on the flightdeck. Emergency action is performed immediately with little or no thought. For example, pilots memorize bold face items that can be safely performed without any analysis, but which must be done to avoid a higher risk to life or property. However, if the pilot were to think about the situation, even for a few seconds, the bold face items might be delayed just long enough to cause a more severe risk. Non-normal, but not emergency situations often require a great deal of analyzing before arriving at the best solution.

The bioelectrical schematic of how the brain retrieves, organizes, judges, and forms a decision has not been empirically validated, but it has been theoretically expressed (Bass & Radzio, 2003; Jensen, 1995; Orasanu, 1993). A pilot can choose to attend to a stimulus (radio call, warning horn, airspeed indicator) or to inhibit it. The ability to selectively attend to or inhibit stimuli is of great concern to pilots and those that train them (Telfer & Biggs, 1988). When this ability is fractured or missing, the instructor must look for reasons why.

Persons with Attention-Deficit Hyperactivity Disorder (ADHD) are of special concern in this regard and more should be done to help student pilots who have been diagnosed and treated since childhood (Barkley, 1990). Although outside the purview of this paper to discuss in depth, the reader is invited to review important findings about ADHD and individuals diagnosed with this disorder in work by Barkley and Grodzinsky (1994), regarding the neuroscience of ADHD, and the hampered development of judgment in ADHD individuals, caused in part by a lagging growth of the frontal lobe (Aylward et al., 1996; Castellanos et al. 1996). It is better for the student pilot and the instructor if issues of judgment are discussed early on in training.

In recent years, some NASA Ames human factors researchers have focused on how pilots learn and retain information. They have looked at how memory affects decisions. Steve Casner has challenged the FAA's approach to Airmen General Knowledge testing, because pilots often memorize the answers to questions posted on the Internet and during a test they select answers that match what they have memorized. Casner has pushed for more in depth learning, rather than rote learning. Although his reasoning is on track, it will be difficult for Part 141 flight schools to shift to the in depth method.

There are three general types of memory: short-term, working, and long-term. Information refresh rates for short-term memory are about every 20 seconds, while refresh rates for long-term memory are measured in months or years or maybe the life of the host (Hubbard, 2000). Working memory is what is used for everyday task performance, and it is a marriage of short-term and long-term memory operations (Baddeley, 1999). In pilot training, it is the instructor's job to introduce the student to the uses of these types of memory, even though not mentioning them, and then to help the student pilot hone his or her skills of recall (Telfer & Biggs, 1988). As an aside, Telfer is still being referenced today, even though his work appears to be dated. His insights, as well as Biggs' insights, were not tied to one formula or one design, but were more practical and pilot-friendly.

Instructors play a vital role in judgment development, because they can select methods of instruction that build the student's memory (see Part 2 of this paper). Orderly development of long-term memory has a direct impact on how well a student pilot will do when the instructor is not around to field questions. From a constructivist point of view, the environment in which a learner is placed has an enormous influence on what is learned. Learning involves the constructing of meaning (Clark, 2005). Instructors have the ability to create the right environment and to assign meaning to the objects, events, and tasks that reside within that environment. These assignments of meaning can be grouped with other meanings to create a schema, or a collection of meaningfulness centered on a single subject (Anderson, 1996; Baddeley, 1999).

A schema can be a Gestalt—an indivisible pattern—but it is more likely to be an arrangement of objects of knowledge that freely attach themselves to each other and yet are not required to stay glued together (Anderson, 1996; Hawkins, 1987). This freedom to associate or disassociate knowledge elements is intuitively possible, but it is not yet empirically validated, by observing actual bits of knowledge move about in the brain. In lieu of actual observation, cognitive scientists have used many types of tests as a means to reveal how knowledge is acquired. Some of those tests have been in judgment training (Jensen, 1995).

The retention of special emergency procedures, say for takeoff, is one example of how pilots combine knowledge for a specific purpose, because it is not possible to discuss options when the emergency condition (engine failure at rotate speed) requires an immediate decision. To ensure a margin of safety even in the worst conditions, pilots memorize a sequence of productions, which Anderson (1996) called compositions or proceduralizations. Although Anderson's work has evolved over time, the general structure of cognition, in his view, is the same. Not only is the knowledge retained in long-term memory, it is ordered in a special way so that if the right cue were present, the pilot would automatically react. In the presence of the cue or the excitation, compositions in long-term memory flood working memory as if data were dumped en masse. Sense-making is already predetermined, because with the composition comes a complete environmental picture. This is why simulator training is required for most types of pilot learning.

As an individual builds knowledge and experience, he or she also builds judgment: the ability to make a choice that is nearer pole A or to make a choice that is nearer pole ~A. Good flight programs build knowledge and experience in an intentional way, similar to how most constructivists approach the learning environment (Clark, 2005). Information gained during pilot training is stored in three ways: for immediate use and then forgotten (telephone numbers, addresses, and radio frequencies), for use during an event and then partially forgotten (instrument approach altitudes and courses, or directions to a destination), and for use any time in the future (airspeed for slow flight, social security number, or mother's maiden name) and mostly unforgotten. As regards forgotten information, think of forgotten information as bits of knowledge disconnected from their meaningfulness as it was in the past. Since they have become disconnected from meaningfulness, they might not be recalled as in their previous sense-making state. For example, it may have mattered that you knew your locker combination when you were in high school, but when you did not need to remember it, the knowledge of the combination of numbers became disconnected from its relevance. For all practical purposes, it has been forgotten, even though in your brain's cognitive space it is very present.

During pilot training, student pilots acquire new knowledge, which can be stored in a very selective way, if the student, with the instructor's help, builds associations between previously acquired knowledge and newly acquired knowledge (Telfer & Biggs, 1988). For example, driving a car and taxiing an airplane to the runway are similar activities, since both require steering and following a pathway to a destination and both involve operating a vehicle. What has been learned in past experience while operating an automobile can be used or transferred by the brain to build new relationships, or new schema. With much practice, millions of prototypes, collections of memory (schema), can be created and stored for later use. In the presence of a problem, these specially created prototypes will present as the first options for problem solution if there has been sufficient practice beforehand. Figure 1 illustrates one view of how this might happen.

Having defined tensional meaningfulness, having given an operational definition to judgment, and having presented some of the more popular theories on how one arrives at the best decision, it is time to order the space between the opposing poles of A and ~A. So far, there is chaos. But, by using logic, Set Theory, and Venn diagrams, one can identify the poles, and all the intervening space.

Defining Cognitive Boundaries: Venn Diagrams

J. Venn's contribution to logical argumentation is the Venn diagram: a means to visually display logical arguments without the logical or mathematical notation normally associated with statistical representations of probability (Hays, 1994). Visually displaying a logical induction has its merits, as will be demonstrated.

A Venn diagram is a handy way to explain how one phenomenon relates to another phenomenon. In some literature, as in Hays (1994) and again in Dekker (2005), phenomena are events. All literature on Venn diagrams will have to address its basic principles, so newer literature is no more meaningful than older descriptions of this method. Hays is a statistician and Dekker is a cognitive psychologist. Both are constrained by Venn's illustrations. Both Hays and Dekker have found Venn's work helpful in debunking illogical thinking.

One concept that needs to be analyzed in depth is situation awareness. Often mistakenly assumed to be a single event, the term is actually an array of events which interact and change the end state of situation awareness. Venn's diagram and the helpful notation of set theory help give order to the chaos between A and ~A.

Situation Awareness Training. For example, if one wished to illustrate situation awareness (SA) as a Venn diagram, it could be presented as two concentric ellipses within a defined space resembling Figure 4. The larger ellipse is labeled ideal situation awareness and the interior ellipse is labeled actual situation awareness. A version of this same illustration is featured in Dekker's *Ten Questions About Human Error* (2005). Put in equation form (see Equation 1), and taking into effect that relationships are a factor (*f*) of interactions between events, situation awareness appears to be simply deduced. Whatever remains after subtracting *actual* SA from *ideal* SA, is a loss of SA—considering that the result is a factored quantity.

But Dekker does not agree with this description, for the reasons stated earlier. Situation awareness is not a single event, but at least 22 separate events (Dennehy & Deighton, 1997). Situation awareness is often associated with whether an airplane pilot is aware of his or her position relative to other entities within a column of airspace (Endsley, 2000). Since losing SA can be dangerous, pilots need to learn how to control all the events within the conceptual field of situation awareness. However, if training to mitigate the effect of SA relies on inaccurate presentations, as Equation 1 shows and Figure 4 illustrates, aircrew will be left without a means to improve SA. Trainers might need to revise their course objectives for situation awareness training, if lesson plans do not describe SA accurately.

Loss of SA = *f* (large ellipse – small ellipse) (1)

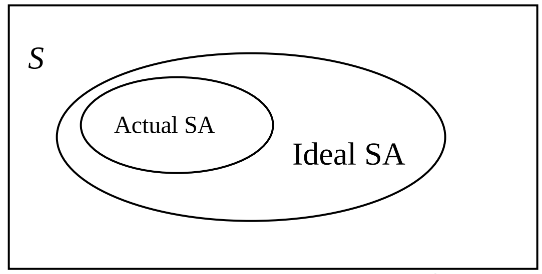

Figure 4. Venn Description of Situation Awareness (adapted from Dekker, 2005, p. 92)

Defining the Problem in Space S

Venn diagrams provide a simplified view of more complex interactions. To understand the more complex interactions, one needs to turn to Set Theory for help. Set Theory resides within the disciplines of Mathematics and Statistics. Statistical representations of Set Theory are more meaningful for this essay and will be used to describe the interactions between events. Probability Theory will be used to express ideas that are and are not present within a notional space. Set Theory has also been used to create categorical syllogisms, or logical arguments with statements of what is true or false. Logic is also represented in the following descriptions of events within a described space. This mathematical/statistical approach to training is different from many other decision-making approaches, because it has the capacity of depicting judgment as being both behaviorally descriptive and philosophically logical.

Whether one analyzes, associates, or just applies rules to solve a problem, all problems and their solutions occupy a finite space (Figure 5), within a larger space where all problems and solutions pertaining to piloting aircraft exist (Figure 6). The arrangement of problems in Figure 6 is not indicative of the way they really exist in our brain, but it does illustrate the notion that problems and their solutions can occupy space together.

Based on Probability Theory all problems and all solutions theoretically and probabilistically exist in the same space *S* at the same time. For each partition *P* within space *S*, space *P* = Ø (null set) and space *P* = *f* (*p*(A~A) or *p*(B~B) or…*p*(N~N)). Partition *P* also equals the factor (*f*) of the probability of the null set of each pairing (*p*(A and ~A) = Ø, *p*(B and ~B) = Ø, and so on to p(N and ~N) = Ø) (Colle & Reid, 1997). An objective truth is not known, only theorized to exist probabilistically.

Philosophically this theoretical approach does not necessarily confirm a realist's view of the material world, where there is an objective truth *out there* that only needs to be discovered (Dekker, 2005). Believing that there is *only* an objective truth would defeat the purposes of a Venn diagrammatic view of problems and their solutions, as illustrated in this paper. Although a *best fit* approach to problem-solving is often sought, problems seldom present in the same way as they did in the past, which forces trainers of pilots to present alternative solutions even to well-defined problems, in case events do not unfold as they did before.

Therefore, during any flight (space *S*) there is a probability that a problem (P_1) will occur or not occur ($\sim P_1$). If a problem (P_1) does occur, it will be solved by using what has already been stored in long-term memory. The orderliness of the solutions depends on how careful the instructor or classroom professor was in helping the students imprint proposed solutions, which can also be construed as part of judgment training. Orderliness is also dependent on an individual's past experience. Since it is difficult to assess exactly how students—in an earlier time—formed their solutions and stored them for later use, it is even more imperative for trainers to guide discussions about solutions to a problem, where each student has an opportunity to orally present his or her solution.

Several probability statements can be made about Figure 5. First, A and B and C are within space *P*, but are not space *P* (Hays, 1994). They do not exist outside the problem, but they also do not define the problem, only the solution possibilities. For well-defined, ill-defined, and rule-based problems, the problem and its solution are theoretically linked and exist in partition *P*. When a student is presented with a problem, he or she will apply the appropriate solution, if the event has been previously practiced; or if he or she is presented with a novel problem he or she will improvise, by trying alternatives until one solves the problem. Therefore, one can say that (A or B or C)$\sim P$; (p(A) or p(B) or p(C))$\sim p(P)$ (Hays, 1994). This notation directly affects test construction and will be discussed later in Part 2 of this paper.

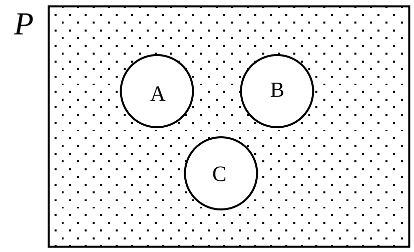

Figure 5. Problems/Solutions within Partition P_n within Space *S* as mutually exclusive (Space *S* not shown)

S

P_1	P_2	P_3	P_4	P_5
P_6	P_7	P_8	P_9	P_{10}
P_{11}	P_{12}	P_{13}	P_{14}	P_n

Figure 6. All Possible Problems Related to Piloting Aircraft (Partitioned) (Space *S* is shown)

Situation awareness, once again, provides a concrete example of how A, B, and C interrelate. Dennehy and Deighton (1997) *inter alia* listed, stress, workload, spatial awareness, and time perception as distinctive parts of SA. There is an expected interrelationship between these parts, but it is not always so. If A = stress, and B = workload, and C = time perception, then for partition *P* (the problem set), A or B or C can at one instance be separate events unrelated to SA, and at another instance be interconnected events directly related to SA (A and B and C). Theoretically, these events can simultaneously be related and unrelated to SA. If this simultaneity did not exist, then none of these sub-events could be examined as being separate and a part of SA. In judgment training, being able to discuss each sub-event helps students understand its significance and its relationship to other sub-events.

Second, all the solutions in Figure 5 are mutually exclusive, such that $p(A) \sim p(B \text{ or } C)$; $p(B) \sim p(A \text{ or } C)$; and $p(C) \sim p(A \text{ or } B)$ (Hays, 1994). The probability of space *P* is not A or B or C ($p(P) \sim p(A \text{ or } B \text{ or } C)$) (Hays, 1994). Problems must be differentiated from solutions, but there should not be an exclusion of either from partition *P*. It is just as important to declare that a possible solution is wrong as to declare that a solution is right, or the best. When a flight instructor takes the time to explain why other solutions are not appropriate, the student is learning how to discriminate among several options and is building judgment.

Complex solutions might involve the intersection of two possibilities (A and B, A and C, or B and C). This is particularly true for a proper analysis of situation awareness. In Figure 7 there is a combining of solution A and solution B in partition *P*, such that the intersection of A and B (AB) represents a solution that is not A (~A) and not B (~B), but a part of both. The remaining area not in the intersection can be presented as A and ~B or B and ~A (Hays, 1994). The skill of combining solutions to form a new solution must be first understood in the classroom and then practiced until thoroughly learned.

Situation awareness is a complex concept, and its very makeup is built upon interrelationships between events, such as stress, workload management, and time perception. Each event contributes a part of itself to a part of another event. Stress and time perception have a cause-effect relationship, where a perception of time causes stress and where stress causes a perception of time.

In Figure 7, relationships between events (A and B) appear to be formed by what A and B have in common and what A and B do not have in common. If a line were drawn between the center of event A and the center of event B, all possible relationships between A and B could be described using the theory of tensional meaningfulness. Where the line crosses the interrelated part shown as AB, one can expect to find the highest degree of fusion of A and B.

This tensional meaningfulness must be intentionally created during pilot training. Clark (2005) quoted from a study by Hamm, making the connection between experience and the intentionality of knowledge-building during that experience. The end points must be absolutely clear, and all the intervening events must be put in proper perspective to those end points. For example, during an icing scenario (no deicing boot or bleed air on the wings), where the pilot finds him or herself in icing conditions, he or she must make a decision. Staying in the icing conditions is not a good decision. Therefore, the decision to exit icing can be represented as a probability *p*(A) and the decision to stay in the icing and do nothing can be represented as a probability *p*(~A).

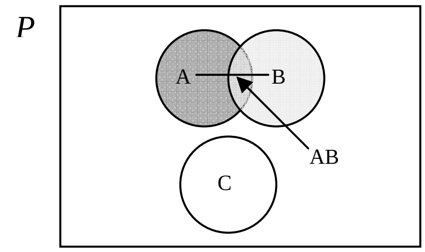

Figure 7. Combining Solutions

What the instructor needs to do is present the points in opposition (A and ~A) and then ask the student why one decision is better than the other. How the student explains his or her answer is the moment the instructor identifies judgment. Judgment in this example is neither A or ~A, but is an intervening element between the two.

Figure 8 illustrates how a trained pilot would approach a problem: in this case it is an icing problem. Before a problem exists, it is theoretically *out there*, out of sight and mind. As soon as it becomes apparent to the pilot that a problem exists, he or she will begin to form a solution, from an array of many solutions, all the while keeping in mind the nature of the problem. The problem (P_1) remains indistinct among all the events discernable during flight, until the point in space-time when the problem becomes conspicuous (salient), when the status quo of normal flight operations is interrupted and attention is drawn to the interruption.

Notice that after the intrusion, by identifying partition *P*, one can begin to test alternative solutions systematically for problem P_1. For each A and ~A decision, there is an intervening judgment that indicates why A or ~A was chosen. The same is true for all alternatives, such that B or ~B, C or ~C, and so on are all considered. By examining the judgment operating between each decision, the instructor can surgically remove erroneous thinking or implant proper thinking. In terms of the more complex architecture behind the act of deciding refer to Anderson (1996). Some of his examples, particularly elements of his Adaptive Control of Thought (ACT) process, follow similar logical patterns as those described herein.

One proposed way that the brain systematically accepts (attends to) or rejects (inhibits) possible solutions is illustrated in center-surround fashion, thoroughly explained in Dagenbach and Carr (1994). There are other proposed ways, such as parallel distribution theory, but for this paper center-surround will take precedence. As regards center-surround, the intrusion (P_1) takes center stage and all the alternatives are immediately placed around it, waiting for the individual to decide which solution remains and which solutions are rejected (Dagenbach & Carr, 1994). In Figure 8, the "after" part of the illustration shows the problem (P_1 from Figure 6) in the middle, surrounded by possible solutions. The efficacy (power to cause an effect) of a solution is tested in probability terms, such that for space P and problem P_1, the tension of p(A) or p(~A); p(B) or p(~B); p(C) or p(~C); p(D) or p(~D); and p(E) or p(~E) are all tested.

If the instructor pilot has properly trained his or her student pilots, they all should be considering the same number of alternatives and accepting or rejecting the same solutions. This can be verified in several ways. First, during a ground evaluation or a debriefing session, the instructor can ask the student to recall the steps that he or she would take if confronted with a problem, say icing. This oral interview is useful in that the student has all the time needed to fully explain what he or she would have done. The debriefing or ground evaluation method can also be conducted after a simulator session or flight in the airplane. Second, students can be assessed while performing in a simulator training session. The problem will appear at some point during the session and in real time the student will follow through with his or her solution to the problem. This type of assessment is better than the post hoc debriefing, since the level of extrinsic interference (freezing the problem) can be controlled.

The theoretical part of this paper has illustrated several key aspects of judgment training. Decisions, when placed in opposition, can reveal intervening judgment strategies that are neither polarized to one decision or its polar opposite decision. The illustration of the magnet and iron filings presented a good picture of how disorder (layer of iron filings) could be brought into order (magnetic field) in the presence of another set of objects (bipolar magnet). When a pilot is presented with a problem, apparent disorder in the brain suddenly becomes organized in the presence of oppositional factors such as A and ~A. In the presence of an icing problem, the decision to exit the icing condition (A) is weighed against its oppositional equivalent of staying in the icing condition (~A).

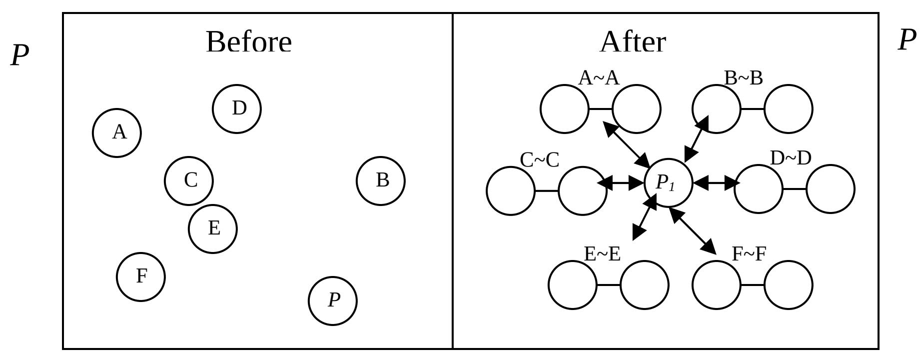

Figure 8. Problem Recognition at the Point of Salience

We also know that a properly trained student pilot will have the judgment to make decisions that are knowledge-based (ill-defined problem), knowledge-based (well-defined problem), or rule-based. If the instructor or professor has been careful about how he or she approached each decision type, judgment will have been developed in these three unique ways.

The second part of this paper translates theory into practice, giving the practitioner plenty of ideas on how to develop and assess the training. Each decisional type (Mauro et al., 2001; Orasanu, 1993) will be described in terms that instructional designers, flight instructors, and academic faculty will find handy when writing courseware.

PART 2: USING SET THEORY TO DETERMINE INSTRUCTIONAL CONTENT

Throughout the first part of the paper theory and practice were commingled intentionally. Theoretical equations are helpful, but plain

English descriptions are more helpful to the practitioner. Illustrations can be helpful, if they express an intuitive notion. The magnetic field illustration presented in Figure 2 needs little explanation. Venn diagrams look simple visually, but they can represent a complicated set of operations or probabilities. If you are an instructor, you are waiting to see a clear depiction of how theory can be translated into practice in the classroom or simulator training room or airplane.

What follows is a practical guide for course developers, flight instructors, and collegiate aviation professors. Orasanu's (1993) three categories of decisions will be used to differentiate between and among the approaches to problem-solving, judgment development, and decision-making. The theoretical equations for each decision type will be presented first, followed by the practical guide. Within the practical guide, the reader will find instructions for the classroom and simulator (if appropriate), suggestions for companion texts, types of testing, and testing strategies.

This practical guide is somewhat different from other instructional guides, in that it presents the logical progression of instruction in terms of probability statements and Set Theory. Other instructional methods, such as Dick, Carey, and Carey (2001) or that used by the International Civil Aviation Organization [ICAO] (1991)[1] use a systematic approach based on behavioral objectives, not cognitive objectives, such as are needed in judgment training.

Theoretical relationships can also be used to create test questions, and determine whether the correct and incorrect answers are logically presented: whether they are mutually exclusive.

Knowledge-Based (Ill-Defined Problem)

Theoretical Equations and Practical Guide. If space $S = p(P_1 \text{ and } P_2 \text{ and } \ldots P_n)$; and space $S = p({\sim}P_1 \text{ or } {\sim}P_2 \text{ or } \ldots{\sim}P_n)$; and space $P_1 = p(A{\sim}A \text{ and } B{\sim}B \text{ and } \ldots N{\sim}N)$; or space $P_1 = p(A{\sim}A \text{ or } B{\sim}B \text{ or } \ldots N{\sim}N)$ then:

- *Instruction Classroom*: Present as many problems as possible during the classroom portion of the course ($P_1 \ldots P_n$). Follow up with conditional statements (this problem will happen when…) ($P_1 = p(A{\sim}A \text{ and } B{\sim}B \text{ and } \ldots N{\sim}N)$). For each problem, have the class list as many solutions as possible. Next, present a scenario for one problem and have the students list alternative solutions (A~B~C~D~E…). Finally, have the students deselect alternative solutions that are not the best fit, but have the students explain why these alternatives are not the best fit.
- *Instruction Simulator*: Use these same problems as the underlying theme for simulator sessions during the lab portion of the same course.
- *Companion Text*: AC 60-22, ADM; Jensen (1995)
- *Testing*: Knowledge tests in classroom and practical tests in simulator (required)
- *Testing Strategies for Simulator*: Each student should complete several sessions, where various scenarios are used to probe the student's problem-solving ability. To determine judgment, use the debriefing to interview the student. Ask the student to explain why he or she chose a particular solution to the problem. Where the student's judgment is effective, reinforce this behavior. Where the student's judgment is ineffective, explain why his or her judgment was ineffective. If ineffective judgment is found, during the debriefing provide the student with an additional scenario (similar to the one experienced) and have them explain how he or she would solve the problem. Reinforce effective judgment.

Knowledge-Based (Well-Defined Problem)

Theoretical Equations and Practical Guide. If space $S = p(P_1)$; space $S = p({\sim}P_2 \text{ or } {\sim}P_3 \text{ or } \ldots{\sim}P_n)$; or space $P_1 = p(A{\sim}A)$; or space $P_1 = p{\sim}(B, C, D, \text{or} \ldots N)$ then:

- *Instruction Classroom*: Since the focus is on only one problem that has been observed and resolved in the past, instruction can be narrowly focused. Provide basic knowledge of the problem, perhaps from NTSB accident reports. Differentiate this specific problem from other problems that might overlap. Finally, describe the recommended best fit. During guided discussion, present a variety of scenarios where this problem is featured. Have the students apply the best fit solution to each scenario. Include the entire class.

[1] As of 2005, the 2nd edition of the Training Development Guideline was still current.

- *Instruction Simulator*: During simulator training, provide scenarios with only one major problem and only one best fit solution. During the debriefing interviews, discuss other scenarios that are similar and have the student provide a solution. Change the conditions of each scenario, so that the students have practice applying best fit solutions in different settings.
- *Companion Text*: AC 60-22, ADM; Jensen (1995)
- *Testing*: Knowledge tests in classroom, practical tests in classroom, practical tests in simulator.
- *Testing Strategies for Classroom*: Simple, well-defined problems provide an opportunity for testing in the classroom, because best fit solutions need to be reinforced. At the beginning of each classroom session, present the problem of the day. Have the students write down their solution. After the students finish their written solution, select several students to read their solution to the class. Where there are errors in judgment, the instructor can provide rationale for the judgment that best fits the scenario. Comprehensive testing in this way is too time-consuming and ineffective, since not all scenarios can be properly debriefed.
- *Testing Strategies for Simulator*: see Instruction Simulator.

Rule-Based (Condition-Action Rules)

Theoretical Equations and Practical Guide. If Space $S = p(P_1)$; or Space $P_1 = p(A)$ ~B or ~C or …~N then:

- *Instruction Classroom*: Rules, if not connected to a problem or scenario, are difficult to learn. Therefore, a problem (Condition) needs to be present, where the solution is the application of a rule (Action Rule). Studying rules without problems is not only boring, it is also ineffective. Where student pilots run into trouble in their judgment is when they do not see that a rule needs to be applied. For example, when a pilot is preparing for a solo cross-country flight, the rules say that the weather has to be checked, but there is nothing in real life that stimulates the knowledge of this rule. Therefore, provide the students with personal go/no-go checklists that incorporate rules with decisions needing to be made for any VFR or IFR flight. Many such checklists exist.
  Rules are often associated with their Part number from the Federal Aviation Regulations (FARs). The rule is more important than the Part number; however, where evaluators and instructors put an emphasis on memorizing Part numbers, you will have to spend extra time reinforcing this association.
- *Companion Text*: Title 14 CFR (FARs); Aviation Law text (Hamilton and Gesell discuss FARs in their texts); Jensen (1995).
- *Testing*: Knowledge-based, paper and pencil; matching; multiple-choice; *Simulator sessions are not required.*
- *Testing Strategies for Classroom*: If rules must be associated with actual references from the FARs, administer quizzes at the beginning and ending of every session where these rules are presented. Every week, start the class with a problem needing a rule applied. Have the students write down that rule and its reference. Collect the papers and grade them. Correct the papers and pass them back to the students. If a student failed to give the right rule and reference, make that student provide the correct rule and reference on a retake of the test. I suggest that these papers not be counted as part of the grade. At the end of the block of lessons on the FARs, give a test with a representative sample of those rules that most apply to flying by student pilots. When grading, do not offer the correct rule and reference if the student made an error. Make the student who erred provide the correct rule and reference. For rule-based learning, the student must always be corrected if an error occurs. Therefore, since following rules is imperative to safe flight, I suggest raising the minimum passing grade to 85. Any score below 85 will require the student to correct the test to 100%. Of course this scoring regime will need to appear in the syllabus and it will need some explaining. If there are questions, contact the author of this essay.

CONCLUSION

When complex terms are relegated to qualitative narrative, sense-making depends on the skill of the writer and the ability of the reader to understand what the author had intended. Cognitive psychologists have tried to depict the sequence of events, and the overlapping elements of decision-making for airplane pilots for better than three decades. Jensen (1995) and Orasanu (1993) were some of the earlier researchers who concentrated on how pilots make decisions. Much of what they have presented in academic journals has been built upon by others, but the more recent contributions have not substantially replaced earlier notions of judgment and decision-making.

This essay on the theoretical mechanisms of judgment training introduced tensional meaningfulness as a way to identify and separate judgment from decisions. It stated that if two poles of any problem could be identified (A and ~A), then all intervening expressions of solution, relative to the problem, could be examined and shown to be either closer to the best solution or farthest away from the best solution. The Set Theory expression of this relationship, when depicted as a Venn diagram, had shown two circles within a set space, with an overlapping area along the axis between the centers of each circle (Figure 7). The area combining circle A and circle B, or AB, described how the two events related; but the shared area also indicated the possibility that more than one solution could be found and implemented relative to any problem.

These findings were the basis for the development of a more practical guide for judgment training, found in Part 2.

Set Theory and Probability Theory could be used to more accurately describe complex concepts, such as situation awareness or complacency; and the logical progression of Set Theory would provide a means to systematically analyze course materials of all types.

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Beyond Pilot Error: The Effects of Corporate Culture and Individual Sensemaking at Acme Community Air Service.

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ABSTRACT

In this research study we examine the corporate culture of an aviation organization and how that culture and individual sensemaking influence flight crew safety decision-making in a less-than-optimal, high-workload environment. A quantitative methodology (content analysis) and two qualitative approaches (focused and individual interviews) as well as observation are employed in the study. We conclude flight crews clearly understand the corporate cultural expectations and that such expectations frame individual sensemaking and decision processes especially when crews are faced with mission variances. The research methodology used in this study provided the researchers a rich set of data that made clearer the link between corporate culture and individual decision-making processes.

BACKGROUND

Acme Community Air Service (ACAS), Inc.[iii] is committed to providing humanitarian assistance to over 400 million people representing hundreds of people groups. ACAS has a long and distinguished history of successfully creating lines of communications by employing aircraft to reach some of the world's most needy inhabitants in over 35 countries. These groups survive in some of the most inaccessible and inhospitable regions of Africa, Asia, Eurasia and Latin America. Many suffer under oppression and lack the most basic resources. It is among the world's neediest, the "unseen," that ACAS is making a difference.

ACAS's operations are most often conducted in foreign nations where crews and staff personnel fly, maintain aircraft, and live in environmentally harsh working conditions. To accomplish its mission, ACAS owns, operates, and maintains a number of smaller single and multi-engine aircraft permitting access to remote areas that would preclude operating larger turbo-jet aircraft.

ACAS has long recognized the need for a strong aviation safety program and, in 1977, began assigning trained safety personnel at the corporate level. Its safety program has evolved over the years and ACAS has done much to develop well-trained pilots, maintenance personnel, and staff.

The organization has also designated senior, experienced pilots as instructor pilots/safety officers in various overseas operational areas where they serve as both flight and maintenance safety supervisors. Additionally, their corporate safety department conducts regularly scheduled on-site safety audits of flight, maintenance, and ground safety operations throughout its many locations. The organization has created a notable standardization and safety communications system rivaling that of commercial aviation operators in the United States.

ACAS has also made significant safety progress by modifying its aircraft to increase accident survivability for its crews. These modifications include such new technologies as "crashworthy" crew seats, modified cargo restraint systems and the latest in communication and navigation equipment. Other strides include initial and recurrent training curricula and a pilot standardization program.

The organization's safety efforts have paid off. ACAS has enjoyed a notable decrease in its accident rate five years after it instituted its safety program. However, even with such a reduction, its accident rate has continued to be a significant factor negatively impacting its operations.

[iii] Acme Community Air Service is a pseudonym for the organization depicted in this research study.

ACAS Organizational Structure

Field personnel are directly supervised and report to a "Field Director," whose responsibilities include budget control, maintenance, flight operations and scheduling, housing, safety and security (for both operational personnel and their families), and planning. Field operations may include from one to five or more aircraft, pilots, mechanics, support personnel, and indigenous workers. ACAS has created local standardization instructor pilots and maintenance staff who also report to the field director. We have designated the Field Director as "Middle Management."

Field supervisors report to regional directors who oversee numerous field operations. These upper-level managers coordinate ACAS operations and ensure compliance with corporate goals, budgets and procedures and, in this report, are referred to as "Headquarters."

Accident Reporting at Acme Community Air Service

When ACAS began its operations in a Latin American country shortly after World War II, its first airplane contacted a small hut in a village during a landing roll-out. The company's accident report stated:

> This is primarily an accident report—not for the purpose of fixing "blame" such as is common in commercial and military circle[s]—but in order that all who are interested in this field might benefit with us from the experiences which have been learned the "hard way." (ACAS President, 1946)

The language and concept communicated in the report was well-ahead of its time and would have been an excellent model for any aviation organization to emulate. Unfortunately, just a few lines later under "Cause" the all-to-familiar "Pilot error" appeared in the report and ACAS has continued to blame the pilot "such as is common in commercial and military circle[s]" (ACAS President, 1946). Thus ACAS corporate imprinting (Pettigrew, 1990) helped shaped its corporate culture[iv], and, in particular, the lens through which its members view accident causation and how members regard the role of safety and production in ACAS.

Instead of looking to individual, or pilot "error," we propose that understanding what is communicated to ACAS flight crews with respect to organizational safety expectations (culture), how that message is understood by its flight crews in the context of their individual operational environments (schema), and how that understanding influences operational decisions under anomalous operating conditions (sensemaking) will provide a more insightful explanation of accident causation (Harris, 1994; Reason J. , 2002; Hofmann, 1998; Dekker, 2001; Vaughan, 1990; Hudson; Dismukes & Tullo, 2000; Helmreich, 1994; Helmreich, Wilhelm, Klinect, & Merritt, in press).

RESEARCH DESIGN

Clearly "safety culture" in any organization is an element of "organizational culture" in which individual organization members make sense of safety and production expectations. Helmreich contends that national, organizational, and professional culture contributes to, and is implicated in, aviation accidents and organizational culture is displayed in its "…attitudes and policies regarding punishment of those who commit errors, the openness of communications between management and flightcrew, and the level of trust between individuals and senior management" (Helmreich R., 2000, p. 134). We sought to understand, interpret and evaluate the ACAS safety culture and individual sensemaking from a communications perspective because "…organization sensemaking is accomplished…and displayed communicatively" (Pacanowsky & O'Donnell-Trujillo, 1982, p. 123) and "communication is a central component of sensemaking and organizaing" (Weick, Sutcliffe, & Obstfeld, 2005, p. 413).

[iv] The researchers adopt the definition of James, James and Ashe: "…culture is engendered by system values (and involves system norms)…" (James, 1990, pg 41).

Understanding ACAS members' sensemaking required analysis of significant organizational safety communications and how such corporate communications affect not only the "way things are done around here," but how "*I* perceive things *should be* done around here" (Harris, 1994; Pacanowsky & O'Donnell-Trujillo, 1982, p. 124; Hemmelgarn, Glisson, & James, 2006; Weick, Sutcliffe, & Obstfeld, 2005).

This required a unique approach and included employing the interpretive powers of two qualitative research techniques: focused and individual interviews, and a quantitative methodology; content analysis.

Content Analysis

ACAS accident reports are made available to all members of the organization after an extensive internal analysis has been made by the safety department and corporate recommendations have been approved by the ACAS president and senior management.

Content analysis was used to identify the intended ACAS corporate safety message represented in its published accident reports. Aircraft accident reports were chosen for analysis because they are the most widely disseminated, available to all ACAS pilots via the internet, and generate significant interest among ACAS flight crews. Additionally, ACAS accident reports demand high-level organizational attention and require senior management involvement in crafting the report. All accident reports, 113 between 1984 and 2004, were selected for analysis. These years were chosen because 1984 represented the greatest decline in the organization's overall accident rate and the year it appears that ACAS's initial safety emphasis began to make a significant difference. 2004 is the last year ACAS experienced an accident.

Procedure. A content analysis protocol and coding-sheet (Appendix A) was developed by the researchers to analyze all 113 ACAS aircraft accident reports (Fiffe, Lacy, & Fico, 1998). Five analytical and administrative categories were selected and defined for analysis. The five concepts selected for study included accident attribution, mission pressure, recommended corrective action (from the organization's perspective), the importance of the flight or mission, and determination of the report writer's clarity.

Six volunteer raters analyzed the accident reports. The volunteers were trained using the protocol and coding-sheet. When the training was complete, the raters were each asked to analyze the same two randomly selected ACAS accident reports using the coding-sheet. Results from their analysis were evaluated using Krippendorff's Alpha-Reliability for inter-rater reliability (IRR) (Hayes & Krippendorff). The raters achieved an IRR 91%.

Results.

The content analysis of ACAS accident reports was revealing. Of the 113 accident reports analyzed, individual pilots (pilot error) were singled out in 49.6% of the accidents (Table 1). The reports did not hold ACAS headquarters accountable except in combination with middle management and the accident pilot and these accounted for less than 3% of the total. The total number of accidents in which the pilot was fully or partially blamed represented 79.6% of the total and when accidents attributable to external conditions or where causes were "unknown" (17 accidents) were disregarded in the total, that percentage increased to 93.8% (Table 2).

Although ACAS headquarters most often assigned "pilot error" as the causal factor in its accident investigations, the accident reports attributed most of the pressure to carry-out assigned flights to middle management (Table 3).

Who should be assigned responsibility for correcting unsafe acts, ensuring proper compliance with SOP standards, and reallocating resources to mitigate error? ACAS looks to its flight crews and local management to make corrections (Table 4).

Although ACAS headquarters controls all resource allocations for the organization, and the most senior and experienced flight instructors and flight crews are found at its center of operations, ACAS required those on the "pointy end of the spear" to solve problems that might be better addressed by organizational decision-makers in a position to provide appropriate resources and guidance.

Table 1. *Accident Attribution*

Accident Attribution				
Grouped Findings	Percentage	ACAS Accident Report Findings	n	Percentage
Flight Crew	79.6	Pilot	56	49.6
		Pilot & Operating Conditions	22	19.5
		Pilot & Middle Management	10	8.8
		Pilot, Middle Management & Headquarters	2	1.8
Management	5.3	Middle Management	5	4.4
		Middle Management & Headquarters	1	0.9
External Factors	8.8	Operating Conditions	10	8.8
Unknown	6.2	Unknown or Undiscernable	7	6.2
		Total	113	100.0

Table 2. *Accident Attribution*

Accident Attribution				
Grouped Findings	Percentage	ACAS Accident Report Findings	n	Percentage
Flight Crew	93.8	Pilot	56	58.3
		Pilot & Operating Conditions	22	22.9
		Pilot & Middle Management	10	10.4
		Pilot, Middle Management & Headquarters	2	2.1
Management	6.3	Middle Management	5	5.2
		Middle Management & Headquarters	1	1.0
		Total	96	100.0

Table 3. *Mission Pressure*

Mission Pressure				
Grouped Findings	Percentage	ACAS Accident Report Findings	n	Percentage
Management	94.7	Middle Management	100	88.5
		Middle Managemt & Pilot	5	4.4
		Middle Management & Operating Conditions	1	0.9
		Headquarters	1	0.9
Flight Crew	3.5	Pilot	3	2.7
		Pilot & Operating Conditions	1	0.9
Unknown	1.8	Unknown or Undiscernable	2	1.8
		Total	113	

Table 4. *Required Corrective Action*

Required Corrective Action				
Grouped Findings	*Percentage*	*ACAS Accident Report Findings*	*n*	*Percentage*
		Pilot	10	8.8
		Pilot & Middle Management	51	45.1
		Pilot, Middle Management & Headquarters	22	19.5
Flight Crew	75.2	Pilot, Middle Management & Operating Conditions	1	0.9
		Pilot, Middle Management, Headquarters & Operating Conditions	1	0.9
Management	21.2	Middle Management	16	14.2
		Middle Management & Headquarters	7	6.2
		Headquarters`	1	0.9
Unknown	2.7	Unknown or Undiscernable	3	2.7
Missing		Missing	1	0.9
		Total	113	

Since all ACAS accident reports are generated from the headquarters (with field input), it's not surprising that, Headquarters requires itself to be part of the corrective action in only one of the recommendations and seven others when combined with middle management.

ACAS headquarters, however, is in a better position to guide production expectations and give priority to the allocation of resources that would contribute to a safer operational system and thus better support safety in the field. ACAS's current managerial approach ignores leadership responsibility for maintaining a safe system and may overlook and/or contribute to latent systemic threats.

The message is clear. As reflected in its accident reports, ACAS's cultural norm or organizational expectation is that blame for mishaps lies principally with its pilots and middle management. This organizational expectation is consistent with the philosophy of its founders and has been repeatedly reinforced over the years through its accident reports.

ACAS field employees should anticipate that if they are involved in a mishap, they will be blamed, and the organization will expect them and their field manager to "solve the problem." Though the SOP may state that implementation of "safety programs, practices and oversight" is the responsibility of ACAS management, the organization's actions define "management" as the accident crew and first level supervisor.

A third cultural expectation is that resources required for maintaining a safer operational environment must be generated at the lowest organizational levels. This is evidenced by its requirement that organizational safety program failures (accidents) be addressed and solved at the field level. This cultural "norm" is further reinforced by the lack of ACAS headquarter support for common industrial safety equipment as well as the organization's inattention and inability to defend against, trap, or mitigate the effects of even the most fundamental threats to worker safety.

SENSEMAKING

Simply put, sensemaking is an individual "making sense" of situational anomalies occurring in organizational life. Sensemaking aids in managing ambiguity, allowing "interdependent people [to] search for meaning, settle for plausibility, and move on" (Weick, Sutcliffe, & Obstfeld, 2005, pg 419; Dougherty & Drumheller, 2006; Mills & Weatherbee, 2006).

How do ACAS flight crews make sense of organizational norms when carrying out operational flights? It can be argued that any routine commercial flight operated in highly-developed aeronautical systems, under familiar operating conditions, and with the best of pre-flight, enroute and post-flight resources, is unique and poses unique and diverse threats to crew safety. However, ACAS crews most often operate in non-RADAR environments without the advantages of weather reporting systems while performing takeoff and landing operations on undeveloped landing strips that require specialized training. Mission variance and in-flight irregularity is the norm. Each crew must not only consider individual aircraft capabilities, his or her own physical state, but make sense of a constantly changing in-flight environment especially when unknown or un-forecast weather conditions are encountered or aircraft abnormalities unexpectedly occur.

Under such circumstances, how do crew members make sense of ACAS organizational mission and safety requirements? How organizational culture affects sensemaking requires, according to Harris, recognizing the role individual schemas play in sensemaking. Schemas are those

> …dynamic, cognitive knowledge structures regarding specific concepts, entities, and events used by individuals to encode and represent incoming information efficiently. Schemas are typically conceptualized as subjective theories derived from one's experiences about how the world operates that guide perception, memory, and inference (pg 310).

Harris identifies five culturally relevant schemas[v] that guide individual interpretation of external organizational cues. Such cues can have common interpretations among groups because of shared experiences, well-organized lines of communications, and because "individuals value the ability to predict and understand their circumstances that a shared conception of reality makes possible" (pg 313).

ACAS FOCUSED AND INDIVIDUAL INTERVIEWS

How crew members perceived the ACAS corporate safety message was accomplished through focused and individual interviews. This methodology was chosen because the crew members are not only intimately acquainted with ACAS culture, they have shared corporate knowledge, understanding and experiences. Members of focused interviews can be stimulated to share personal observations and experiences by other members and, through discussion, mutual support as well as deliberation, can reveal shared schemata (Merton, Fiske, & Lendall, 1990; Morgan, 1997; Lindlof, 1995, pg. 3).

While focused interviews are clearly an excellent qualitative method, they may create an "unnatural social" setting for the participants. Such an environment may suppress individual members' willingness to share opinions and experiences. In order to mitigate any group member inhibitions, we also conducted individual open-ended interviews. Employing both methodologies facilitated cross-referencing and data triangulation (Morgan, 1997).

ACAS employs 176 flight crew members. We conducted five focused interviews representing large, medium and small operations located in three national sites. The interviews were attended by current ACAS flight crew members and represented a sample population of 42 (24% of the total ACAS flight crew population). The researchers were limited to particular geographic areas and could only travel with ACAS personnel during headquarters scheduled visits. The sample population, therefore, was chosen based on a non-probability, convenience sampling technique (Creswell, 2002, pg. 167).

The focused interviews represented bases of operations ranging from one pilot and aircraft to ACAS's largest operation employing numerous pilots, support personnel, and aircraft. One focused interview was conducted at the ACAS United States Operations Center (USOC) during a scheduled pilot-refresher training course. All interviews were taped (with the permission of the participants) and transcribed. All participants were promised anonymity and understood that any identifiable comments would not be shared with ACAS administration. All interview transcriptions were de-identified.

Three other focused interviews were conducted at ACAS headquarters. The first was

[v] Self Schemas (self-in-organization), Person Schemas ("other" person(s)-in-organization), Organization Schemas (cultural manifestations in groups of others), Object/Concept Schemas (organizational semiotic communication), and Event Schemas (event-in-organization) (pg 311-313).

with ACAS senior administrators and the second was with a class of newly recruited pilots while the third interview involved the new pilots' spouses. The newly hired pilots and their spouses had just completed most of the ACAS indoctrination class and had not yet been assigned to a field of service.

Procedure. An interview guide was created prior to the first focused interview and was consistently used throughout subsequent interviews. Four criteria[vi], developed by Merton et. al., for conducting an "effective" focused interview were used to develop the interview guide (1990, pgs. 11-12; Morgan, 1997, pg 45).

Transcripts were coded using the NVivo 7 qualitative data analysis program (QSR, 2006). The software allowed the data to be analyzed employing a cross-case strategy and easily permitted either a variable-oriented or case-oriented analysis. This approach made it easier to understand, generalize, and explain the data (Miles & Michael, 1994, pg. 173).

While the unit of analysis for focused interviews is generally considered the "group," it can be argued that such analysis must also consider the relationship and interchange between group members. In other words "…we must recognize not only that what individuals do in a group depends on the group context but also that what happens in any group depends on the individuals who make it up" (Morgan, 1997, pg 60). Morgan further argues that the three most common focus interview coding methodologies[vii] are "…actually nested within each other because coding all mentions of a topic will also determine whether that topic was mentioned by a specific individual or in a particular group" (pg. 60).

Since the goal is to understand, from the flight crew's perspective, how crews conceptualized what is important to ACAS as it related to flight operations and safety (culture), the focused interview, then, is particularly useful in that it reveals not only individual, or "self schemas," but provides the researchers with insight to "person schemas" (person(s)-in-organization) and "organization schemas" (Harris, 1994, pg 312). If such schemata are common to groups, then they represent "shared experiences and shared exposure to social cues regarding others' constructions of reality" (pg. 313) and become manifestations of corporate culture.

RESULTS

Why ACAS? When operational pilots in focused interviews were asked to describe why they considered and ultimately chose to work for ACAS, their responses were reduced to the following four categories:

1. ACAS Operates Safely
2. ACAS Cares For Its Staff
3. ACAS's Purpose
4. ACAS Operates Technologically Advanced Aircraft

Of these categories new pilots and their spouses (two focused interviews) mentioned their belief that ACAS operates safely 49 times during the interviews (pilots: 32, spouses 17) while experienced ACAS pilots and the those in senior management (four focused interviews) spoke most about ACAS's purpose, or mission, as being their reason for choosing ACAS. (Tables 5 & 6)

Safety at ACAS. When asked to describe safety and ACAS, groups framed safety in terms of flight and the ACAS mission. Organizational cultural issues as well as organizational communications were also topics of discussion among the groups.

Safety and Mission. Tension between safety and mission at ACAS generated most of the responses in both the pilot's groups and senior management while among the new pilots it wasn't mentioned at all.

[vi] An effective focused interview involves: 1) Range—allowing interviewees freedom to explore a large scope of subjects. 2) Specificity—provides specific data. 3) Depth—creates a climate that reveals the participant's meanings and perspective. 4) Personal Context—the context in which personal beliefs and perspectives are revealed.

[vii] Coding: 1) All mentions of a given code. 2) Individual participant mention of a given code. 3) Group mention of a given code (Morgan, 1997, pg. 60).

Table 5. *New Pilots and Spouses. Why Did You Choose ACAS?*

New Pilots and Spouses Focus Interview Groups: n=2		
Data Reduction	Responses (n)	**Percentage**
ACAS Operates Safely	49	80.3
ACAS Cares For Its Staff	4	6.6
ACAS's Purpose	7	11.5
ACAS Operates Technologically Advanced Aircraft	1	1.6
Total Responses	61	100.0

Table 6. *ACAS Senior Management and Pilots. Why Did You Choose ACAS?*

ACAS Senior Management and Pilots Focus Interview Groups: n=4		
Data Reduction	Responses (n)	**Percentage**
ACAS Operates Safely	1	2.3
ACAS Cares For Its Staff	3	6.8
ACAS's Purpose	39	88.6
ACAS Operates Technologically Advanced Aircraft	1	2.3
Total Responses	44	100.0

Table 7. *ACAS Pilots - Safety at ACAS*

ACAS Pilots (Three Focus Groups)		
Data Reduction	Responses (n)	**Percentage**
Safety and Mission	70	57.4
Organizational Culture	49	40.2
Organizational Communications	3	2.5
Total Responses	122	100.0

Table 8. *Senior Management - Safety at ACAS*

Senior Management		
Data Reduction	Responses (n)	**Percentage**
Safety and Mission	41	65.1
Organizational Culture	13	20.6
Organizational Communications	9	14.3
Total Responses	63	100.0

Focus groups described safety and mission (organizational purpose) in terms of "tension" or "pressure." Tension was mentioned 18 times in descriptions of flight operations, resources, and safety and, within the same context, pressure was expressed nine times. Many pilots expressed their opinion that the conflict between operational requirements and safety were rooted in a lack of resources and local budget concerns. Likewise, fatigue was correlated by some of the participants with scarce resources.

Not all agreed. Some believed that tension between operational necessity and safety was "healthy" while others expressed the tension or pressure as an internal phenomenon.[7]

Mention and discussion by the participants of tension and mission pressure, whether internal, external, or "healthy" demonstrates Harris's "self schemas," "person schemas" (person(s)-in-organization), and "organization schemas" that fit the corporate cultural message transmitted in ACAS accident reports. The accident reports reinforce the fact that the ACAS Corporate offices will hold local (field) units accountable for deviations from its SOP and, according to the pilots we interviewed, perceive that ACAS is placing them in a position that creates pressure to get the job done and do so without error. In the words of two pilots:

> (Focused Interview) I agree with the fact that as technicians and we basically are task-oriented people and the pressure to get a job done is there for sure. I think just in the type of personalities that lend themselves to being [humanitarian] pilots. You've got a child out there that's burned or whatever and you may push yourself into a situation that you might not normally put yourself into, just based on the fact that you want to help and serve, you want to… I'm not saying that that's all that bad really…Well maybe the situation needs to be pushed because it is an emergency. You did what you could do up to the limits of both your understanding of your limitations and the aircraft's limitations and as far as the limitations that we have placed upon us by ACAS, you can go right up to those limitations and still try to, you know…. But you do get pushed (Johnson & Stobbe, 2005).
>
> (Individual Interview) And there are all kinds of different…pressure[s], and some of them are invented by us, some of them aren't. Sometimes we come up with our own internal pressures… "Well, it'd be really nice if I could do this," for example "I've already done 8 landings, and I'm going to be squeezing it in today if I get this done, but if I take this extra 50 kilos now, then I wouldn't have to come back here in the afternoon, and that would cut me down to 6 landings, and then I know I could make it home easy (Johnson & Stobbe, 2005).

Most ACAS pilots we interviewed are motivated to complete assigned missions and they are well-aware of the risk, challenging operational flight conditions, and ACAS's humanitarian purpose. Their desire to accept the risk and challenge works itself out into a "can do" attitude that is amplified by ACAS's cultural norm of personal as opposed to organizational responsibility and accountability. (Table 6)

Reinforcing cultural norms of "mission" and "safety" as separate or mutually exclusive concepts creates tension as flight crews attempt to balance conflicting requirements. Clearly both are required to effectively and successfully complete individual missions and ensure the long-term viability of ACAS, however, ACAS pilots we interviewed were quick to explain to us; "Safety is important," but then, "…you've got a flight ahead of you that's been scheduled, you're expected to do it, um, that's what you're there to do, so it's go, go, go, get it accomplished, let's get the task done, do it well" (Johnson & Stobbe, 2005).

Such cultural norms are indicators of what Westrum would term a "Bureaucratic" culture. Bureaucratic organizational cultures tend to reduce responsibilities for misadventures at the lowest bureaucratic levels and require that solutions and fixes be completed at the same level. A healthier approach represented in a "Generative" or high-reliability organization,

[7] De-identified responses are available from the researchers.

tends to view such accidents as systemic failures requiring organizational support (Reason, 2002, pg. 38; Westrum, nd.).

Senior ACAS administrators described organizational "tension" in terms of budgets and personnel resources as well.[8] Such pressure is communicated throughout the organization and creates additional stressors on pilots operating in the field. At the same time most senior administrators believed that pilot standardization, training, and reinforcing SOP requirements would mitigate the additional organizational pressure placed upon individual pilots and local ACAS managers. Senior ACAS decision-makers clearly place not only decision-making authority at the field level; they hold field managers accountable as though they are separate corporate entities while providing little management training or support.

Comments made during the senior management focused interview summed up ACAS Headquarters perspective on responsibility and accountability and the organization's belief that an appropriate and effective safety program can and should be built around its SOP.

> But we try to do it exactly and it's unavoidable [tension]. I don't think you were here … when we talked about a pilot that's in a war situation, has a lot [of] tension, but there is still an expectation that they have to fly. Our challenge is to equip them [ACAS Pilots] in order to manage the tension and equip them for that.
>
> I remember a communication that came out from the presidents' office following an accident. And it had a statement [emphasizing following SOP guidelines]. And I think some of our guys were thinking, "I know the book says this, but to get the job done I really got to push that aside even though, even though the conditions are favoring for it."

> The [ACAS pilots] will operate by the [SOP]…, or they won't be operating. So that kind of broad statement covers everything but how it is communicated? It's communicated from every level hopefully consistently the same message. That we want to standardize, we want to keep you guys safe.

Operating guides and SOPs are important and foundational to any organization and the message that ACAS wants to "keep you guys safe" is appropriate. But relying on written standards and a standardization program alone may create what Reason would label "Dangerous Defenses"—defenses that actually "set-up" organizational failure and do little to focus investigation on latent systemic threats and underlying causes of accidents (1997).

CONCLUSION

What's important to ACAS? Simply put, it's "Mission first." How does this corporate cultural norm work itself out in how individual crew members make sense of corporate expectations? Based on focused interviews, ACAS pilots understand they are responsible for carrying out the mission and there is little tolerance for deviations, mishaps, and accidents. This is an organizational, or ACAS cultural norm and it is clearly communicated through its accident reports and understood by its pilots. From senior management to pilots in the field, schemas and cultural expectations are congruent and consistent. Such corporate expectations are not evident in the new pilots we interviewed. In fact tension between "mission and safety" was not a topic of discussion among the ACAS nascent aviators. As these new pilots become acculturated it is likely the organization's culture of "mission first" will become salient and cue personal schemata of service (Table 5) creating the "tension" that currently exists in ACAS flight crews and senior management (Harris, 1994, pg 314).

Organizational stressors[9] such as tension (conflicting safety and mission expectations), conducting flight operations in less-than-optimal conditions (although typical for ACAS pilots), and requiring its flight staff to perform

[8] De-identified responses are available from the researchers.

[9] Stressors are rooted in organizational culture and, depending upon the individual, may create stress (Beehr, 1991).

additional organizational duties contributes, in varying degrees, to individual stress and fatigue. Both stress and fatigue are implicated in poor in-flight decision-making, incidents, and accidents (Trollip & Jensen, 1991; Orlady & Orlady, 1999; National Transportation Safety Board, 2002; Aarons, 2003; Human fatigue bigger risk to safety than realized, 2004).

ACAS flight operations most closely parallels corporate flight operations. A NASA study, "Crew Factors in Flight Operations XIII: A Survey of Fatigue Factors in Corporate/Executive Aviation Operations" reported that corporate pilots described slow reaction times, decreased alertness, loss of situational awarness, and slowed perception were the results of fatigue. What were the factors that caused fatigue in the corporate flight world? Long duty days, multiple flight segments, and workload were some of the issues raised by corporate pilots. Corporate pilots do not have the added stress of flying into and out of primitive grass airstrips (often more suitable for helicopter operations) as do those working for ACAS. Most executive flight crew are housed in up to date, air-conditioned offices with modern equipment. Yet these same flight crews reported that additional duties including aircraft maintenance, flight planning, dispatch duties, and baggage handling created flight-crew fatigue (Rosekind, Co, Gregory, & Miller, 2000). Such duties are carried out by ACAS personnel as well and, in addition, they may be charged with hangar and personal housing maintenance, base supervisory oversight, information (IT) and communications maintenance, and administrative duties (Johnson & Stobbe, 2005).

In the words of one accident pilot:

> No, I'd say [the work days] were pretty average as far as working here in the hangar. My problem is that I'd get home having received a couple of [requests] from [customers] whose email wasn't working…Ok, for the month of June, I think it was, the accident was in the beginning of August, but for the month of June we had two information technology interns here that were supposed to come… the initial idea was for them to come and install a new HF radio email system. Well, as it turns out they were only going install a new phone email system and we don't… I think we had nine users, all of us plus two [customers] in town, and it involved learning a whole new system – a Linux system. And so I had to do study time and work time with them on the [IT] hub, during the day and so there were days when I didn't fly and had to do that. I did make some flights bringing these guys out to some stations where they could check the software and install some new stuff and see if they could get the HF [high-frequency] system going better. And those flights went well. I dealt with some weather on a couple of them and didn't have any problems with that. I felt that my flying was good. I didn't feel that I was cutting anything short or hanging on by a thread or anything like that. But I do admit that I was getting tired, especially the week before the accident and there were I think there were three nights that I was up to 11 o'clock or later working on the system (Johnson & Stobbe, 2005).

"The role of workload in fatigue is complex," NASA reported, "and not clearly defined. However, anecdotal evidence and common sense suggest that higher workloads by contribute to fatigue, particularly over the course of a long duty day" (Rosekind, et. al, 2000, pg. 21).

"Pilot Error," most often the conclusion of ACAS aircraft accident investigators, ignores the effect of corporate expectations placed on flight crews. ACAS expectations (production and safety) are clearly understood by its crews and when those crews are faced with decisions that impact those expectations, ACAS should anticipate most of its crew members, based in individual sensemaking shaped by those cultural expectations, will make choices that place mission ahead of safety.

APPLICATION

The qualitative and quantitative approaches used in this research study have application both in aircraft accident investigation and, more importantly, before such accidents occur. Our methodology sheds light on the effect of corporate culture and how that culture is communicated and interpreted by its crewmembers. This proactive approach provides decision-makers with the tools they need to make appropriate and responsible safety and production decisions while identifying systemic errors that set crews up to fail that are often masked by the all-to-familiar “pilot error.”

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APPENDIX A

Content Analysis Protocol

Introduction

This is a content analysis of the published accident reports of Acme Community Air Serve (ACAS) from 1982 to 2001. We want to understand where ACAS typically places responsibility for its aircraft accidents. The following definitions are important in selecting and analyzing the content under study.

Procedure

1. *Source:* Code this field with the last two digits of the accident year followed by a dash (**-**) and the report number. For instance report 7 for 1983 would be coded 83-7.

2. *Accident Attribution:* For the purpose of this study, accident attribution refers to responsibility for the accident. Responsibility is defined as: Answerable, accountable (to another for something); liable to be called to account. Accident attribution has four possibilities; the crew member, ACAS middle management (Field Director), ACAS Headquarters and/or conditions beyond the control of ACAS such as un-forecast weather. Attribution of responsibility may be placed in one or more of the categories.

    a. *Total* means total responsibility can be placed in that category.
    b. *Partial* denotes responsibility can be divided among more than one category.
    c. *Unknown* signifies that the accident report does not clearly attribute responsibility to any category.
    d. *N/A* means the accident report clearly does not attribute responsibility to any category.

3. *Mission Pressure*. Mission is defined as; A task which a person is designed or destined to do; a duty or function imposed on or assumed by a person; a strongly felt aim or ambition in life. Also; determined to achieve a goal, complete a task, fulfill an obligation, etc. Pressure means the action of moral or mental force, or of anything that influences the mind or will; constraining influence; to bring pressure (to bear): to exert influence to a specific end; to bring (or put) pressure on (someone): to urge or press (someone) strongly in order to persuade.

    Mission pressure then describes the real or perceived pressure, from ACAS management or the pilot, to begin, continue and/or complete the assigned mission. Assignment of the source of pressure can come from four possible sources; the pilot, ACAS middle management, ACAS Headquarters and/or conditions beyond the control of ACAS such as un-forecast weather. Attribution of may be placed in one or more of the categories.

    e. *Total* means 100% of the mission pressure can be placed in that category.
    f. *Partial* denotes mission pressure can be divided among more than one category.
    g. *Unknown* signifies that the mission pressure cannot be clearly attributable to any category.
    h. *N/A* means the accident report clearly does not consider mission pressure.

4. *Corrective Action.* These are recommended actions to be completed by either the pilot, middle management or ACAS headquarters (includes ACAS Safety Department). The report may suggest actions be completed by more than one level of management. Such required actions are generally listed under "recommendations" in the accident report.

i. *Total* means that category is to complete all recommended actions.
j. *Partial* denotes the report requires more than one category to complete corrective action(s).
k. *Unknown* signifies that required actions cannot be clearly attributable to any category.
l. *N/A* means the accident report clearly does not require corrective actions. e.

5. *Mission Importance*. Code this according to the purpose of the flight.
   m. *Administrative*. Means the flight is in support of ACAS operations. Examples would include flights to transport ACAS officials and visitors, transport supplies and maintenance flights.
   n. *Training*. Pilot proficiency, check rides and in-country checks fall into this category.
   o. *Routine*. Scheduled ACAS flights in support of customers, government or indigenous peoples.
   p. *Emergency*. Emergency flights for medical or political reasons.

6. *Writer's Message*. Was the accident report:
   q. *Clear*. Easy to understand, fully intelligible, free from obscurity of sense, perspicuous.
   r. *Ambiguous*. Admitting more than one interpretation, or explanation; of double meaning, or of several possible meanings; equivocal.

Pilot (PT)	**1**
Middle Management (MM)	**2**
ACAS Headquarters (MH)	**3**
Operating Conditions (OC)	**4**
PT + MM	**5**
PT + MH	**6**
PT + OC	**7**
PT + MH + OC	**8**
PT + MM + MH	**9**
PT + MM + MH + OC	**10**
MM + MH	**11**
MM + OC	**12**
MM + MH + OC	**13**
MH + OC	**14**
UNK	**15**
N/A	**16**

1. **Source** ____________________

2. **Responsibility**

	Total	Partial	Unknown	N/A
Pilot				
Middle Management				
ACAS Headquarters				
Operating Conditions				

3. **Mission Pressure**

	Total	Partial	Unknown	N/A
Pilot				
Middle Management				
ACAS Headquarters				
Operating Conditions				

4. **Corrective Action**

	Total	Partial	Unknown	N/A
Pilot				
Middle Management				
MAF Headquarters				

5. **Mission Importance**

Administrative	
Training	
Routine	
Emergency	

6. **Writer's Message**

Clear	
Ambiguous	

An Application of High Fidelity FTDs for Ab Initio Pilot Training: The Way Ahead

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ABSTRACT

Decreases in simulation costs and increases in aircraft training costs led to the need for further investigation into the application of simulation-based training. Researchers conducted an eighteen-month study using ab initio student pilots as participants. This study applied a Federal Aviation Administration (FAA) approved, Part 142, flight-training curriculum that included 60% flight training device (FTD) use. Researchers identified five causal factors that warranted further investigation. The causal factors identified were visual fidelity, procedural similarity, dynamic flight environment, difficulty of task, and visual scanning and response. These causal factors have the potential to affect transfer of training (ToT) from simulated flight to aircraft flight. Steps are being taken to optimize training while considering the causal factors.

INTRODUCTION

The training value of aircraft-specific simulation has long been recognized, but typically, the costs have been too expensive for all but a few ab initio pilot training schools and centers. Flight training devices (FTD) have demonstrated utility for "a variety of aeronautics applications such as training, research and development, and accident investigations" (Chung, 2000, p. 14). Increases in fidelity and decreases in costs have made FTDs a viable training option for the ab initio training segment. Increasing cost efficiencies through application of simulation for training necessitates continued investigation (Macchiarella & Doherty, 2007).

Rising fuel costs, increasing insurance costs, and increasing costs associated with modern complex aircraft and avionic systems have boosted operating expenses for training aircraft. Training schools and centers can recoup some of these ascending costs by using cost efficient FTDs (Macchiarella & Brady, 2006).

Flight training devices are an efficient medium for training pilots. Technological advancements in computer processing speeds and storage capacity are leading to increased capabilities. Contrastingly, FTD costs are decreasing for a given level of fidelity and functionality (Chung, 2000). Simulation also saves time by enabling trainers to position the student pilot into the exact situation required to learn specific skills (Liu, Blickensderfer, Vincenzi, & Macchiarella, in press). This capability saves time by cuing up the FTD to a desired point to initiate training instead of having to take a large portion of the training flight just to arrive at the desired point. With this approach, students can focus more time on training. The learning principles of exercise and intensity are maximized by focusing on the to-be-trained task (Federal Aviation Administration, 1999). Additionally, simulation offers more options to training centers. With the same number of physical airplanes, a training center can increase its number of student pilots using simulators. The combination of these factors can justify the increased use of FTDs for ab initio pilot training purposes.

Defining fidelity requires addressing a vast array of factors that concern how well a simulator mirrors reality. The multifarious use of the word fidelity makes it difficult to agree upon a definition. A widely accepted definition is "The accuracy of the representation when compared to the real world" (Department of Defense, 2007). Kaiser and Schroeder (2003) describe four different forms of fidelity. These forms are physical, visual, motion, and cognitive. Physical fidelity relates to the tangible form of the simulation that matches the actual appearance of its real-world counterpart. Visual fidelity involves the relationship between the visual scenes viewed in the simulation compared to the scenes experienced by a pilot in the real world aircraft. Motion fidelity describes the relationship between the movement dynamics of the simulation to the movement dynamics of the simulated system in the real world. Cognitive fidelity relates the mental activities engaged by the pilot while in simulation, to the cognitive activities performed by the pilot in the aircraft (Doherty & Macchiarella, 2007).

Fidelity is often a crucial factor to cost-efficient simulator design. The main issue in simulation development addresses the degree of fidelity designed into a device to meet the identified need of the user. Roscoe and Williges (1980) clearly describe this relationship. These authors identify the best balance of fidelity and cost as the "honey region" (p. 195).

Recently developed FTDs often include visual systems, force cueing, and aerodynamic modeling characteristics. These attributes were not readily available when the Federal Aviation Administration (FAA) first defined and then regulated how nonmotion-based flight simulators could be used for pilot training (Macchiarella, Arban, & Doherty, 2006). High fidelity and relatively low cost FTDs are now available for ab initio pilot training.

Researchers at Embry-Riddle Aeronautical University (ERAU) completed an eighteen-month project examining the use of FTD-based simulation for ab initio pilot training. The FTDs applied in the research were equipped with enhanced visual systems and enhanced aerodynamic modeling. Three of the four forms of fidelity (i.e., physical, visual, and cognitive) were readily observable during the research.

TRANSFER OF TRAINING

Transfer of training (ToT) is a methodology for measuring the knowledge, skills, and attitudes (KSA) acquired from a training environment and subsequently demonstrated during real world application. The training goal is to have positive transfer of KSAs from simulation to task performance in the aircraft. Positive transfer manifests itself as reduced time on task and reduced training cost necessary to master a real world task. Negative transfer is possible. It is evidenced by a decline in skills, perseverance, or motivation from the trainee's standpoint. Positive transfer is desired (Liu et al, in press). The concept of ToT is the most common method to measure the degree of skill transfer between simulation and performance in the aircraft in order to determine simulation effectiveness (Roscoe & Williges, 1980).

Evidence exists indicating that flight training in simulators can yield a high positive transfer to performance in real flight. Although previous studies demonstrated the effectiveness of simulation for flight training, questions remained regarding how effective simulation is for training initial flight skills for ab initio pilots. Findings in prior work have generated mixed results (Rantanen & Talleur, 2005). It is necessary to investigate further the effect of FTDs as these devices relate to ab initio pilot training. Researchers have shown that learning and skill acquisition can be transferred from one setting to another similar setting (Gerathewohl, Mohler, & Siegel, 1969).

Three major factors of particular interest that affect the transfer of training are identical elements, stimulus and response, and trainee motivation. Increased identical elements between simulation and actual flight can manifest an increased rate of transfer (Thorndike, 1906). Osgood's (1949) description of stimulus and response contrasts this position. Transfer of training can be obtained using training tasks and/or devices that do not exactly duplicate the real world condition. However, these devices do maintain the correct stimulus-response relationship (e.g., an FTD used to teach any psychomotor flight task). Motivation and attitude need to be considered as factors in training effectiveness assessment. If motivation is lost or the trainee does not progress at a suitable rate then he or she will fall behind (Liu et al, in press). A trainee with a well-established foundation of skills will aid the learning and development of new skills. When pre-existing skills have a positive affect on the development of a new skill, the change in skill is referred to as positive transfer. Conversely, hindrance of new skill acquisition by pre-existing skills is called negative transfer. Both can be measured by a transfer effectiveness ratio (TER) (Roscoe & Williges, 1980).

Calculating the TER requires counting the practice number of iterations for a task until experimental and control group participants achieve prescribed levels of proficiency in their respective training programs. The TER is calculated by subtracting the number of iterations of a task in the aircraft for experimental group from the number of iterations of the same task performed by the control group. This resultant number is subsequently divided by the number of iterations in the simulator (i.e., an FTD) performed by the experimental group (Roscoe & Williges, 1980). Higher TERs indicate greater transfer from simulation to the real world condition (e.g., a TER of 1.0 indicates a higher level of transfer than a lower TER like 0.4) A TER of one indicates that for each iteration in the FTD, an iteration is saved in the airplane. All positive ratios demonstrate savings in airplane flight for the experimental group. The TER equation is:

$$TER = \frac{C - E}{E_{(FTD)}}$$

METHODS

Participants

The ERAU study used experimental group training with a hybrid curriculum utilizing FTDs and airplanes. The control group trained solely in airplanes. Certified Flight Instructors (CFI) performed the data collection for both groups. The CFIs were standardized in data collection to facilitate reliability and validity. Fifty two undergraduate students participated in this research; 26 were assigned to each group. Participants volunteered for the research and were randomly assigned to a group. All participants were regularly enrolled undergraduate students studying Aeronautical Science at ERAU. The attrition rate for the participants in this training cohort was 27%. Thirty eight participants were used for research data collection and final statistical analysis. (See Table 1.) The mean age of the control group was 18.5 years and the mean age of the experimental group was 18. The mean flight hour total time at the start of the research was 0.24 hours. Flight costs for research participants were normalized to the university's regular flight costs; students received a stipend to participate. Each participant possessed, as a minimum, a current Class III Medical Certificate.

The research utilized aircraft and FTDs obtained from the university's regular training fleet.

The Cessna C-172S "Skyhawk" was used for flight training aspect of the research.

Table 1. *Research Groups*

	Male	Female	Totals
All Flight - Control	14	4	18
Experimental	15	5	20

The Frasca 172 FTD was used for 60% of the training for the experimental group's curriculum. A Level 6 FTD, the device used at ERAU, is defined as a non-motion training simulation that is aircraft specific (Federal Aviation Administration, 1992). This device was further equipped to handle the high angle of attack envelope necessary to train ab initio pilots. Enhancements to the FTD include, longitudinal and lateral-directional propeller destabilizing effects, longitudinal and lateral-directional gyroscopic effects, p-factor, stall model, and an asymmetric wing lift (i.e., spin). These additions, which achieved the desired fidelity, prompted the ERAU researchers to refer to these FTDs as being *Level 6 Plus*. The visual system provides a 220-degree out-of-the-cockpit view of the flight environment (see Figure 1). Air vents in the cockpit blow air on the pilot to represent cabin airflow levels experienced in flight. RPM settings, flap movements, stall warning, airspeed, and engine power determine the aural cues. The radio and intercom systems functionality match actual radio and intercom systems in a C-172S (see Table 2) and have the capability of being networked with other FTDs for a fleet wide simulation. (Macchiarella, Arban, and Doherty, 2006).

Table 2. *C-172S Capabilities.*

Variable Omni Range Radio
Distance Measuring Equipment
Global Positioning System
NAV II Avionics
Garmin 430
Instrument Landing System

Research Design

The study used two groups. The control group was trained solely in the C-172S and the experimental group's training utilized the C-172S and the FTD.

Figure 1. FTD with instructor workstation

The independent variable was the training platform. There were 34 dependent variables, which represented the number of iterations necessary to achieve the PTS standards for 34 tasks associated with Private Pilot Certification.

Procedure

The participants in the research received the same academic ground training as regular Aeronautical Science students. However, the students involved in the research were assigned to specific flight blocks. These blocks provided only the prescribed curriculum to its respective groups. All flight training used a building block approach (Federal Aviation Administration, 1999). Training was applied in stages. Once enrolled in a stage, the participant completed the prescribed curriculum. The tasks were progressive and had to be completed before starting the next stage. Students assigned to the experimental group had to perform to practical test standards (PTS) prescribed levels of performance for each task in simulation before attempting it in an airplane. The training sessions were scored. Upon completion of a training session, the instructor pilot placed a data collection form in a designated location for processing and evaluation by the researchers. The experimental curriculum contained 60% simulated flight and 40% airplane flight for a total of 69.7 hours of flight training. Students in the experimental group training with the FTD had approximately 28 hours of flight in the real aircraft. The control group's curriculum was comprised of 100% aircraft flight.

MANOVA

Researchers calculated a multivariate analysis of variance (MANOVA) to conclude if the number of flight iterations performed in airplane flight to achieve PTS were significantly lower for the experimental group. A MANOVA analysis was chosen to reduce the possibility of a Type I error given the large number of dependant variables. There were no tasks with significantly higher mean iterations for the experimental group in the airplane. For all dependent variables $p = 0.05$ with 1, 36 degrees of freedom (see Table 3).

DISCUSSION

The focus of this research was to quantify the TER from simulation to real world performance in an airplane. A by-product of this effort was the identification of five possible causal factors that influenced the implementation of the FTD-based flight training curricula. The five causal factors were *visual fidelity*, *procedural similarity*, *difficulty of task*, *dynamic flight environment*, and *visual scanning and response*. The researchers examined the TERs, training environment, and student pilots to hypothesize the affect of these factors and the associated implications for ToT. It is realized that cost savings can be obtained from utilizing a combination of FTD flight and actual aircraft flight versus just aircraft flight. The objective was to have 40% of the time spent in the aircraft and 60% in the FTD. However, by the end of the research period the percentage of simulated flight decreased. Instructor pilots implemented extra training modules immediately prior to the Private Pilot certification check ride; the researchers did not try to control this occurrence due the experimental nature of the application of a high degree of simulated flight. Individual instructors remain responsible for the success of each student pilot at Private Pilot certification.

At the end of the research the training curricula consisted of 45.5% of FTD flight and 54.5% aircraft flight; this percentage of simulated flight was a large portion of the curriculum's training effort. Researchers performed post-hoc analysis of the curriculum, TERs, and causal factors to help optimize the ratio of FTD-based flight to real flight. Future Private Pilot curricula will likely be comprised of 58.1% FTD flight and 41.9% aircraft flight.

Table 3. *Transfer Effectiveness Ratio (TER) Scores for 34 Private Pilot Task*

	TER	*F*	*p*
Preflight Inspection*	0.64	76.98	0.00
Cockpit Management*	0.72	37.84	0.00
Engine Starting*	0.59	67.16	0.00
Taxiing*	0.77	19.58	0.00
Before Takeoff Check*	0.82	71.75	0.00
Traffic Patterns*	2.19	17.58	0.00
Normal and Crosswind Takeoff and Climb*	0.57	18.40	0.00
Normal and Crosswind Approach and Landing*	2.1	31.76	0.00
Soft-field Takeoff and Climb	0.06	0.10	0.76
Soft-field Approach and Landing	0.32	1.45	0.24
Short-field Takeoff and Max Performance Climb	0.13	0.63	0.43
Short-field Approach and Landing	0.27	1.17	0.29
Forward Slip to a Landing*	0.48	5.67	0.02
Go-Around/Rejected Landing*	0.51	4.23	0.05
Steep Turns*	0.32	4.22	0.05
Rectangular Course	0.32	2.77	0.10
S-Turns	0.53	3.30	0.08
Turns around a Point	0.2	0.20	0.66
Pilotage and Dead Reckoning	0.09	0.10	0.75
Diversion	-0.02	1.06	0.31
Lost Procedures	0.18	1.27	0.27
Navigation Systems and Radar Services	0.1	0.63	0.43
Emergency Approach and Landing*	0.69	4.97	0.03
Systems and Equipment Malfunctions	0.41	2.57	0.12
Straight-and-Level Flight (IFR)	0.09	0.45	0.51
Constant Airspeed Climbs (IFR)	0.1	0.09	0.77
Constant Airspeed Descents (IFR)	0.05	0.13	0.72
Turns to Headings (IFR)*	0.3	3.99	0.05
Recovery from Unusual Attitudes (IFR)	0.09	0.72	0.40
Radio Communication Navigation Systems/Facilities & Radar Services*	0.82	5.50	0.02
Maneuvering During Slow Flight*	0.38	10.75	0.00
Power-Off Stall*	0.27	6.82	0.01
Power-On Stall*	0.34	9.79	0.00
After Landing, Parking and Securing*	0.74	26.92	0.00
* indicates a significant F value.			

The Way Ahead

The results of the research illustrated that the experimental group required fewer trials to achieve standards in the aircraft when compared to the all-flight control group. Thirty-three of the 34 PTS tasks in the FTD demonstrated positive transfer (See Table 3). In addition, over half of the tasks were significantly different between the groups (Doherty and Macchiarella, 2007).

Instructional designers have the opportunity to realize cost efficiencies with FTD-based training. The cost benefits made available through FTD use can be gained in about two years once the costs of acquisition are amortized (Cardullo, 2005).

Table 4. *FTD and Airplane Use Percentages for Several Private Pilot Curricula*

	Airplane	**FTD**
ERAU Regular Curriculum	78.5%	21.5%
Experimental Curriculum – Percentage Goals	40.0%	60.0%
Experimental Curriculum - Final Percentages	54.5%	45.5%
Goal for Airplane and FTD Use - Immediate	67.5%	32.5%
Goal for Airplane and FTD Use - Objective	58.1%	41.9%

The cost savings associated with utilizing FTDs in place of aircraft can be advantageous. Currently, the university reduces private pilot certification flight training costs by 12.63% through the application of FTDs for flight training. As FTD usage increases and acquisition costs are amortized, monetary savings increase. The proximate cause of this situation is due to the hourly expense rate for the FTD being substantially lower than the hourly rate of aircraft. Future flight training curricula with higher levels of FTD use will lead to greater cost savings.

The *ERAU Regular Curriculum* (i.e., the Part 142 approved private pilot curriculum in use at the university) is comprised of 21.5% FTD flight and 78.5% airplane flight. This is the most expensive of the curricula when compared to curricula using greater levels of FTD-based training. This situation is due to higher airplane use (see Table 4). When comparing the *ERAU Regular Curriculum* to the *Experimental Curriculum - Final Percentages*, a 29.24% cost savings was realized. If the *ERAU Regular Curriculum* is compared to the curriculum percentages of *Goal for Airplane and FTD Use – Objective* (i.e., the objective curriculum based upon research, task analysis, and optimization of FTDs) a cost savings of 13.62% is realized.

Five Causal Factors

Visual fidelity, procedural similarity, difficulty of task, dynamic flight environment, and visual scanning and response were the five causal factors hypothesized to after transfer during the research. The 220° visual system of the FTD allowed for the presentation of a high degree of visual fidelity. ERAU instructional developers and simulation specialists are addressing causal factors as part of an effort to maximize the positive effect on training. Work has been accomplished and the training of ab initio pilots via FTDs will continue to be improved upon.

Visual Fidelity

A low fidelity visual scene at low-level flight altitudes provides poor cues for pilots training for ground reference maneuvers. The progression towards increased visual fidelity to enhance training scenarios is underway. The desire is that the students flying in the FTD will feel more as if they were in an actual aircraft. ERAU has assembled a team to enhance the visual fidelity in the FTDs. The team uses images (i.e., graphic art) that are photorealistic and placed at key locations in the virtual environment. Initiating a sense of vection is of paramount importance to the placement of these virtual entities. Vection is the perception of self-motion induced by visual stimuli (Department of Defense, 2007). New equipment (e.g., display projectors) have also been integrated to improve visual clarity and pixel count in the visual scene. One of several lower level lessons learned are typified by the realization that all visual system projector light bulbs should be replaced simultaneously, in any given FTD, to ensure consistent brightness. The optimization of the visual systems is an ongoing process for increased vection.

Procedural Similarity

Procedural similarity between training in the virtual environment and the real airspace affects transfer as reflected by TERs. Cognitive fidelity addresses the state of recognition and appreciation of a virtual world experience as authentic to the true world. Training scenarios in the FTDs' virtual environment airspace affected cognitive fidelity; realism was limited to the degree that the CFI could role play other air traffic and air traffic control (ATC) simulated airspace seemed to affect transfer to real world flights. ERAU is in the process of increasing the cognitive fidelity of its synthetic flight training environment through the addition of virtual air traffic (VAT) and voice recognition interactive virtual air traffic controllers. This addition will allow ab initio pilots to feel more realism during simulated flight. A significant portion of learning how to become a pilot is not only learning the maneuvers, but also being able to interact with ATC. VAT is intended to create a realistic training environment. These changes are designed to optimize FTD-based ab initio pilot training. The goal is to have student pilot thought processes in the simulator mirror the thought processes occurring during flight in real airspace.

ERAU and the Frasca Corporation have entered into a joint effort to produce a VAT environment. The objective system integrates a selectable, scalable simulation providing virtual air traffic and air traffic control. Student pilots will interact with the system based on input from a graphical instructor station. The pilot in the FTD will have access to all the normal functionality provided by the Frasca FTD. The virtual air traffic controller will understand the pilot's speech and have awareness of the pilot's flight situation and location.

ERAU and Frasca are providing different resources during development. ERAU's focus will be on subject matter expert (SME) assistance for the design, development, and integration of virtual air traffic controller and semiautonomous/autonomous virtual air traffic functionality. ERAU will provide expertise for the development of proper air traffic phraseology for the local training environment to include necessary pilot and ATC radio calls for the voice recognition. The university will perform instructional design to develop scenario-based lessons that apply the system for pilot training. This process will be proofed during "beta" testing and usability testing. Frasca is performing integration of the hardware and software. Frasca's integration work will also provide a means of modifying airspace control measures and voice recognition abilities so the system is adaptable to a changing flight environment.

Difficulty of Task

Different flight tasks require varying and graduated levels of skill to perform the task to standard. Most ab initio pilots master the more demanding psychomotor tasks during the later stages of training. Soft-field Takeoff and Climb, Soft-Field Approach and Landing, Short-Field Takeoff and Climb, Short-Field Approach and Landing proved more difficult to master for participants in both groups during the research (see Table 3). Data suggested that these tasks were difficult to achieve regardless if practice occurred in an FTD or airplane.

Training to standard in the FTD did not seem to mitigate the difficulty of mastering these tasks. The sequencing of training tasks in the curricula had the goal of adhering to the building block principle of learning (i.e., a concept where knowledge and skills are best learned based on previous associated learning experiences) (Federal Aviation Administration, 1999).

The PTS serves as the measurement tool. It provided a set of observable tasks that could be verified by the instructor pilot during aircraft operations. Some tasks were more easily taught by the instructor pilots than others were. ERAU is examining the sequencing of difficult tasks (e.g., Short-Field Approach and Landing). Additionally, the PTS does not address other skills for flight that may account for variability in pilots. (Doherty & Macchiarella, 2007).

Dynamic Flight Environment

A dynamic flight environment includes all of the complexities of real world weather, environmental conditions, and air currents. Phenomena, such as weather and turbulence, continuously change and have been difficult to replicate exactly in an FTD. Without a radical redevelopment of the physics-based flight environment, ERAU is modifying its training scenarios to incorporate multiple varying degrees of weather phenomena. Scenario-based training that incorporates varying meteorological conditions is specifically designed for individual training modules. The researchers are unable to increase the fidelity of virtual weather, but will modify the scenarios to have more varying weather conditions.

Visual Scanning and Response

The application of the results of ERAU's research necessitates the need to isolate the factors associated with visual scanning and response while learning in the FTD. In the absence of proprioceptive stimuli, ab initio pilots training in an FTD rely only on their visual senses. The data indicated that tasks normally highly associated with a high degree of cueing from proprioceptive senses are being learned by students in the FTD (e.g., Maneuvering during Slow Flight, Power-Off Stall, and Power-On Stall). The curricula are based upon an integrated approach of practice (i.e., the student focuses attention outside of the aircraft, however, switches focus inside of the aircraft to flight and system gages to verify aircraft state) (Federal Aviation Administration, 1999). The researchers hypothesize that students learning to fly primarily in an FTD may have a heightened ability to verify aircraft state while gazing inside. Further research is necessary to isolate factors in this area.

CONCLUSION

Increasing cost efficiencies and increasing relative fidelity available with FTDs have influenced ERAU's decision to adopt FTDs and highly integrate these devices into its flight training curricula. The desired goal is to replace a significant number of flight hours that would be performed in a real airplane. ERAU's goal for FTD integration into its objective curriculum is 41.9% FTD-based flight. Using FTDs to this degree will realize a cost savings of 13.62 % when compared to the *ERAU Regular Curriculum*. Research at ERAU concluded that the degree of positive transfer, revealed during the study, warrants further application and refinement of its FTDs and the FTD-based curricula. ERAU researchers and instructional designers will continue to investigate causal factors affecting ToT and the optimized level of application of simulation in flight training curricula.

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The Role of the Course Website in Improving Access to Educational Materials for Nontraditional Aviation Students

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ABSTRACT

Nontraditional students have become the rule rather than the exception in many collegiate aviation programs. These students are often constrained in terms of their ability to devote the same amount of time to their classroom efforts as do their traditional peers. Such constraints may result from scheduling conflicts with work or, to a lesser extent, scheduling conflicts due to the location of classes at multiple and physically-separated campuses. Provision of classroom materials such as course syllabi and lecture notes, through the use of a course website, can help alleviate some of the scheduling concerns that affect nontraditional students. It is instructive to determine the degree to which such a website helps students feel that the convenience of their learning experience has been improved. A study of the use of a course website for this author's aviation classes over a period of two semesters in 2006 and 2007 indicates significant improvement over those courses not employing websites in perceived learning convenience as a result of easier student access to course materials.

INTRODUCTION

While the term "nontraditional student" is not a precise one, some general characteristics that help define the term have been described by Horn (1996). In that study, a nontraditional student was considered to be a student possessing one or more of the following characteristics: the student delayed entry into the postsecondary educational environment, attended on a part-time basis for at least part of the academic year, worked full-time (35 or more hours per week), had at least one dependent other than a spouse, or did not have a high school diploma. Horn defines three specific levels of nontraditionalism among postsecondary students; students at the lowest level, defined as "minimally nontraditional," are those with a single nontraditional characteristic as described above. According to a National Postsecondary Student Aid Study conducted by the National Center for Education Statistics (NCES, 2002), 73% of all postsecondary undergraduate students during the period 1999 – 2000 could be described as, at least, minimally nontraditional.

Two of the characteristics used to define nontraditionalism that are likely the least intrusive in terms of the data collection process are those of weekly employment hours and the number of credit hours for which the student is enrolled. Accordingly, these two characteristics were selected for the survey employed in the research methodology. It should be noted that 39 percent of the undergraduates in the NCES study were employed full-time, while 48 percent were enrolled part-time. As a result, it is reasonable to assume that the majority of the students surveyed who are, by definition, minimally nontraditional will meet at least one of these two criteria, and that all of the students who meet either of the criteria are, again by definition, at least minimally nontraditional.

Nontraditional students often have major constraints placed upon the time they have available for class attendance. These constraints may result from being employed full-time, or, in the case of students taking classes at multiple campuses separated by some physical distance, from scheduling conflicts between classes. The NCES study (2002) indicated that the percentages of nontraditional students whose class schedules were limited by their employment ranged from 47.4 percent for minimally nontraditional students to 72.0 percent for highly nontraditional students, those with four or more of the characteristics of nontraditional students described above. A separate study by Dutton and Dutton (2002) suggested that scheduling conflicts between class time and work time were considered "very important" by 55.8 percent of the students taking a computer programming course online at North Carolina State University, and also that conflicts between scheduled class periods were perceived to have the same degree of importance by 22.4 percent of those students.

The use of a course website to provide the course description, syllabus, lecture notes, and supplemental material can be considered an intermediate step between a fully-online course offering and no use of online course materials delivery whatsoever. Twigg (2003) refers to a hybrid delivery system as a “supplemental approach” to course redesign, and Rivera, McAlister, and Rice (2002) discuss the use of such a hybrid system in what they term a “web-enhanced” course format. Student satisfaction levels measured in that study were somewhat higher with the hybrid format than they were with either a traditional format or with a completely online offering of the same course. Ehrmann (n.d.) suggests that the forms of instructional material used in a hybrid delivery system should be those that most faculty find “easy to create, adapt, and share,” and specifically recommends a web-based syllabus, as it affords all students enrolled in the course the ability to view changes to the syllabus at once.

Technical factors such as the speed of the broadband connection used by the student and the availability of the course web server can certainly affect the student’s perception of the delivery system, as can the accessibility of an Internet-enabled computer to the student. These factors directly affect the technology acceptance model proposed by Davis, Bagozzi and Warshaw (1989) which addresses the questions of perceived usefulness and perceived ease-of-use, and were investigated by Selim (2003). Such problems, while they will undoubtedly always be present to some extent, might be minimized by careful attention to the details of the delivery system that is used to provide the required services.

RESEARCH METHODOLOGY

Purpose of the Study

The purpose of this study was to gauge the perception of learning convenience held by students enrolled in Aviation Technology courses at the Indianapolis Campus of Purdue University over a two-semester period during which course materials delivery was facilitated with a web-based hybrid delivery system. A course description, objectives, syllabus, lecture notes, and supplemental material were available on a separate web page for each course taught by the author over that period, and those web pages were accessible from a home page to which students were given the corresponding universal resource locator (URL). The individual course pages required both a login identifier and a password for access, and students were given these, as well.

Study Population

Forty-nine unique students who enrolled in eight different courses over the two-semester period were targeted as the sample population for this study. While it was not guaranteed that the entire sample population would fit the criteria mentioned previously for nontraditional students, questions were asked in the survey itself that would allow the determination of whether the respondents were minimally nontraditional in the sense of Horn (1996) with a reasonable degree of confidence.

Survey Instrument

A ten-question survey was created to measure the desired parameters. This survey consisted of six questions designed to determine the students’ perception of the increase in convenience due to the hybrid delivery system. These questions were provided with standard five-choice Likert scale responses ranging from Strongly Disagree (1) to Strongly Agree (5). The remaining four questions were used for data validation and to determine the degree of nontraditionalism of the study population.

The survey, entitled “Purdue AT Course Website Survey”, was created using SurveyMonkey.com, a popular website that provides online survey tools for researchers. The survey was tested on a small population prior to being released to the data collection stage, and feedback from that test was used to refine the instrument to facilitate easier comprehension and improve response accuracy.

Survey Procedure

An e-mail was sent to current and former students targeted for participation in the two-semester study on April 26, 2007. The e-mail included a URL link to the survey, and addressed both the amount of time required to complete the survey (judged to be five minutes or less) and the confidentiality of the responses. The e-mail also included a link that allowed recipients to decline participation in the survey if they so desired.

Three of the 49 e-mails sent (6.1 percent) were returned as undeliverable. One recipient declined to participate in the survey by responding to the corresponding URL. A total of 38 recipients of the invitation e-mail, or 77.6 percent, responded favorably and completed the online survey by May 15, 2007. It was determined that this rate of response was satisfactory for analytical purposes, so no reminder e-mail invitations to participate in the survey were sent. It is recognized that there is a fine line between encouraging survey participation by the sending of multiple invitations and the loss of credibility associated with the sending of unsolicited bulk e-mail, and that recognition tends to cause the researcher to remain on the conservative side in determining an appropriate number of e-mail reminders to send to the target population.

RESULTS OF THE STUDY

The first two questions of the survey, each providing for a five-choice Likert scale response, allowed the respondents to provide noncomparative opinions on the general convenience of accessing course information (descriptions, objectives and syllabi) and course materials (lecture notes and supplemental material) from the course website. As Figures 1 and 2 show, the majority of survey respondents felt strongly that access to both of these types of data was convenient through the use of the website.

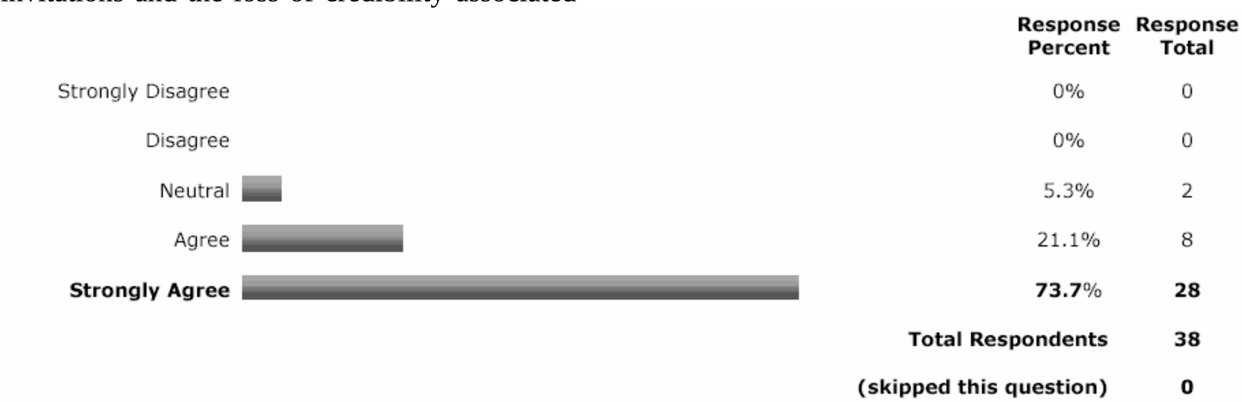

Figure 1. The course website has provided you with a convenient means of accessing course information (description, objectives, and syllabus).

Figure 2. The course website has provided you with a convenient means of accessing course materials (course notes and supplemental materials).

The next two questions provided data to assist in the determination of the factors responsible for limiting the students' time available for class attendance. The first, Figure 3, indicates that a plurality of respondents strongly agreed that the course website had allowed them to obtain materials that they would not have otherwise obtained due to their work schedules, while the majority either strongly agreed or agreed with that assertion. The second, Figure 4, indicates that, while a large percentage of respondents were neutral on the question of whether the website had allowed them to obtain materials that the scheduling of their other classes would have not allowed them to obtain otherwise, a majority (52.6 percent) either agreed or strongly agreed that this was, indeed, the case.

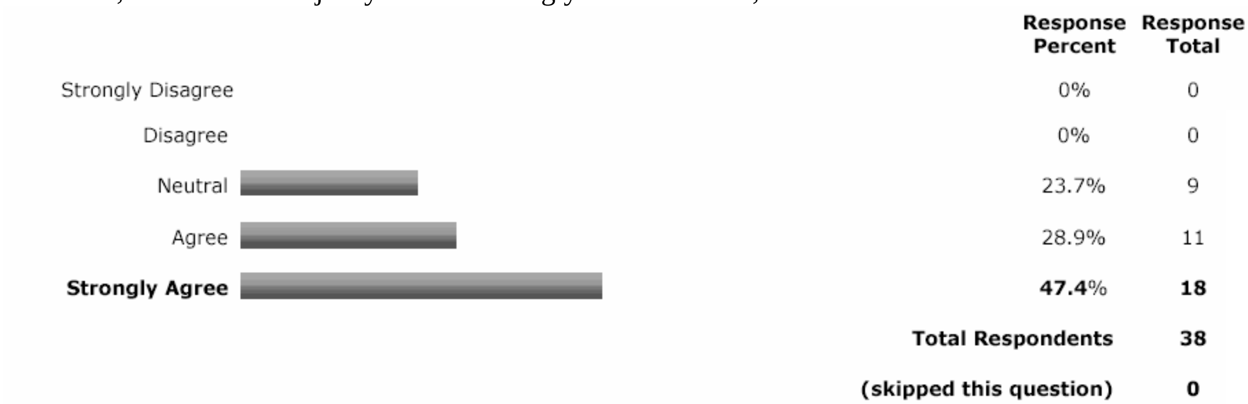

Figure 3. The course website has allowed you to access materials that your work schedule would have prevented you from otherwise obtaining during a regularly scheduled class period of this course.

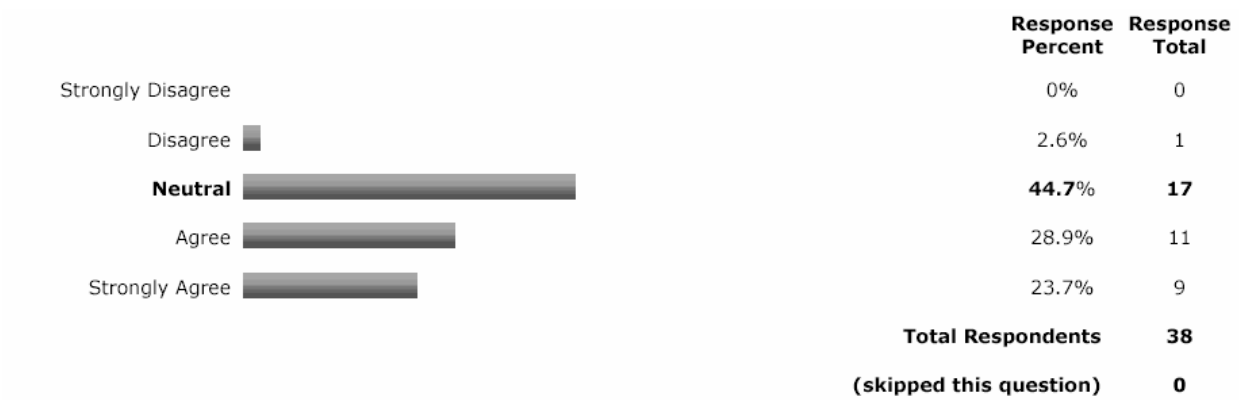

Figure 4. The course website has allowed you to access materials that the scheduling of your other classes would have prevented you from otherwise obtaining during a regularly scheduled class period of this course.

The fifth survey question (Figure 5) was designed to determine whether students responding to the survey were able to access materials from the course website that they would not have accessed when they were actually present in class. It should be noted that not all materials accessible from the website were offered in the form of printed handouts during regular class periods. Materials requiring less printing, such as the course outline and syllabus for each course, were generally made available to students in class, while materials of a more paper-intensive nature, such as lecture notes and supplements, were made available on request. In-class requests for these printed materials decreased throughout the two-semester study period.

Figure 5. The course website has given you the opportunity to access materials that you would not have otherwise accessed during regular classes when you were present.

The sixth question (Figure 6), the last of the questions of the five-choice Likert response type, was designed to elicit a comparative judgment of the overall convenience afforded the student through the use of the course website. A majority of the respondents strongly agreed that their learning experience had been made more convenient with the hybrid delivery system, compared with traditional-style courses.

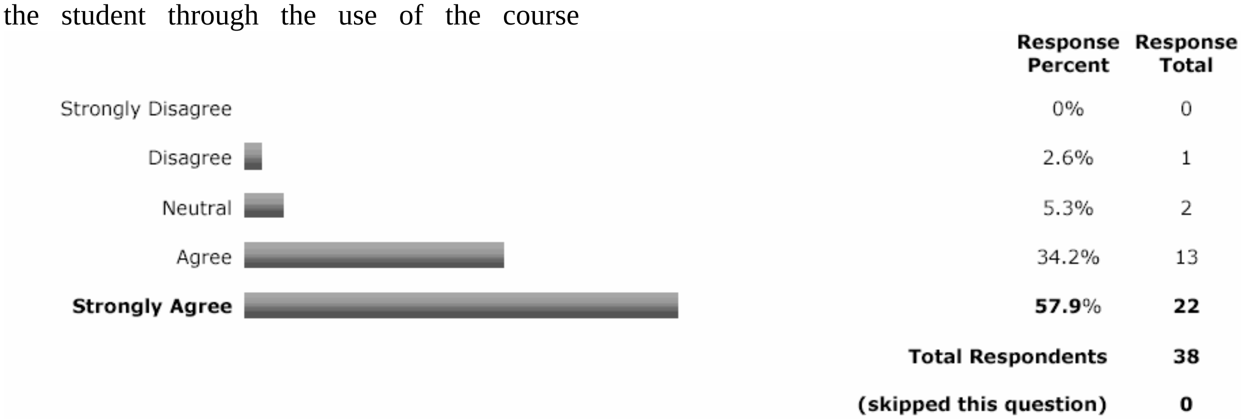

Figure 6. Compared with other courses that do not offer course websites, this course and its associated website have made your learning experience more convenient.

The remaining four questions were designed to allow the assessment of demographic information and the degree of nontraditionalism of the survey respondents. The Indianapolis campus of Purdue University's Statewide College of Technology provides both two-year and four-year degree programs, and the resulting distribution of the class levels of the respondents was fairly uniform (Figure 7).

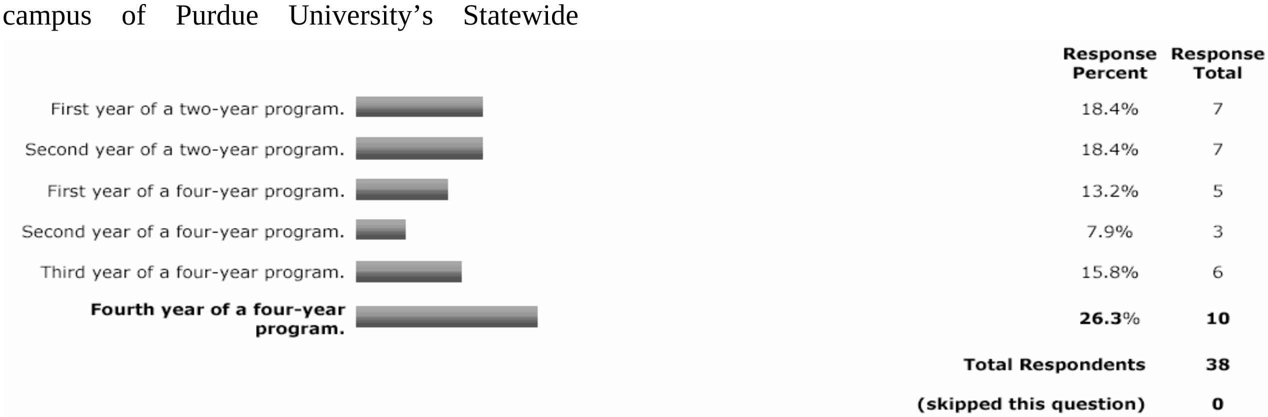

Figure 7. Please select your class level.

Percentage of full-time employment of the survey respondents was then determined. According to the results, the majority (55.3 percent) of students were employed between 30 and 40 hours per week (Figure 8). This implies that these students are, are least, minimally nontraditional or nearly so.

Figure 8. Please select the percentage of time that you are employed.

The next question allowed the determination of the enrollment status (full-time or part-time) of the participants. Five distinct credit hour enrollment categories were created, as shown in Figure 9. Note that, while a 12 hour credit load is considered full-time at Purdue University, it was desired to provide an enrollment category that would indicate the nearness of a part-time student to full-time status, and vice versa, without creating an excessive number of discrete choices, hence the inclusion of the 10 to 14 hour category. The survey results indicate that at least 26.3 percent of the respondents were enrolled part-time, and therefore can be considered at least minimally nontraditional. A plurality of respondents, 42.1 percent, were taking from ten to fourteen credit hours, classifying them as either marginally part-time or marginally full-time, depending on the particular programs in which they were enrolled. Finally, 31.6 percent of the respondents could be considered strictly full-time, as they were enrolled for at least fifteen credit hours.

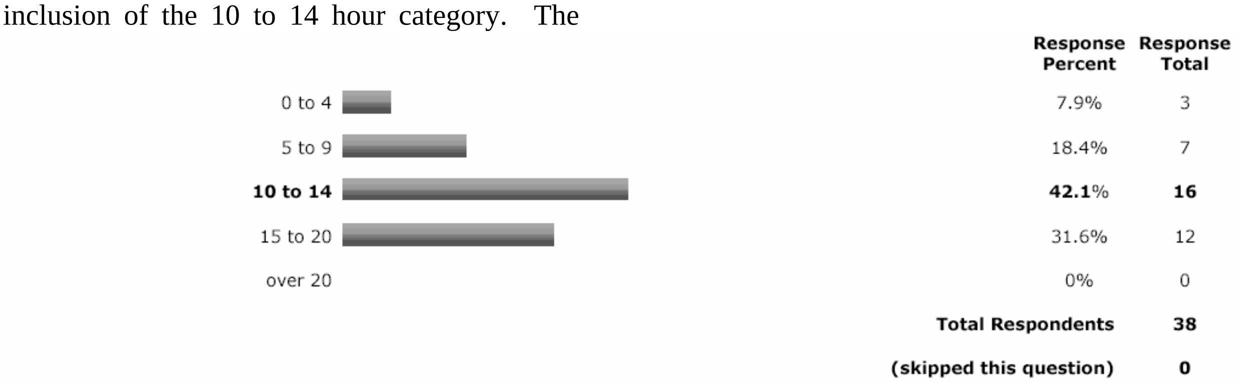

Figure 9. Please select the number of credit hours you were taking during the semester you were enrolled in this class.

In order to determine the amount of time respondents actually spent on campus, the last question in the survey was included (Figure 10). The results show that the hours per week spent on campus by the respondents were somewhat evenly distributed up to around 12 hours, with 94.7 percent indicating that more time was spent than that required for attendance of a single three credit hour class.

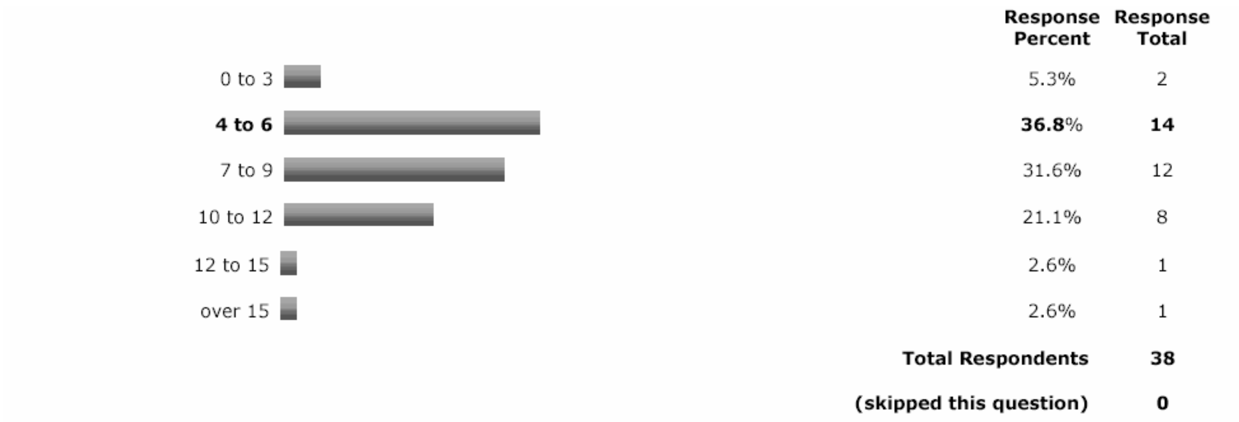

Figure 10. Please select the number of hours per week you spend on the Aviation Technology Center campus.

ANALYSIS

It is clear from the analysis of the first two survey questions that the course websites involved in this study were perceived by the majority of participating students to be helpful in making access to both course information and course materials more convenient. The apparent success of this hybrid delivery model, from a perspective of convenience of access, affirms the findings by Rivera, et al (2002).

One may hypothesize that, among those students whose class schedules are affected by their work schedules, some additional encroachment by work scheduling requirements upon scheduled classes exists, and the research conducted in this study supports that hypothesis. It might also be supposed that, in cases where scheduling conflicts have had an effect on the student's decision to take a certain section of a particular course and where time between classes at physically separate campuses is minimal, additional reductions in the degree of that student's availability for class have occurred, and that supposition is supported by this study, as well.

While it appears that conflicts between scheduling of classes were somewhat involved in reducing the time that the participants had available for class and thus were factors in making web access to course information and materials important, the instrumental factors in this regard were conflicts due to work schedules. It is interesting to examine the correlation between the responses to the questions related to perceived convenience and the responses to the questions involving class and work scheduling conflicts. Accordingly, the Pearson product-moment correlation coefficient (Hogg & Craig, 1978; Cohen, et al, 2003) was calculated for these particular datasets. The Pearson correlation between the variable related to convenience of access of course materials (Question 1), the more strongly correlated of the two noncomparative convenience variables, and the work schedule variable (Question 3), was found to be 0.393. The Pearson correlation between the former variable and the class schedule variable (Question 4) was determined to be 0.320. Both of these coefficients indicate a weak positive correlation between the variables in question.

It is also useful to examine the correlation between the work schedule variable and the variable related to the percentage of full-time employment of the respondents (Question 8). That correlation coefficient was determined to be 0.098, indicating no significant correlation between the variables. This indicates that the degree of convenience perceived by respondents accessing course materials through the website because of inconvenient work schedules does not necessarily depend on the number of hours per week that those respondents are employed.

Finally, as a check to verify the validity of the responses received, correlations between the number of credit hours for which the students were enrolled, the percentage of time employed, and the amount of time per week spent on campus by the students were examined. As one might expect, a moderate positive correlation (0.411) exists between the number of credit hours for which students were enrolled and the amount of time spent on campus, while a weak negative correlation (-0.120) exists between the percentage of time employed and the amount of time spent on campus. It is also interesting to note the inverse relationship that exists between the number of students taking more than ten credit hours (28 students, from Figure 9) and the number of students who report being on campus for more than ten hours per week (10 students, from Figure 10). Possible explanations for this relationship are that some students were enrolled in either hybrid or fully online courses, or that students were simply absent from classes a portion of the time due to the class and work scheduling conflicts discussed above, or to other reasons.

CONCLUSION

As the postsecondary educational system progresses through a series of changes from the traditional course offering to the online offering, a hybrid method of instructional delivery that combines elements of each is a viable option. It was demonstrated that the aviation students participating in this study perceived that their learning experience was made more convenient through the use of such a hybrid delivery method involving a course website for better access to course information and materials. It was also demonstrated that the majority of the students participating in the study were at least minimally nontraditional. As the technological landscape grows and improves, it is expected that the delivery of exclusively online courses will proliferate. At the present time, however, the hybrid delivery model as described herein appears to provide an effective solution to the problem of course materials access by nontraditional students whose time and class attendance is constrained by work and scheduling issues.

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Improving Scoring Consistency of Flight Performance through Inter-Rater Reliability Analyses

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ABSTRACT

Students, as well as the other stake-holders of flight schools, must be sure that the scoring of flight performance is such that the scores are a meaningful indicator of the student's performance rather than an arbitrary indicator of the instructor's perception. The scores should be somewhat consistent from one instructor to another. The apparent inconsistency in scoring from one instructor to another can be examined by conducting inter-rater reliability (IRR) analyses. Inter-rater reliability measures the extent of agreement between two or more individual raters – it is used to measure the consistency of a scoring or rating system, and those who use it. This foundational investigation was designed to assess inter-rater reliability between instructor pilots when observing 10 sample flights performed by student pilots. Results of the study indicated that inter-rater reliability was low. Suggestions for improving the consistency of flight instructor scoring are discussed, as well as recommendations for future research.

INTRODUCTION

There are many different organizations that offer flight training, whether it is a local Fixed Base Operator (FBO), or a two – or four-year college program. Though ground school and written exams issued by the Federal Aviation Administration (FAA) are standardized, training from school to school may not identical, even though fully compliant with FAA regulations. Even within a flight school that has very exacting standards, training may vary between flight instructors for any number of reasons, such as the instructors' abilities, experience level, and perhaps interests. Regardless of their personal characteristics, all instructors must do one thing: evaluate student performance. And yet, because of their personal characteristics, experience, and training, instructors may perceive student performances differently from one another. The reasons for differences in instructor perception of student performance can be systematic or arbitrary, conscious or subconscious, innocuous or malicious; one simply cannot catalog another's motives, but one can see the result of the instructors' perceptions: difference.

When scoring a student pilot, there is the student pilot's performance, which is objective, and the instructor pilot's perception of that performance, which is subjective. In the best of circumstances, the performance and the recorded perception of that performance share a high degree of similarity. That is, the instructor ought always to record a score that accurately and precisely reflects the student's performance. However, this is not always the case. Some perceptions of performance are too forgiving, while others are overly critical. In other words, the same student pilot can receive a passing score from an overly forgiving instructor and a failing score from an overly critical instructor for an identical or near-identical performance, leaving the student confused or frustrated.

Students, as well as the other stake-holders of flight schools, must be sure that the scoring system is such that the scores are a meaningful indicator of the student's performance rather than an arbitrary indicator of the instructor's perception. Furthermore, the scores should be consistent from one instructor to another.

The apparent inconsistency in scoring from one instructor to another can be examined by conducting inter-rater reliability (IRR) analyses. Inter-rater reliability is "used to assess the degree to which different raters/observers give consistent estimates of the same phenomenon" (Trochim, 2001, p.96). Inter-rater reliability measures the extent of agreement between two or more individual raters – it is used to measure the consistency of a scoring or rating system, and those who use it (DeVellis, 2005; Trochim, 2001). The purpose of this investigation, then, is to determine the inter-rater reliability of instructor pilots when evaluating student pilot performance.

REVIEW OF THE LITERATURE

After an extensive review of the literature, published articles focusing on IRR in aviation were not found. There were, however, many other examples of IRR studies conducted extensively in other fields, such as sports, psychology, health care, and education.

Inter-rater Reliability in Sports

Flying and sports are related activities in that they are both simultaneously physical and mental, or psychomotor, to denote the inseparability between the physical and mental aspects. One such study, *Development of an Instrument to Assess Jump-Shooting Form in Basketball* (Lindeman, Libkuman, King, & Kruse, 2000), examined the physical form and movements of a jump shot. A scoring instrument for assessing jump-shots was developed based on the expertise of several recognized basketball coaches. Four raters viewed video tapes of 32 shooters and rated the shooters' form and movement according to the scoring instrument developed. The conclusion was that the instrument may help discern a correlation between the shooter's form and the shooter's success rate. This study shows the applicability of an inter-rater reliability analysis when evaluating psychomotor activity scoring. An inter-rater reliability study may, therefore, be appropriate when evaluating flight performance scoring, since flying an aircraft is also a psychomotor activity.

Inter-rater Reliability in Psychology

Inter-rater reliability studies are often used in psychology to determine if scales and other methods of measuring patient behavior are reliable means of assessment. These studies have been used to assess rating scales and assessment methods related to sleep disorders (Ferri, Bruni, Miano, Smerieri, Spruyt & Terzano, 2005), mental capacity (Raymont, Buchanan, David, Hayward, Wessley & Hotopf, 2006), agoraphobia (Schmidt, Salas, Bernert & Schatschneider, 2005), delusions (Bell, Halligan & Ellis, 2006 and Meyers, English, Gabriele, Peasley-Milkus, Heo, Flint, et al., 2006), social dysfunction in schizophrenia and related illnesses (Monroe-Blum, Collins, McCleary, & Nuttall, 1996), and other means of rating psychological disorders (Drake, Haddock, Terrier, Bentall & Lewis, 2007).

Using inter-rater reliability studies to validate psychological testing is not limited to the United States. It has also been used in China (Leung & Tsang, 2006), Korea (Joo, Joo, Hong, Hwang, Maeng, Han, et al., 2004), Japan (Kaneda, Ohmoria & Fujii, 2001), in the Arabic language (Kadri, Agoub, El Gnaoui, Mchichi Alami, Hergueta & Moussaoui, 2005), Turkey (Tural, Fidaner, Alkin & Bandelow, 2002), Greece (Papavasiliou, Rapidi, Rizou, Petrapoulou & Tzavara, 2007 and Kolaitas, Korpa, Kolvin & Tsiantis, 2003), and France (Thuile, Even, Friedman & Guelfi, 2005). In all of these articles, scales or other methods of assessment were tested, and validated using inter-rater reliability studies.

Inter-rater Reliability in Health Care

Training health care practitioners also has parallels to training pilots. Both health care and flying require mental aptitude and physical skills. Bann, Davis, Moorthy, Munz, Hernandez, Khan, Datta, and Darzi (2005) studied 11 surgical trainees and put them through a 15 minute, six-station rotation of basic surgical tasks. One of the results of this experiment confirmed that video assessment is a reliable means of assessing performance. A similar study concluded that inter-rater reliability of video taped cases was excellent, having a reliability coefficient of .93 (Hulsman, Mollema, Oort, Hoos & de Haes, 2006)

Inter-rater reliability studies are not used solely in the training of health care professionals, but also to verify the rubrics for rating the effectiveness of out-of-hospital CPR (Rittenberger, Martin, Kelly, Roth, Hostler, & Callaway, 2006) and for rating the severity of rosacea (Bamford, Gessert, & Renier, 2004). Bamford, Gessert, and Renier (2004) reported that a scoring rubric with a scale ranging from 1 to 10 may tend to provide an unreliable rating, but when the scale was reduced to a range from 1 to 5, the inter-rater reliability coefficient was much greater, indicating reliability.

Inter-rater Reliability in Education

In *An analysis of statistical techniques used in the Journal of Educational Psychology, 1979-1983*, Goodwin and Goodwin (1985) reported that from 1979-1983, 40 out of 92 reliability studies in the Journal of Educational Psychology were inter-rater reliability studies, comprising nearly half of the studies, by far the greatest percentage. Considering how commonly researchers use inter-rater reliability studies to establish or verify reliability in an educational setting, the Goodwin's article indicates that performing an inter-rater reliability study at flight schools is a legitimate pursuit.

CALCULATING INTER-RATER RELIABILITY

In his 2005 entry into the Encyclopedia of Social Measurement, Robert F. DeVellis reported that there are two influences at work in the process of measuring scores: "(1) the true score of the object, person, event, or other phenomenon being measured, and (2) error (i.e. everything other than the true score of the phenomenon of interest)" (p. 315). A true score is considered to be an objective performance with the opportunity for error resulting from the instructor's perception. The instructor's perception is susceptible to error, thus the disconnect between the true score (objective performance) and the recorded score (instructor's perception). Error is simply a phenomenon to be dealt with through statistical processes and analysis.

In order to get a clear depiction of the level of agreement between raters, consideration must be given to agreement between raters due to chance; chance being a type of error. A thorough review of the inter-rater reliability literature found that Cohen's kappa coefficient was used extensively to test for chance-corrected agreement. Though there are other means (coefficients) of determining inter-rater reliability, Cohen's kappa was used in this study due to its wide use in other IRR investigations.

Cohen's Kappa Coefficient

In the late 1950's and throughout the 1960's, Jacob Cohen conducted seminal research focusing on inter-rater reliability. Cohen proposed a coefficient represented by the Greek letter kappa (κ), as the standard coefficient for inter-rater reliability, with $\kappa \geq .70$ being considered reliable. This is not merely a 70% agreement, because agreement can happen by chance, instead, kappa accommodates the expected frequency of ratings; thus eliminating mere chance agreement (Cohen, 1960; Gwet, 2002b).

A study conducted by Holey and Watson (1995) provided a stark example of the necessity for kappa rather than using mere percentage of agreement when performing an inter-rater reliability study. In their study, some cases resulted in a percentage of agreement between raters of 100%, while the kappa coefficient, which accounts for chance agreement, was 0.01, the absolute lowest number possible.

The purpose of the kappa statistic is to account for and eliminate agreement by chance, chance being a type of error, so that the researcher can get a clearer idea of how much agreement there really is between raters. The coefficient, then, distinguishes between purposeful agreement and accidental agreement. In a reliability formula, the quantified possible error becomes the denominator, while the quantified true score is the numerator. Thus, whatever reliability coefficient is used it is the "ratio of variability ascribable to the true score relative to the total variability of the obtained score" (DeVellis, 2005). Or, in the terms chosen for this investigation, it is the ratio of the pilot's objective performance and the instructors' recorded perception of that performance. In this study, it is assumed that any disconnect in the relationship between the pilot's performance (true score) and the instructors' recorded perception (obtained score) is due to the raters, not the pilot.

The way to find this coefficient, then, is to measure rater against rater rather than pilot against rater. Each rater observes the same flight performance; therefore, the raters ought to record identical scores. In practice they may or may not. This is why one performs an inter-rater reliability study, to discover these discrepancies between true score and obtained score, should discrepancy (error) exist.

METHODOLOGY

This investigation was designed to assess inter-rater reliability between instructor pilots when observing flights performed by student pilots. The study included videotaping the performance of student pilots flying an industry standard instrument flight rules (IFR) pattern. Four instructor pilots reviewed the recorded flight performance footage and scored the performance of 10 student pilots' on a scale of 1 to 5. A score of 1 represented an unsatisfactory performance; 2, marginal; 3, good; 4, very good; and 5, excellent.

Flight Pattern

In *The Pilot's Manual: Instrument Flying* (Kirshner, 1990) there are several flight patterns to choose from. The pattern used for this investigation is referred to as Pattern D. It was chosen because it is long enough to give the raters something substantial to score, yet not so time-consuming as to prove burdensome.

Pilot Participants

Student pilots enrolled in a flight program at a four-year research university participated by flying the aforementioned flight pattern using a PCATD. The researcher explained to the students that they were being videotaped for the purpose of investigating inter-rater reliability. They were assured that these scores, good or bad, would not figure into their course average. Their identities were protected by preventing any distinguishing features from being recorded on video. Also, the order in which the flight performances were viewed was different from the order they were recorded. Thus, the student who flew the first flight on the day of recording might have actually have been the last flight viewed by the raters.

Rater Participants

The rater-participants were selected from the pool of instructor pilots at the flight school. All instructor pilots were offered a chance to participate, resulting in four volunteers. These instructor pilots watched and scored the videotaped flights. The raters were assured of their anonymity and that their performance in this study would not impact their employment at the flight school. Also just as with the student pilot participants, the researcher did not collect or record any demographic data about the rater participants. There is nothing to indicate that the results would have been better or worse with more or fewer raters because the literature found did not suggest an optimal number of raters to use. A future researcher could find an optimal number based of further experimentation.

Scoring Rubric

In order to measure inter-rater reliability, a scoring mechanism, such as a rubric, must be used. The flight school at which this study was performed already had a scoring rubric and that same rubric was used in this investigation.

Flying the Pattern

Prior to sitting at the PCATD, the researcher briefed the student pilots. The pattern is rather complex, and depending on the skill of the student pilot, the researcher gave verbal instructions, if necessary. The student pilots' ability to perform the flight pattern well or poorly was immaterial. The raters were entirely unaware of which student referred to the pattern and which students performed the pattern from memory.

DATA COLLECTION PROCEDURE

The experiment was conducted in a classroom equipped with a PC, projector, and movie screen. The four raters sat in the same room, but were seated far apart to prevent communication between them. They were given instructions and a score sheet and were briefed by the researcher about how to behave during the test (i.e. no talking, gesturing, or using other means of communicating during flights, no talking about the flights during break times, etc.). It took three hours to watch all of the flights. Two short breaks and one longer break were included.

RESULTS

Raw Scores

The raters watched the flights and marked their scores on the score sheet that was provided. These scores are not averages of aspects of the flights such as altitude, heading or air speed scores, but rather single scores for the entire flight. The raw scores are shown in Table 1.

The numbers 1 through 5 indicate the scores the raters gave to each of the 10 flight performances. A score of 1 represents an unsatisfactory performance; a 2, marginal; a 3, good; a 4, very good; and a 5, excellent.

Table 1. *Flight Performance Scores by Rater*

Rater	Sample Flight									
	A	B	C	D	E	F	G	H	I	J
1	4	5	2	1	4	3	2	3	1	5
2	4	5	1	1	4	4	2	4	1	3
3	3	3	1	1	3	4	1	4	1	2
4	3	5	1	1	3	3	2	4	1	4

At first glance, these scores appear to show good agreement, especially in sample flights C, D, G, H and I. A brief examination of the raw scores also reveals that Rater 1 evenly distributed the scores; the only rater to do so. Raters 2 and 4 had very similar results, with only disagreement being between a score of 3 and 4. Rater 3 gave the most scores of 1, and gave no scores of 5. However, to properly analyze the data for inter-rater reliability, the raw scores were analyzed using the methodology of Cohen's kappa coefficient.

Contingency Tables Used to Calculate Cohen's Kappa Coefficient

Cohen's kappa coefficient is derived using only two raters, therefore, six contingency tables were developed. Table 2 is the contingency table for Rater 1 and Rater 2 and is provided as an example.

Table 2. Agreement/Disagreement between Rater 1 and Rater 2

		Rater 1							
	Score	1	2	3	4	5	Row Totals:	*a*	*ef*
Rater 2	1	2	1	0	0	0	3	2	.6
	2	0	1	0	0	0	1	1	.2
	3	0	0	0	0	1	1	0	.2
	4	0	0	2	2	0	4	2	.8
	5	0	0	0	0	1	1	1	.2
Column Totals:		2	2	2	2	2	*N*	*Σa*	*Σef*
							10	6	2

Given: $N = 10$, $\Sigma a = 6$, $\Sigma ef = 2$

κ = $(\Sigma a - \Sigma ef) \div (N - \Sigma ef) = (6 - 2) \div (10 - 2) = 4 \div 8 =$ **.50**

In Table 2, (Rater 1 versus Rater 2), {1,1}, meaning that both Rater 1 and Rater 2 each provided two sample flight performances with a score of 1, unsatisfactory. Both Raters had one agreement of a score of 2, marginal {2,2}; no agreement for a score of 3, good {3, 3}; two agreements for a score of 4, very good {4,4}; and one agreement for a score of 5, excellent {5,5}. The total number of agreements (*Σa)* between Rater 1 and Rater 2 was six.

As shown in Table 2, *N* equals 10, the number of sample flight performances. Column *a* is the number of agreements. This number is simply the cells showing agreement (e.g. 2, 1, 0, 2, 1) transferred over to a single column. In order to account for chance agreement, the expected frequency (*ef*) is determined by dividing the product of the row and column totals by the number of samples, (*N*), 10. This is the expected frequency by chance.

To find kappa, then, the difference of *Σa* minus *Σef* is divided by the difference of *N* (number of samples) minus *Σef* (sum of expected frequency). That is: $\kappa = (\Sigma a - \Sigma ef) / (N - \Sigma ef)$.

Kappa is evaluated next. As was stated previously, a kappa of .70 or greater is considered satisfactory; less than .70 is not.

This calculation was done for each possible permutation without replicating pairs. After the result of each table was tallied, the resultant coefficients were then analyzed to determine the inter-rater reliability of the instructor pilots in comparison with each other.

Summary of Results

The scores were tallied and the kappa for each rater pair calculated. As stated previously, the minimum desirable kappa coefficient is .70. The results in this study were markedly lower.

Table 3. Summary of Kappa for Each Rater Pair

Rater Pair	Kappa
Rater 1 vs. Rater 2	.50
Rater 1 vs. Rater 3	.00
Rater 1 vs. Rater 4	.50
Rater 2 vs. Rater 3	.38
Rater 2 vs. Rater 4	.47
Rater 3 vs. Rater 4	.44
Average	.38

The best kappa was .50, and the worst, 0. The average kappa coefficient was .38, just over half of the desired .70.

Although all of the rater pairings in this study fell far below .70, one rater, Rater 3, seemed the least reliable of the four. The three pairings in which Rater 3 was involved were the least reliable, one of which had a kappa of 0, entirely unreliable. Rater 1, with whom Rater 3 shared the kappa of 0, enjoyed the two highest reliability scores, .50, with Raters 2 and 4.

Each rater was paired three times. When each rater's three pairings were averaged, Rater 1 scored a .33, Rater 2, .45, Rater 3, .27, and Rater 4, .37. However, removing Rater 3 from the averages, so that each rater was only paired twice, Rater 1's average rose to .50, Rater 2 to .48 and Rater 4 to .48. Among Raters 1, 2 and 4, the scores are extremely similar (pair 1 & 2 .50, pair 1 & 4 .50 and pair 2 & 4 .47). Thus it seems that removing Rater 3 improved the inter-rater reliability in this study. Without Rater 3 the overall average reliability increased from .38 to .49. This is still well below .70, but much better.

DISCUSSION

This investigation was designed to assess inter-rater reliability between instructor pilots when observing 10 sample flights performed by student pilots. Four instructor pilots reviewed the recorded flight performance footage and scored the performance on a scale of 1 to 5. A score of 1 represented an unsatisfactory performance; 2, marginal; 3, good; 4, very good; and 5, excellent. Inter-rater reliability was determined by using Cohen's Kappa coefficient. Ultimately, the study indicated that the inter-rater reliability was low; having an average kappa of .38, well below the desired .70.

The resultant coefficients are such that the study did not yield good inter-rater reliability. Because of this, steps should be taken to improve inter-rater reliability at the flight school. Two suggestions are to engage in extensive recurrent training and to improve the scoring rubric.

Recurrent Training

These scores show low inter-rater reliability which may indicate the need for recurrent training, which may help the flight school reinforce the scoring criteria. In the case of Rater 3, more training would be required than for Raters 1, 2 and 4. In sample C, while Raters 1, 2 and 4 agreed upon a score of 5, Rater 3 awarded a score of 3. In sample G where all others gave a score of 2, Rater 3 gave a 1. And in Sample J, where there was no agreement among any raters, Rater 3 gave the low score of 2. After examining the raw scores, it is evident that the most common disagreement was between the scores 3 and 4. It may be that Raters 1, 2 and 4 need to review the scoring standards to help them differentiate between performances that rate a 3 rather than a 4, while Rater 3 needs a greater amount of training to align that rater's expectations of student performance with flight school standards.

It may also be helpful to begin training instructor pilots how to interpret the standards used to score student pilot performance first using simple maneuvers and working their way up to complex patterns, just as the students themselves must work their way up from simple maneuvers to complex patterns. This recurrent training may be of little use unless the standards are better defined through an improved scoring rubric.

Scoring Rubric Improvements

It could also be that the scoring rubric needs improving. There seems to be a disconnect between the description of the quality of performance and quantifiable data. For example, "An 'Excellent' (5) grade will be issued when a student's performance far exceeds and is well above the completion standards." Unfortunately, there is little to define exactly what makes a performance far exceed or well above the completion standards. The same can be said for scores 4, 3, 2, and 1. The definitions of the scores may be too broad.

The scoring sheet provided the rater the completion standards from the lesson in which Pattern D is taught. The altitude standard states only that a student pilot must remain within plus or minus 200 feet of the starting altitude. This standard is very broadly defined and leaves too much open to interpretation by individual instructor pilots and hence affects inter-rater reliability. An example of how to fine tune the altitude standards could include the following scores:

- a score of 5 should require the student remain within plus or minus 50 feet;
- a 4, plus or minus 100 feet;
- a 3, plus or minus 150 feet;
- a 2, plus or minus 200; and
- a 1 indicates that the student violated the 200 foot limit in either direction, and therefore is unsatisfactory.

The other standards, heading, bank angle and airspeed, could also be redefined to more precisely indicate how skilled the student is, rather than leaving a broad range that is susceptible to loose interpretation. Perhaps by fine-tuning the standards and requiring the instructor pilots to be retrained in these newer, more precisely defined, standards would help to improve inter-rater reliability. Fine-tuning these standards may require further research.

Recommendations for Further Research

This investigation represents a foundational study, meant to lay the groundwork and establish a method to study inter-rater reliability at flight schools.

The first recommendation is to expand the number of samples, the number of raters, or both. It may also be beneficial to utilize other means of measuring inter-rater reliability. Other possible statistical techniques include calculating alpha and rho. In the interest of finding the best analytical method, alpha, rho, and other coefficients should be tested along with the increase in samples and raters until an agreed upon method is derived.

The second recommendation is to choose different flight patterns. One suggestion is to begin testing particular maneuvers such as shallow, medium and steep turns, ascending and descending turns, or constant airspeed climbs. These are just examples, and a future researcher could experiment with particular maneuvers rather than entire patterns. At the same time, one could also consider choosing from a catalog of other instrument patterns, more or less challenging than Pattern D.

It may also be beneficial to collect demographic information on the flight instructors. Differences in scoring may be dependent on experience levels, previous training, and other similar factors.

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Stakeholder Perceptions of Specialized Accreditation by the Aviation Accreditation Board International: Part One - Collegiate Aviation Administrators

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ABSTRACT

The Council on Aviation Accreditation (CAA) was established in 1988 in response to the need for formal, specialized accreditation of aviation academic programs. The first aviation programs were accredited by the CAA in 1992, and as of November 2007, the newly renamed Aviation Accreditation Board International (AABI) recognized a total 78 accredited programs at 26 institutions worldwide. Although the number of aviation academic programs accredited by the AABI has steadily grown, there are currently only 26 percent of UAA member institutions with AABI accredited programs.

In an effort to understand the current status of specialized accreditation in collegiate aviation and the reasons why so few aviation programs are accredited by the AABI, a comprehensive study was undertaken to determine the perceptions held by the following four stakeholders of collegiate aviation regarding specialized accreditation by AABI: administrators of both AABI accredited and non-AABI accredited aviation programs, aviation program students, and aviation industry employers. This article is the first in a series of three reporting the results of this nationwide study.

This study utilized a non-experimental, mixed method research design, with quantitative and qualitative attributes. Descriptive research and cross-sectional surveys were tools used to gather data. Data analysis was conducted on both nominal and ordinal data via frequency distributions, content analysis, chi-square, and Mann-Whitney *U*-test.

Recommendations specific to part one of this nationwide study include: (a) The Aviation Accreditation Board International should explore the intrinsic merits of accreditation to truly determine how beneficial AABI accreditation is and the degree to which AABI is fulfilling its original purpose; (b) Administrators of AABI accredited programs with a strong belief in the value of AABI accreditation to collegiate aviation should educate administrators of non-AABI accredited programs about these benefits; and (c) Administrators of non-AABI accredited programs should examine the new outcomes-based AABI criteria to determine if the flexibility inherent in the new criteria are sufficient to enable their programs to pursue AABI accreditation.

INTRODUCTION

The institutions comprising the system of higher education in the United States, although quite diverse, endeavor toward a common goal of educational excellence. These institutions, in their journey toward excellence, seek to ensure quality of academic programs, receipt of federal funds, ease of student transfer among institutions, and employer confidence in their future graduates (Eaton, 2000). A historically American manner in which institutions achieve these goals has been to seek accreditation.

Accreditation, which has been defined as the "status granted to an educational institution or program that has been found by its peers, including professional and public representatives, to meet stated criteria," can be granted to an institution by national and regional accrediting associations, and to a specific program or school by specialized and professional accrediting associations (Daniel, 1985, p. 49). The voluntary nature of accreditation in higher education is a distinctly American invention (Wellman, 2003). Although governmental agencies in other nations establish, approve, and monitor educational institutions, the United States, through a process of peer- and self-review, maintains a high quality system of higher education with little federal or state interference. Indeed, Young (as cited in Gropper, 1986) states, "higher educational institutions [in the United States] have, for many years, carried out a successful and proud history of self-regulation" (p. 4).

The Aviation Accreditation Board International (AABI) was initially established as the Council on Aviation Accreditation in 1988 for the purpose of establishing formal specialized accreditation for non-engineering aviation programs. Although a 1988 University Aviation Association (UAA) member survey revealed general support for the establishment of a formal accrediting organization for aviation programs, and an admirable goal of the AABI is to "stimulate collegiate aviation program excellence and self-improvement," there currently exist only 26 institutions with AABI accredited aviation programs and 5 additional institutions with aviation programs in candidate status (AABI, n.d.). This amounts to only approximately 26 percent of UAA member institutions with aviation programs that are accredited by the AABI. In that regard, the main purpose for conducting this research was to determine why so few aviation programs are accredited by the AABI and to measure the perceived value of AABI accreditation among aviation program administrators, collegiate aviation students, and aviation industry employers.

The results of this nationwide study should be useful to educators in college aviation, accreditation organizations (specifically the AABI), and to professional associations representing both collegiate aviation educators and those employed in the aviation industry. By detailing the perceived value of AABI accreditation among collegiate aviation administrators, students, and industry employers, the AABI will better understand how their efforts are viewed among their constituency. Additionally, current non-AABI accredited programs will have a greater sense of the role AABI accreditation plays in student decisions as to which institution to attend, as well as aviation industry hiring decisions. The findings of the study may serve as an impetus for more aviation programs to apply for AABI accreditation. Likewise, the findings may serve to motivate AABI to evaluate the current role and purposes of the organization in light of the issues revealed in the study. This article, however, presents only partial findings of this nationwide study investigating the perceived value of AABI accreditation among various stakeholders. As the first in a series of three articles, it presents a thorough review of the literature and details findings from administrators of AABI accredited and non-AABI accredited collegiate aviation programs.

REVIEW OF THE LITERATURE

An exhaustive search of the literature uncovered only one previously conducted case study of the AABI (Prather, 2006a), and only two studies addressing views of AABI accreditation among collegiate aviation programs (Prather, 2006b; Sherman, 2006). Thus, in addition to the field of aviation, other academic fields were reviewed during this project to locate comparable studies which may prove beneficial in understanding the current issues being faced by the AABI.

While involved with the AABI initial and reaffirmation review of aviation programs at Central Missouri State University, Sherman (2006) experienced the many questions and objections that faculty and administrators often voice about the commitment necessary to conduct the required AABI self-study. As a result, Sherman investigated the reasons programs have for seeking accreditation, the time required to complete the various phases of the accreditation process, the costs of accreditation, and the use of faculty and staff to complete the self-study. His qualitative study garnered an overall response rate of 25.6 percent. In his findings, it is clear that AABI accredited programs believe strongly in AABI accreditation and point to the many benefits AABI accreditation provides (including higher quality, rigorous self-review, outside guidance, etc.). It is also clear that non-AABI accredited programs see very few benefits and point to why they are not accredited (including lack of student and industry awareness, the expense involved, standards which are applicable only to larger programs, etc.) Although the study concludes by summarizing the findings, no recommendations are offered to improve the AABI accreditation process or assist AABI in more fully developing into a worldwide accrediting organization. Interestingly, Sherman (2006) recommended a future study that examines student perception of AABI accreditation and what role, if any, such accreditation played on student decisions as to which institution to attend. The current study is designed to address that issue, among others.

Although the Accreditation Board of Engineering and Technology (ABET) currently accredits programs at approximately 550 institutions, only approximately 3 percent of engineering management (EM) programs specifically, are accredited by ABET in the U.S. A study by Farr & Bowman (1999) examined EM programs to determine the causes for so few ABET accredited EM programs and the potential for increased efforts at accreditation as a result of recently revised ABET accreditation standards. Their survey of a sample of all undergraduate and graduate EM programs revealed that ABET accreditation is simply not a goal of the majority of EM programs. Ironically, however, the authors discovered that ABET accreditation is important to most of the institutions surveyed. In trying to understand this surprising disconnect, the researchers discovered that the most frequently cited reason for not seeking accreditation is the ABET accreditation criteria (with some schools apparently lacking the required depth of engineering in their curriculum and student backgrounds). An additional reason for not seeking accreditation is insufficient resources (possibly referring to the time and personnel required to complete a necessary self-study). Although the 1999 survey revealed that five programs planned to seek accreditation within the next few years, the authors are quick to conclude that "the challenge [in increasing the number of ABET accredited programs] will be to convince EM program directors that the payoff outweighs the significant investment in resources required for accreditation" (Farr & Bowman, 1999, p. 11). That could be true, quite possibly, for aviation programs as well.

The accreditation of business schools has also been studied (Roller, Andrews, & Bovee, 2003; Brennan & Austin, 2003), and although there currently exists three specialized accrediting organizations in that field, these studies reveal interesting findings that are applicable to this study. Roller, et al. (2003) point out that there had not previously been any systematic comparison of the perceived costs and benefits of, and motivations for, specialized accreditation across the three business school accrediting associations (American Assembly of Collegiate Schools of Business [AACSB], Association of Collegiate Business Schools and Programs [ACBSP], and the International Assembly for Collegiate Business Education [IACBE]). As such, these authors (similar to the author of this study) desired to determine the value of accreditation and the reasons why some programs had chosen to seek accreditation while others had not. Utilizing a researcher-developed questionnaire, they gathered demographic and attitudinal information from a random sample of the business deans of both accredited (either AACSB, ACBSP, or IACBE) and non-accredited programs, resulting in 122 responses. The research effort discovered that 24 percent of these programs did not have specialized business accreditation, and of those, 30 percent were not currently in some stage of the accreditation process. In determining the perceived value of specialized accreditation, the respondents rated the following five variables as beneficial (in order of decreasing benefit): (a) accountability for program improvements, (b) opportunities to share techniques/successes/challenges with other institutions facing similar issues, (c) marketing advantages, (d) faculty recruitment advantages, and (e) recognition as a superior institution. Of most significance to this research effort were the reasons provided by non-accredited programs for not seeking accreditation. Various reasons included expense and effort necessary for accreditation, feeling no pressure from current stakeholders, not currently able to meet accreditation standards, and no time available for the self-study. Overall, non-accredited programs viewed accreditation as less important for ensuring program competitiveness and the quality of student learning than did accredited programs. Interestingly, the researchers found very little difference in program goals among accredited and non-accredited programs. The authors summarize the conclusion of this finding by stating that "the decision to seek accreditation is not caused by differences in program goals but rather by the institution's perception that accreditation will help its business school attain those goals" (Roller et al., 2003, p. 203). Further research comparing the success at achieving program goals among accredited and non-accredited programs would provide additional insight in this area.

Brennan and Austin (2003) apply a qualitative design to perform a case study of one business school that sought AACSB accreditation. Their study recognizes the oftentimes strong organizational inertia that must be overcome in implementing the improvements necessary to ensure a successful accreditation effort. In addition, other obstacles must be confronted and successfully dealt with. The obstacles include necessary structural changes, workload increases, accountability, consistency, adherence, and project control.

Rather than examining the perceived value of specialized accreditation in social work education, Mabrey (1998) performed a qualitative analysis by examining accreditation decisions made by the Council on Social Work Education's (CSWE) Commission on Accreditation (COA) from 1985 to 1992. Similar to the AABI in the aviation discipline, the CSWE is the only specialized accrediting organization in the social work discipline. In researching the literature for this topic, Mabrey noted that her study was unique in that there had been no previous empirical analysis of the COA's decisions over a substantial period of time. Further, she discovered that social work was not alone, and indeed, many disciplines are lacking longitudinal analyses of decisions made by their respective accrediting organizations. This, however, is understandable as this information is usually confidentially maintained by the accrediting organization. The methodology chosen for this study (which required the permission of the CSWE Division of Standards and Accreditation) included the review of all COA letters of decision for the seven year time period. Mabrey determined that 66 percent of programs received initial accreditation with no further review, and 51 percent of programs were found in full compliance upon review for reaffirmation of accredited status. Mabrey further found that the evaluative standard of curriculum proved to be the most difficult to meet on first attempts. Overall, her findings suggest that the vast majority of social work education programs are successful in obtaining either initial accreditation or reaffirmation of accreditation from the COA. Further, less than five percent of all programs ultimately failed to achieve the accreditation status for which they had applied. These findings should prove encouraging for social work education programs (Mabrey, 1998).

Kniess' (1986) study focused on accreditation by the National Recreation and Park Association (NRPA). Specifically, he examined why some recreation and park programs seek NRPA accreditation and others do not. His survey of chief academic officers and department heads revealed a significant difference in the manner in which chief academic officers and department heads perceived the NRPA accreditation process. Further, some of the respondents to his survey indicated that specialized accreditation in recreation was not important since graduation from an accredited program is not a prerequisite for employment. As one respondent explained (Kniess, 1986, p. 119), "'our alumni are successful without accreditation; can we justify the expense for accreditation from something we are already doing?'" Chief academic officers, in general, felt the specialized accreditation process was not worth the time and effort.

Specialized accreditation in baccalaureate nursing programs was a focus of Litwack's (1986) study. Specifically, Litwack endeavored to explore the attitudes of program and institutional administrators towards specialized accreditation and its impacts on nursing education programs. With a usable response rate of 77 percent from Program Directors and 59 percent from Academic Vice-Presidents, Litwack gathered additional reasons for seeking accreditation, as well as benefits of accreditation. Interestingly, Program Directors consistently rated the benefits of accreditation of higher importance than did Academic Vice-Presidents. Litwack's findings led her to initially recommend that specialized accreditation be eliminated altogether due to costs, questioned purpose, duplication of effort, and alternative quality assurance tools. However, in reality, she explains, this is not likely to occur and is, in fact, not recommended because (a) institutional accreditation, as it exists today, is not prepared to handle the quality issues of specialized accreditation; (b) specialized accreditation is still serving a vital role in the identification of programs for funding, for graduate school admissions, and for institutional support; and (c) while many professional programs have alternative quality assurance tools available, other general education departments do not (Litwack, 1998).

Nursing education programs were the focus of Gropper's (1986) study. Specifically, she conducted a study comparing 14 accredited nursing programs with 14 similar non accredited nursing programs on selected indices of quality, attempting to determine, in essence, if accredited programs were, in fact, of higher quality than non-accredited programs. Additionally, interviews were conducted with each of the program administrators to determine why they either sought or did not seek specialized accreditation. Interestingly, Gropper found no differences between accredited and non-accredited programs in terms of program goals and objectives, distributions of curriculum hours, and student performance on licensing exams. Only small differences (favoring accredited programs) were discovered in faculty preparation at the doctoral level and number of graduates working outside the field of nursing. Reasons for not seeking specialized accreditation included costs and uncertainly regarding the validity of the specialized accreditation criteria. Reasons for seeking specialized accreditation included status, prestige, increased self-confidence of faculty, and maintaining options for students in their future work (Gropper, 1986).

In a study of counselor education programs, Rosenbaum (1984) purposed to determine why some counselor educators seek specialized program accreditation, while others do not. Interestingly, at the time of Rosenbaum's study, there were five national specialized accreditation agencies in counselor education. Rosenbaum discovered that economic and status reasons are of higher importance in seeking accreditation than those relating to quality assurance and program improvement. Additionally, respondents indicated that accreditation had a positive effect on an institution's program in areas such as recruiting faculty and students, helping graduates meet licensing requirements, and encouraging program evaluation.

In addition to these studies from academic fields other than aviation, and the studies completed by Prather (2006b) and Sherman (2006), previous studies (Kuhns, 1994; Lindseth, 1996, 1998, and 1999) have been conducted on quality in aviation education (albeit to the exclusion of AABI's role). Kuhns (1994) attempted to establish a series of national norms of quality in aviation education by surveying aviation program administrators. His study revealed that the number one indicator of a high quality aviation program was high quality faculty. Linking this finding to the AABI and professional credentials, Johnson & Lehrer (1995, p. 252) mention that the CAA "will be more willing to professionally accredit institutions that employ faculty members with a doctorate . . . ." The respondents to Kuhns' study felt that the University of North Dakota was the best four-year program in the U.S. and Embry-Riddle Aeronautical University was the best Master's degree program. Interestingly, both of these institutions, at the time of Kuhns' study, had (and continue to have) AABI accredited programs.

In response to the fact that the majority of non-engineering aviation programs are not AABI accredited, Lindseth (1998) endeavored to determine the quality of four-year aviation programs in the U.S. (using criteria other than AABI accreditation standards). He notes that the accreditation criteria mainly address input variables (such as resources, facilities, and faculty), whereas, in determining program quality, we must also measure the outcomes of those programs. Interestingly, although this was not the case at the time of Lindseth's study, AABI has recently transitioned to outcomes-based criteria. Lindseth's survey of 130 experts resulted in the creation of a model of program quality for baccalaureate aviation programs. This model includes the following ten categories: (a) curriculum, (b) students, (c) faculty, (d) program activities, (e) equipment, (f) facilities, (g) leadership, (h) resources, (i) reputation, and (j) value.

The studies previously reviewed, although most are not specific to collegiate aviation, provide a solid foundation for further understanding specialized accreditation and the issues associated with the acceptance of specialized accreditation as a means to ensure quality in specific academic programs. Regardless of the popularity of a particular specialized accrediting organization, these studies reveal that many academic fields seem to have both proponents and opponents of specialized accreditation. The results of this current study may prove useful to various stakeholders as the value of specialized accreditation is being questioned by critics and the number of AABI accredited programs seems less than in other academic fields.

METHODOLOGY

Limitations & Delimitations

As stated by Creswell (2003), all research strategies and statistical procedures have limitations and delimitations. Clearly, this study is no different. A limitation exists with regard to results that might not accurately reflect the opinions of all members of the included populations due to the failure of some sample respondents to answer all open-ended questions and respond with candor.

Delimitations involve the use of a non-experimental research design, which did not allow for the manipulation of independent variables or the understanding of causal relationships. By adopting a non-experimental, mixed method research design, with both quantitative and qualitative attributes, the research questions devised for this study were not answered definitively. Furthermore, this descriptive study will allow only limited relationship conclusions to be drawn (McMillan, 2004).

In addition to delimitations regarding the research design, delimitations as a result of the statistical procedures utilized in data analysis also warrant discussion. The vast majority of questionnaire items asked respondents to rank their level of agreement or disagreement on a Likert five-point scale. Due to the problems in measuring noncognitive traits, such as attitudes and preferences, and in the different manner in which respondents may define "strongly agree" and "agree", for example, the data collected on these Likert items is categorized as ordinal. A number of other items only collected nominal data. As a result, standard statistical methods such as means, *t* tests, or analysis of variance were inappropriate for the majority of questionnaire items. By relying on non-parametric tests, such as the chi square goodness of fit, Mann-Whitney *U*-test, and the Kruskal-Wallis test, there are limitations to any conclusions that may be drawn.

Lastly, to allow for easier data analysis, close-ended items were developed for the questionnaires. However, administrators of non-AABI accredited programs disagreed with the majority of items used to gauge reasons why programs had not sought AABI accreditation. Thus, their level of disagreement does not provide a true representation of their beliefs on this topic.

Research Design

This study utilized a non-experimental, mixed method research design, with both quantitative and qualitative attributes. As contrasted to experimental research, nonexperimental research is used to "describe existing phenomena without changing some condition to affect subjects' responses" (McMillan, 2004, p. 176). As the objective of this study was to investigate the current attitudes about AABI and AABI accreditation among stakeholders, a nonexperimental research design was deemed most appropriate.

The research design is a "mixed method" design in that both qualitative and quantitative data were gathered via cross-sectional surveys. As stated by Creswell (2003), it is not so much quantitative versus qualitative, but rather "how research practice lies somewhere on a continuum between the two" (p. 4). Quantitative and qualitative data were collected via close-ended items and open-ended items on each questionnaire. In essence, this study is considered a descriptive study with data collection via cross-sectional surveys. Plainly, a "descriptive study simply describes a phenomenon" (McMillan, 2004, p. 176).

To effectively apply a mixed method approach, the concept of "concurrent triangulation" was also adopted. Triangulation simply refers to the collection of data from multiple sources aimed at corroborating the same fact or phenomenon (Yin, 2003). More specifically, the strategy of concurrent triangulation, as defined by Creswell (2003), refers to the use of two different methods, such as qualitative and quantitative, during the same data collection period in an attempt to confirm or corroborate findings. This strategy was chosen, as Creswell (2003) recommends, in an effort to "offset the weaknesses inherent with one method with the strengths of the other method" (p. 217). Thus, rather than collecting quantitative data and qualitative data and analyzing these data in isolation, the data were analyzed to find themes of similarity and divergence between the two.

INSTRUMENT DESIGN

Survey of Administrators of AABI Accredited Programs

The researcher developed a questionnaire entitled "Survey of Administrators of AABI Accredited Programs" to solicit opinions regarding AABI accreditation from the administrators or department chairs of AABI accredited programs. The 19 item questionnaire was designed to take less than 5 minutes to complete and was created by applying Dillman's (2000) principles to create a user-friendly and interesting questionnaire that would garner a high response rate and produce useful data. Specifically, the questionnaire contained 17 closed-ended items and two open-ended items.

Survey of Administrators of non-AABI Accredited Programs

The questionnaire entitled "Survey of Administrators of Non-AABI Accredited Programs" was developed to gain insight into why these programs were not AABI accredited. The 18 item questionnaire, which was designed to take less than 5 minutes to complete, contained 16 closed-ended items and two open-ended items.

Validity and Reliability of Measurement

As explained by Alreck and Settle (1995), "a measurement of any kind is valid to the degree it measures all of that and only that which it's supposed to measure" (p. 58). Face validity of the questionnaires was enhanced by informally allowing persons not involved in the study to review the questionnaires for accuracy and ease of completion, resulting in several revisions to the questionnaires. Content validity was enhanced by allowing a group of experts to review each of the questionnaires (Gay and Airasian, 2000). This group of experts consisted of one member of the University Aviation Association (UAA), one member of the Aviation Accreditation Board International (AABI), and the researcher's supervisory committee chair. This jury was presented with an overview of the study and the purpose of the questionnaires. In adapting Litwack's (1986) method, each juror was asked to rate each question on a three-point scale of importance: 1-important; 2-important, but requires revision; 3-not important. Items rated by two out of three jurors as important or important, but requires revision, were included in the questionnaire. In addition to the ranking of items on a scale of importance, constructive comments were also received, resulting in additional questionnaire refinement.

In addition to a focus on validity, reliability was also addressed. Reliability, as explained by Alreck and Settle (1995), means "freedom from random error" (p. 58). A fundamental test of reliability is that of repeatability (Alreck and Settle, 1995). This survey was administered only once, as lack of resources and time did not allow for extensive test-retest methodology. However, McMillan (2004) explains that reliability of an instrument can be measured in terms of internal consistency via the Cronbach alpha, appropriate for instruments in which there is no right or wrong answer to each item. The Cronbach's reliability coefficients for each group were 0.750 and 0.546. As McMillan (2004) states, reliability coefficients of 0.65 are acceptable for measuring noncognitive traits, whereas studies of groups can tolerate a lower reliability, sometimes as low as 0.50 in exploratory research. Further, as suggested by McMillan (2004), additional efforts were implemented to minimize the lower than desired internal consistency of this questionnaire. First, with each of these questionnaires, there were standard conditions of data collection, in which each of the four groups were provided the same directions. Also, the instruments were appropriate in reading level and language of the subjects. Lastly, the questionnaires were brief, thus not experiencing the problems associated with lengthy questionnaires.

In a final effort to address issues of validity and reliability, as well as pre-test the operation of each questionnaire, a pilot study was conducted. A main goal of this pilot study was to determine if the questionnaires were easily understood and could be completed within a reasonable time period. The pilot study consisted of five members randomly selected from each of the sample populations. Responses received from both administrators of AABI and Non-AABI accredited programs during the pilot study closely matched responses collected from these same two groups during the full study.

STUDY POPULATION

Two questionnaires were designed to gauge the opinions of the department administrators of both AABI and non-AABI accredited programs. The survey population (and sample) consisted of one department administrator (or chair) from each of the non-engineering aviation academic program departments that are located at the 23 institutions nationwide with AABI accredited programs (at the time of this study), as well as 76 institutions nationwide with non-AABI accredited programs (utilizing the University Aviation Association institutional member list at the time of this study). The University Aviation Association is a nationwide organization representing collegiate aviation, and contains those programs both accredited by AABI and not accredited by AABI (UAA, n.d.). For administrators of AABI accredited programs, sampling error was +/- 6.3 percent at the 95 percent confidence level, calculated from a 91.3 percent response rate from a population size of 23. For administrators of non-AABI accredited programs, sampling error was +/- 11.8 percent at the 95 percent confidence level, calculated from a 47.36 percent response rate from a population size of 76.

SURVEY PROCEDURES

The implementation of the questionnaires designed for this survey project closely adhered to Dillman's (2000) Tailored Design Method. Specifically, three contacts were made via first-class mail, while the fourth and fifth contacts were made via e-mail and fax, respectively. Each of these five contacts were utilized for the purpose of increasing survey response rate. As Dillman (2000) explains, "Multiple contacts have been shown to be more effective than any other technique for increasing response to surveys by mail" (p. 149). The first contact was made with recipients on June 22, 2007, and the final contact was made on July 30, 2007.

DATA ANALYSIS

Both quantitative and qualitative data were collected as a result of implementing this nonexperimental mixed method research design. The majority of quantitative data collected during this research study involved nominal and ordinal data. As Gravetter and Wallnau (2004) state, "measurements on a nominal scale label and categorize observations, but do not make any quantitative distinctions between observations" (p. 20). Nominal data were collected with dichotomous items (Yes/No) and checklist items. Regarding ordinal data, Gravetter and Wallnau (2004) explain that although ordinal scales allow a determination of differences and direction of differences, they do not allow the researcher to determine the magnitude of difference. Ordinal data was collected during this research study through the liberal use of Likert-scale items on all questionnaires. As Ravid (1994) explains, Likert scale items do not fit the rules for interval data, as "one may question whether the interval or distance between 'strongly agree' and 'agree' is the same as the interval between 'neutral' and 'disagree'" (p. 8). As a result, non-parametric statistical analyses were heavily relied upon in analyzing these quantitative data. SPSS version 15.0 and Microsoft Excel were the statistical analysis software used to analyze quantitative data collected during this study. Specifically, the chi-square test for goodness of fit was utilized to analyze nominal data collected during the study (mainly Yes/No responses and checklist items). The general goal of the chi-square test for goodness of fit is to compare the data with each null hypothesis to determine how well the data fit the distribution specified in the null hypothesis. The Likert-scale ordinal data were analyzed using the Mann-Whitney *U* test, the Kruskal-Wallis test, or simple frequency distributions. When examining data from only one population, frequency distributions were used to express ideas and beliefs most widely held among respondents. When analyzing data from two populations (administrators of AABI and non-AABI accredited programs, for instance), the Mann-Whitney *U*-test was utilized to evaluate relationships between these two groups on various issues. The Mann-Whitney *U* test is appropriate for testing hypotheses with ordinal data (Gravetter and Wallnau, 2004).

To analyze the qualitative data collected during this study, content analysis via a manual coding effort was employed. As Berg (2004) explains, "[content analysis] is helpful in many types of exploratory or descriptive studies" (p. 288). Specifically, comments to open-ended items were printed out and separated with scissors so that each respondent's comment was on a separate piece of paper. For some comments that contained several themes, further data reduction was necessary by using scissors to separate these specific comments. For example, if one respondent commented using several sentences, these several sentences may have touched upon several different themes, thus requiring further separation. This was done to allow grouping of comments into general theme categories. After comments were separated into the theme categories based on their general intent, the number of responses in each theme category was then counted numerically to allow general conclusions to be drawn from the qualitative data.

FINDINGS

Although the nationwide study included 11 research questions, part one of this study presents the abbreviated findings of only 7 of these research questions.

1. Why are AABI accredited aviation programs currently accredited?

To answer this research question, administrators of AABI accredited programs were asked to explain why the aviation program(s) at their institution initially decided to seek AABI accreditation. This open-ended item yielded responses from 22 participants. Content analysis (as described by Berg, 2004) was implemented to discover themes in the responses. This resulted in a total of 38 responses in the following 8 theme categories (in declining number of responses): (a) status/prestige, (b) standards, (c) recruiting mechanism, (d) external peer review, (e) program improvement, (f) required, (g) industry relations/benefits, and (h) leverage. Other popular reasons for seeking AABI accreditation include standardization, recruiting, peer review, program improvement, requirement, industry relations, and leverage. Regarding this last theme, one respondent simply exclaimed, "To protect us!"

2. Are administrators of AABI accredited aviation programs motivated to maintain existing AABI accreditation?

In an effort to answer this research question, administrators of AABI accredited programs were simply asked, "Does your program(s) have plans to maintain existing AABI accreditation?" This dichotomous question allowed only a "Yes" or "No" response. Fully 100 percent of responding administrators from AABI accredited programs explained their program does have plans to maintain existing AABI accreditation.

3. Why are non-AABI accredited aviation programs currently not accredited?

To answer this question, an open-ended item was included on the "Survey of Administrators of Non-AABI Accredited Programs." Specifically, participants were asked to explain "why the aviation programs at your institution are not currently AABI accredited." This item yielded responses from 34 participants. As with research question one, content analysis was implemented to discover themes in the responses. The responses could easily be categorized into the following seven theme categories (in declining number of responses): (a) time/expense/effort versus benefits, (b) currently pursuing AABI accreditation, (c) curriculum requirements/standards, (d) smaller program, (e) similar accreditation, (f) lack of awareness, and (g) currently successful.

4. Are administrators of non-AABI accredited aviation programs motivated to seek initial AABI accreditation?

Research question four was addressed with the use of both quantitative and qualitative data. Quantitatively, research question four was addressed by presenting participants with the following question: "Does your program have plans to pursue AABI accreditation at some point in the future?" For this research question, $H_{0:}$ Administrators of non-AABI accredited programs are divided equally (no preference) about plans to pursue AABI accreditation at some point in the future. For these data, χ^2 (1, n=35) = 3.457, p>0.05. With a critical region beginning at χ^2=3.84 at the 95 percent confidence interval, the decision was made to fail to reject H_0. Therefore, at the 0.05 level of significance, the data do not provide sufficient evidence to conclude that there is a significant difference among administrators of non-AABI accredited programs regarding their plans to pursue AABI accreditation at some point in the future, even though over 65 percent of respondents from non-AABI accredited programs have plans to pursue AABI accreditation at some point in the future.

Qualitatively, research question four was also addressed by presenting participants with the following open-ended question: "If your program(s) is planning on seeking AABI accreditation, please explain what motivated this decision." This item yielded responses from 24 participants. As with research questions one and three, content analysis was implemented to discover themes in the responses. The 24 responses were categorized into the following 7 themed categories (in declining number of responses): (a) prestige, (b) required, (c) improvement, (d) standards, (e) marketing, and (f) leverage and internal review.

5. Is there a relationship between administrators of AABI accredited programs and non-AABI accredited programs regarding their views of AABI and the benefits of AABI accreditation?

Four items were measured to provide insight into the relationship highlighted in this research question. Specifically, the Mann-Whitney *U*-test found sufficient evidence to support a significant difference among administrators of AABI accredited and non-AABI accredited programs regarding their level of agreement with two statements: (a) "AABI accreditation is beneficial to the AABI accredited program," and (b) "It would be beneficial if more aviation programs were accredited by the AABI." On the other hand, the data do not provide sufficient evidence to conclude there is a significant difference among administrators of AABI accredited and non-AABI accredited programs regarding their level of agreement with the following two statements: (a) "Prior to receiving this survey I was unaware of the Aviation Accreditation Board International," and (b) "The AABI should better market itself to collegiate aviation programs."

6. Among administrators of AABI accredited programs, which beliefs most influenced the decision to seek and attain AABI accreditation?

Nine items were developed to address this research question. Respondents were asked to indicate how strongly each of these statements reflected their beliefs as to why their program sought and attained AABI accreditation. Based on the frequency of responses, the following 8 items were agreed to by a minimum of 75 percent of respondents: (a) "To ensure that the program meets standards established by the profession," (b) "To help clarify the program's mission and future direction," (c) "To help attract and recruit highly qualified students and faculty," (d) "To enhance program visibility and recognition," (e) "To assist potential students in selecting a quality training program," (f) "To facilitate the participation of students and faculty in an intensive program evaluation," (g) "To identify for employers those programs which have successfully met the profession's standards of preparation," and (h) "To gain the confidence of the educational community, related professions, and the public." The following item was agreed to by only 50 percent of respondents: "To protect programs from internal budgetary constriction in periods of curtailed enrollment."

7. Among administrators of non-AABI accredited programs, which beliefs most influenced the decision not to seek AABI accreditation?

Eight items were developed to address this research question. Based on frequency of responses, the following four items were disagreed with by the majority of respondents: (a) "Our program is too new to seek accreditation," (b) "We cannot get approval from dean and/or president to seek AABI accreditation," (c) "Our programs do not meet AABI standards," and (d) "We feel the AABI accreditation standards are inappropriate." The majority of respondents only agreed with the following item: "The preparation of the required self-study is too time consuming." Lastly, the following two items gathered a fairly even response of agreement and disagreement: (a) "The faculty in our department do not feel there are adequate benefits for the cost and time involved," and (b) "It is too costly to seek accreditation."

CONCLUSIONS

1. Why are AABI accredited aviation programs currently accredited?

The answer to this question may be summed up with a brief statement: "Because they believe in it." More specifically, administrators of AABI accredited programs are committed to the specialized accreditation process and AABI accreditation in particular. Many of these administrators play an active role in AABI, chairing committees and playing an integral role in matters such as revising the accreditation standards. They enjoy the prestige of being in a select group of AABI accredited programs. They appreciate being held to higher standards, and the benefits realized by reaching these higher standards. They use their AABI accreditation status as a recruiting mechanism, for both students and new faculty. They also benefit from having a rigorous external review of their programs. Accreditation seems to create a culture of continuous program improvement, which then leads to better career opportunities for students and stronger relations with industry. As one respondent adequately summarized, "We wanted to be in step with the best aviation programs in the USA."

2. Are administrators of AABI accredited aviation programs motivated to maintain existing AABI accreditation?

Of those responding to the survey, the answer is clearly, "Yes." In fact, 100 percent of responding administrators of AABI accredited programs are motivated to maintain existing AABI accreditation. Thus, it seems that although obtaining AABI accreditation is not without sacrifice, once it has been obtained, the benefits are real, and it is in the program's best interest to maintain this accreditation.

3. Why are non-AABI accredited aviation programs currently not accredited?

Just as there are multiple reasons why a program seeks accreditation, there are also multiple reasons why a program chooses not to seek AABI accreditation. Generally, the majority of these reasons center around the cost/benefit equation. As one respondent stated, "Cost and time to complete the accreditation process. What is the benefit to our institution for obtaining this accreditation?" Similarly, another respondent mentioned that "Cost concerns are the primary reasons we have not sought AABI accreditation." Surprisingly, the theme category gathering the second most number of responses related to current efforts by programs pursuing AABI accreditation. As one respondent stated, "We are currently pursuing accreditation. Self studies have been conducted in the past but have not been acted upon." Other reasons provided by participants for not currently being AABI accredited include curriculum requirements, having a smaller program not in line with AABI, possessing similar accreditation, lack of awareness of AABI, and being currently successful without AABI. Interestingly, seven of the 35 comments received by respondents pointed to their current efforts to pursue AABI accreditation.

4. Are administrators of non-AABI accredited aviation programs motivated to seek initial AABI accreditation?

Although 65.7 percent of responding administrators stated that their programs do have plans to pursue AABI accreditation at some point in the future, the data, as a result of a chi-square analysis at the 0.05 level of significance, do not provide sufficient evidence to conclude that there is a significant difference among administrators of non-AABI accredited programs regarding their plans to pursue AABI accreditation at some point in the future.

To support this quantitative data, qualitative data were also collected to explore why some non-AABI accredited programs made the decision to begin pursuing AABI accreditation. Of these seven themes uncovered in this data, two themes were most widely held among respondents: (a) prestige/credibility, and (b) required by the university. So, on the one hand, it is a voluntary motivation for a higher level of prestige and credibility, and on the other, a mandate from administration. This would lead one to believe that the source of motivation is just as important as the level of motivation expressed by administrators of non-AABI accredited programs. Indeed, a mandate for accreditation would likely lead to a reluctant pursuit of AABI accreditation with little buy-in and inadequate understanding of the benefits of such accreditation.

5. Is there a relationship between administrators of AABI accredited programs and non-AABI accredited programs regarding their views of AABI and the benefits of AABI accreditation?

To answer this question, four items were developed and appeared on the questionnaire for both administrators of AABI accredited programs and non-AABI accredited programs. A Mann-Whitney *U*-test found sufficient evidence to support a significant difference among administrators of AABI accredited and non-AABI accredited programs regarding their level of agreement with two statements: (a) "AABI accreditation is beneficial to the AABI accredited program," and (b) "It would be beneficial if more aviation programs were accredited by the AABI." The first statement garnered 90 percent agreement by administrators of AABI accredited programs and 57.1 percent agreement by administrators of non-AABI accredited programs. The second statement garnered 85 percent agreement by administrators of AABI accredited programs and only 42.9 percent agreement from administrators of non-AABI accredited programs.

On the other hand, the data do not provide sufficient evidence to conclude there is a significant difference among administrators of AABI accredited and non-AABI accredited programs regarding their level of agreement with the following two statements: (a) "Prior to receiving this survey I was unaware of the Aviation Accreditation Board International," and (b) "The AABI should better market itself to collegiate aviation programs." The first statement garnered 95 percent disagreement by administrators of AABI accredited programs and 82.9 percent disagreement by administrators of non-AABI accredited programs. The second statement garnered 45 percent agreement by administrators of AABI accredited programs and 37.2 percent agreement by administrators of non-AABI accredited programs.

Clearly, these two groups of administrators significantly differ with respect to their belief of the benefits of AABI accreditation to the AABI accredited program and the need for more programs to be AABI accredited. Generally, administrators of existing AABI accredited programs are pro-AABI, while those chairing programs not accredited by AABI tend to be opponents, or at least willing to question the proposed benefits. There are however, some areas of agreement, or at least areas lacking a significant difference among these two groups. First, both groups tend to be aware of AABI. As noted above, although 45 percent of administrators of AABI accredited programs and 37.2 percent of administrators of Non-AABI accredited programs indicated agreement with regard to whether the AABI should better market itself to collegiate aviation programs, these groups also indicated some neutrality with this statement (50 percent and 60 percent, respectively).

6. Among administrators of AABI accredited programs, what beliefs most influenced the decision to seek and attain AABI accreditation?

The nine items developed to gain insight into this research question were generally agreed to by a minimum of 75 percent of respondents. However, one item was agreed to by only 50 percent of respondents: "To protect programs from internal budgetary constriction during periods of curtailed enrollment." Therefore, the beliefs that most widely influenced the decision to seek and attain AABI accreditation, among administrators of AABI accredited programs, are as follows (listed in declining number of responses): (a) "To ensure that the program meets standards established by the profession," (b) "To gain the confidence of the educational community, related professions and the public," (c) "To enhance program visibility and recognition," (d) "To help attract and recruit highly qualified students and faculty," (e) "To identify for employers those programs which have successfully met the profession's standards of preparation," (f) "To help clarify the program's mission and future direction," (g) "To assist potential students in selecting a quality training program," and (h) "To facilitate the participation of students and faculty in an intensive program evaluation." When compared to qualitative responses collected during this study, these findings are expected and in line with respondent comments.

7. Among administrators of non-AABI accredited programs, what beliefs most influenced the decision not to seek AABI accreditation?

Eight items were included on the "Survey of Administrators of Non-AABI Accredited Programs" to address this research question. Based on frequency of responses, the following four items were disagreed with by the majority of respondents: (a) "Our program is too new to seek accreditation," (b) "We cannot get approval from dean and/or president to seek AABI accreditation," (c) "Our programs do not meet AABI standards," and (d) "We feel the AABI accreditation standards are inappropriate." The majority of respondents only agreed to the following item: "The preparation of the required self-study is too time consuming." Lastly, the following two items gathered a fairly even response of agreement and disagreement: (a) "The faculty in our department do not feel there are adequate benefits for the cost and time involved," and (b) "It is too costly to seek accreditation."

These findings are similar to those discovered in other studies (Farr & Bowman, 1999; Gropper, 1986; Kniess, 1986; Liwack, 1986; Roller, Andrews, and Bovee, 2003; Rosenbaum, 1984; & Sherman, 2006). In fact, many previous studies have found that most non-accredited programs question the resources necessary to pursue specialized accreditation, especially in the form of the voluminous self-study that must be prepared. Possibly best summarized by Farr & Bowman (1999, p. 11), "the challenge [for specialized accreditors in increasing the number of specialized accredited programs] will be to convince . . . program directors that the payoff outweighs the significant investment in resources required for accreditation."

DISCUSSION

AABI Accredited Programs

Of those institutions with AABI accredited programs, the findings reveal a strong interest in maintaining AABI accreditation. In fact, not one responding administrator of a currently accredited program has plans to discontinue AABI accreditation. Clearly, these program administrators realize benefits from AABI accreditation, including improved credibility, enhanced recognition, and positioning of the program as a leader in collegiate aviation. According to this group, therefore, once accredited by AABI (even though the process may have required a great deal of work on the part of faculty and administration), the benefits seem to outweigh the costs. As indicated in the recommendations, this point must be stressed to non-AABI accredited programs.

Non-AABI Accredited Programs

Although there are many collegiate aviation programs that are not accredited by AABI, the findings indicate this is not due to the belief that AABI accreditation is not beneficial to the accredited program. As indicated earlier, a majority of responding administrators from non-AABI accredited programs do have plans to pursue AABI accreditation at some point in the future. This is indeed good news for AABI and for collegiate aviation in general. However, for those programs not interested in pursuing AABI accreditation, the findings of the study shed light onto the various reasons for this. Specifically, comments center around several areas, including inappropriateness of AABI standards, current accreditation by another agency (such as ABET), successful without AABI accreditation, and the time and resources necessary to pursue AABI accreditation (e.g., the Self-Study requirement).

Administrators of non-AABI accredited programs were also asked why their programs were not currently accredited by AABI. More specifically, respondents were asked to indicate their level of agreement with eight statements. Surprisingly, none of these statements were highly regarded among respondents. In fact, there was general disagreement among each of the following statements: (a) our program is too new to seek accreditation, (b) we cannot get approval from our dean and/or president to seek AABI accreditation, (c) the faculty in our department do not feel there are adequate benefits for the cost and time involved, (d) it is too costly to seek accreditation, (e) the preparation of the required self-study is too time consuming, (f) our programs do not meet AABI standards, (g), we feel the AABI accreditation standards are inappropriate, and (h) we do not have sufficient information to decide. What then, are the reasons why non-AABI accredited programs have not sought accreditation? Although not completely clear, the qualitative responses centered around six main themes: (a) time/expense/effort versus benefits, (b) curriculum requirements/standards, (c) smaller program, (d) similar accreditation, (e) lack of awareness, and (f) currently successful. As one may gather, a number of these areas were addressed in the statements provided in the questionnaire. However, it seems that respondents were more willing to give open-ended answers than be forced into admitting their programs do not currently meet AABI standards, for instance. In any event, the reasons given for not pursuing AABI accreditation are as diverse as the programs represented. More research is needed to obtain more significant findings in this area.

RECOMMENDATIONS

Although recommendations to AABI should naturally flow from these findings, it is prudent to discuss the changing landscape of accreditation in general and of specialized accreditation by AABI in particular. In essence, substantial changes are now in effect that will greatly affect the manner in which collegiate aviation programs endeavor toward AABI accreditation, and subsequently the manner in which AABI reviews programs for accreditation. Simply, these changes involve a transition from content-based standards to outcomes-based standards. As a result, the specialized accrediting environment has changed. No longer must collegiate aviation programs offer specific courses in a specific sequence to meet AABI standards. Today, these programs must develop learning outcomes for each aviation concentration the institution wishes to accredit through AABI. These learning outcomes, although historically a part of the higher education landscape to some degree, now must be formalized. Programs must develop learning outcomes for their entire program (to include both aviation courses and general education courses), devise methods of assessment to be certain these learning outcomes are being achieved, and then collect evidence to show (an AABI Visiting Team, for example) the level to which these learning outcomes have been achieved and the manner in which students are being prepared to be successful in the aviation industry.

How will this changing landscape in specialized accreditation affect the perceived value of AABI accreditation and the number of collegiate aviation programs accredited by AABI? Obviously, this is an answer this research effort did not attempt to answer. However, based on discussions the author has had in the past with collegiate aviation program administrators, and comments collected from the individuals in this research effort and Prather (2006b), more programs will be interested in pursuing AABI accreditation due mainly to the greater degree of flexibility the new AABI criteria offer. For instance, programs pursuing AABI accreditation under the former content-based standards were required to include a Calculus course within their aviation program degree requirements. In speaking with program administrators, at least two programs had not pursued AABI accreditation in the past because of this single requirement. In essence, they would have been forced to revise their general education requirements to include the Calculus requirement. However, under the new AABI criteria (AABI, 2007, p. 14), programs must only ensure "a combination of college level mathematics and basic sciences appropriate to the program." Although it is unknown at this time, it is possible that more programs will pursues AABI accreditation in the future solely because of the flexibility offered in the new outcomes-based criteria.

Aviation Accreditation Board International

1. AABI should explore the intrinsic merits of accreditation to truly determine how beneficial AABI accreditation is and the degree to which AABI is fulfilling its original purpose. This recommendation stems from the strongly contrasting views among collegiate aviation programs regarding the benefits of AABI accreditation and the apparent success of non-AABI accredited programs.

Administrators of AABI Accredited Programs

1. Administrators of AABI accredited programs who believe strongly in the benefits of AABI accreditation and desire to see collegiate aviation not only maintain, but improve quality standards, should make a concerted effort to educate administrators of non-AABI accredited programs about the benefits of AABI accreditation.

Administrators of Non-AABI Accredited Programs

1. Administrators of non-AABI accredited programs should examine the new outcomes-based AABI criteria to determine if the flexibility inherent in the new criteria are sufficient to enable their programs to pursue AABI accreditation.

CONCLUSION

Although this paper only presents a partial picture of the results from this nationwide study into the perceived value of specialized accreditation by the Aviation Accreditation Board International, important findings were gathered from administrators of both AABI accredited and non-AABI accredited collegiate aviation programs. In general, it appears that administrators are either pro-AABI or not at all interested in AABI. As one may expect, administrators of AABI accredited programs strongly believe in AABI accreditation and have every intention to maintain their AABI accreditation. On the other hand, administrators of non-AABI accredited programs generally point to the expense and effort necessary to pursue AABI accreditation and the fact that their programs are successful without AABI's assistance. Even so, these findings are at odds with the findings of surveys conducted by the UAA in 1974 and again in 1987 concerning the need for specialized accreditation in collegiate aviation. Although the CAA, and subsequently AABI, was created for the benefit of collegiate aviation programs, it appears that only a minority of programs are actually taking advantage of the benefits of AABI accreditation. In the end, it is up to AABI to further investigate the needs of collegiate aviation programs and better tailor their products and services to meeting these needs, while ensuring excellence in aviation education.

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Personality Types of Student Pilots Admitted to the Aviation Flight Program at Southern Illinois University Carbondale

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ABSTRACT

The purpose of this study was to determine if there is a statistically significant common personality type or common combinations of type within the personality profiles among 83 students who enrolled in the Aviation Flight Department at Southern Illinois University at Carbondale (SIUC). The Myers-Briggs Personality Inventory (MBTI) was the instrument used to determine student's personality types. Basic information including age, sex, high school grade point average and ACT scores were also collected. Data collected were analyzed using a chi-square (χ^2) distribution to determine whether there was a statistical significant difference between the MBTI types of the Aviation Flight student population and the general population. The study revealed several personality types and personality type combinations among the students to have a statistical departure from the general population implying that there are personality types or combinations of type of students interested in becoming a professional pilot.

INTRODUCTION

Aviation psychologists have been interested in studying personality characteristics of pilots for years. A pilot's personality characteristics are usually described as having good social skills and reasoning. Also, pilots need to deal with complex information, make quick decisions and often are required to interact with people (Rose, 2001). Pilots are also generally seen as a consistent and stable group. Pilots like their information to be brief and concise and like to be presented with the big picture or overview (Rose, 2001). Flying an airplane is goal directed. It is the pilot's job to select the various sub goals that will lead to the accomplishment of the ultimate goal. Pilots' activities can be thought of as procedural, decisional and perceptual motor (Roscoe, 1980). The manner in which a pilot perceives information and makes judgments is important for the safety and successful completion of a flight.

This study will use the Myers-Briggs Personality Inventory (MBTI) to determine if there is a statistically significant common personality type or common combinations of type within the personality profiles among 83 students who enrolled in the Aviation Flight Department at Southern Illinois University at Carbondale (SIUC).

BACKGROUND

The Myers-Briggs Type Indicator (MBTI) (Myers & McCaulley, 1985) is a personality measure that was developed by Isabel Briggs Myers and her mother, Katherine Cook Briggs. The MBTI was based on Jung's (1921) theory of psychological type. During the past 30 years, there has been an increase in the use of the inventory in both personal and professional settings.

In 1920, a new theory concerning psychological type surfaced from a Swiss psychiatrist named Carl G. Jung. In 1921, Jung theorized that what appears to be random variation in human behavior actually is orderly, logical, and consistent and is the result of basic differences in mental functioning and attitude (Wicklein & Rojewski, 1995). He wrote, "what appears to be random behavior is actually the result of differences in the way people prefer to use their mental capacities" (The Myers & Briggs Foundation, 2005, C.G. Jung's Theory, ¶ 1). The essence of Jung's personality theory was based on four mental processes or functions. These functions include sensing, intuition, thinking and feeling. Each of these functions involves an individual's orientation towards themselves and their environment through perception and judgment (Myers & McCaulley, 1985). Perception includes the process of becoming aware of things, people, ideas, and occurrences. Judgment includes the process of coming to a conclusion about what has been perceived. Perception and judgment make up a large portion of our mental activity. Perception determines what we see in a situation, and judgment determines what we will decide to do with what we have perceived (Myers, 1980). Jung also observed that every person was energized by the external world which was referred to as extraversion or receiving energy from the internal world which was referred to as introversion. Jung's book, *Psychological Types*, was not well received by the public. His perspective was one of a practicing psychologist who treated patients with severe psychological problems and his focus was the unsuccessful development of type that he found in his patients. The book was not popular due to the specialized German audience and the academic language that it contained (The Myers & Briggs Foundation, 2005).

In *Psychology Types* (1921), Jung suggested that individuals can arrange mental habits between opposite poles of three personality dimensions. The first of these pertains to the direction of a person's energy. Jung used the terms introversion and extroversion. The second, which refers to one's cognitive or mental function, pertains to how the person perceives information and what type of information is attractive to the person (Pearman & Albritton, 1997). These are referred to as sensing and intuition. Jung's third dimension, which is also a mental or cognitive function, pertains to one's judgments or decision making about the information that has been received. These were referred to as thinking and feeling. Isabel Briggs Myers and Katherine Briggs added a fourth dimension to Jung's model: the fourth dimension pertains to a person's orientation to the world. Myers and Briggs used the terms judgment and perception. Each was named after the mental functions associated with the orientation (Pearman & Albritton, 1997). Thinking and feeling was associated with the judgment orientation. Sensing and intuition was associated with the perception orientation. These four dimensions, Extraversion (E) and Introversion (I), Sensing (S) and Intuition (N), Thinking (T) and Feeling (F), and Judging (J) and Perceiving (P) make up the psychological typology within the MBTI (Pearman & Albritton, 1997).

The first dimension, extraversion or introversion, pertains to whether a person focuses on and is energized by the inner world or the outer world. The individual that prefers extraversion is energized by the outer world (The Myers & Briggs Foundation, 2005). The extravert seeks engagement with the environment or an event to be experienced and likes to move into action and make things happen. An extravert will often talk aloud even when alone so they can experience an external event (Lawrence, 1996). On the other hand, an introvert prefers to focus and be energized by their inner world. Typically an introvert focuses on ideas and concepts and tends to be more reflective. The introvert will deeply consider before acting and will also prefer to be alone. There are some misconceptions concerning the term introvert. Introversion does not necessarily mean shy or always wanting to be alone (The Myers & Briggs Foundation, 2005).

The second dimension, sensing or intuitive, pertains to how an individual takes in or perceives information. The individual that prefers sensing will pay more attention to the information they can obtain through their five senses. The sensing person will pay more attention to the practical and to detail and will rely on past experience rather than trust words. The sensing person will attend to the present moment rather than look toward future possibilities and is seen as methodical and certain. The individual that prefers intuition over sensing will pay more attention to patterns and possibilities (Lawrence, 1996). One who is intuitive will see the big picture instead of focusing on the details and will rely more on ideas than past experiences. They are often seen as creative and imaginative (The Myers & Briggs Foundation, 2005).

The third dimension, thinking or feeling, pertains to how an individual makes decisions or judges the information that he/she has absorbed. The individual that prefers thinking will use more logic and put more weight on objective and impersonal facts when making a decision. One who prefers thinking over feeling will tend to be more truthful than tactful (The Myers & Briggs Foundation, 2005). The thinking preference will also put more attention to ideas or things than human relationships. Because of this, they can also be seen as uncaring or indifferent. One who prefers thinking also wants to be treated justly and fairly (Lawrence, 1996). The individual that prefers the feeling preference will put more weight on personal situations and the people concerned during the decision making process. Unlike the person with the thinking preference, the individual that prefers feeling will value harmony within groups more as well as be more aware of people's feelings. The feeling preference also likes praise and feels the need to please people even in smaller matters and will try to be more tactful than telling the hard truth (The Myers & Briggs Foundation, 2005).

The fourth dimension, judgment or perception, pertains to an individual's use of their judging mental process (T or F) or perceiving mental process (S or N) in the outer world (McCaulley & Martin, 1995). The individual that uses judging as his or her preference tends to have a more structured and decided lifestyle. Those individuals who have a judging preference like to plan ahead and keep to a schedule. Generally this person will only like to have one project going at one time and finish it before they start another. The individual that uses perception tends to prefer a more flexible lifestyle. Unlike judging types, perceiving types prefer to keep their options open to new developments. Perceiving types may have several things going on at one time and sometimes struggle getting everything accomplished (Lawrence, 1996).

The MBTI generates preference scores that describe a person's personality interaction with the world on the four dimensions just discussed. These dimensions generate 16 possible types based on the different combinations (Pinckney, 1985). The 16 types consist of the following in table 1:

Table 1. *The 16 Personality Types of the Myers-Briggs Type Indicator*

ISTJ	ISFJ	INFJ	INTJ
ISTP	ISFP	INFP	INTP
ESTP	ESFP	ENFP	ENTP
ESTJ	ESFJ	ENFJ	ENTJ

Note. (The Myers & Briggs Foundation, 2005)

It is important to understand that individuals use both poles of each preference. For example, a person who prefers extroversion would at times function as an introvert. There is not a type that is better than another or any preference that is wrong. Jung's theory assumes that during the normal course of development, a person develops preferences that seem natural to the individual (McCaulley, 1990). After the preferences have been developed, believed to happen by the age of 7, people later in life learn to appreciate the processes that were less preferred earlier in life. While all the preferences are considered equal, they all have strengths and challenges. Understanding one's type can help an individual appreciate how everyone contributes to work situations as well as events in someone's personal life.

It is important to realize that the MBTI is more than just an instrument measuring preference type. It is a complex interrelated personality system. As mentioned previously, there are four mental functions or processes. Everyone uses both of the perceiving processes, sensing (S) and intuition (N), and both judging processes thinking (T) and feeling (F), but only prefers one of each pair over the other (Lawrence, 1996).

The four dimensions include focus of interest, information gathering, involvement with information, and the deposition of information. The description of each personality type is solely based on preference, not ability, and does not suggest that a person cannot function in ways other than one's preference (Pinckney, 1985). The possibility has been suggested that the nature of the MBTI's assessment of an individual would be not only for understanding of oneself, but relevant to career counseling (Keirsey & Bates, 1978). Because of the nature of the MBTI, it seems well suited for the psychological assessment of career counseling.

Many people choose careers dictated by their passions. However, other people are more pragmatic and give more weight to practical concerns when choosing a career (Tieger & Barron-Tieger, 2001). Selecting a career can be difficult. Knowing your personality preference by use of the MBTI can aid in this discovery of an individual's career path (McCaulley, 1990).

There are some critics concerning the validity and reliability of the MBTI. Pittenger (1993) states:

> The patterns of data do not suggest that there is reason to believe that there are 16 unique types of personality. Furthermore, there is no convincing evidence to justify that knowledge of type is a reliable or a valid predictor of important behavioral conditions (p. 483).

Comrey (1983) and other researchers have questioned whether the MBTI did or did not adequately represent the Jungian theory on which it is based (Capraro & Capraro, 2002).

Allen L. Hammer, who is a researcher for Consulting Psychologists Press Inc. and the publisher of the MBTI, contends that the MBTI is being held to different standards from other career development instruments (Zemke, 1992). Hammer also contends:

> The underlying concept for the use of instruments in career counseling since the 1930's is matching people with a job that is congruent with their interests and preferences. The MBTI does that as well or better than any instrument on the market (Zemke, 1992, p. 46).

Personality studies for pilots date back to World War I where there was a demand for pilots as well as effective selection methods (Ganesh & Joseph, 2005). Many personality studies for pilots in the past have focused on primarily on military pilots. The objectives of many of these studies centered on the identification of personality traits that could predict successful adaptation to military aviation for the use of pilot selection (Dillinger, Wiegmann & Taneja, 2003). Patterns developed from these studies which described military pilots as outgoing, active, competitive as well as dominant and achievement oriented (Ashman & Telfer, 1983; Dillinger, Wiegmann & Taneja, 2003; Fine & Hartman, 1968). Several of these studies failed to find a relationship with personality profiles among pilots and their success in military training programs. North and Griffin (1977) reviewed research from the previous 60 years which included reviewing personality inventories. Between 1950 and 1976, forty different inventories and scales were used for pilot selection. There was no relationship found between pilot personality and selection of aviation candidates. Given this inability to find a relationship, researchers lost interest in personality inventories within the aviation industry.

Interest, however, has been revived recently as studies have been accomplished linking pilot personalities and stress coping strategies (Dillinger, Wiegmann & Taneja, 2003). Other recent pilot personality studies have been done linking personality characteristics to successful pilot candidates. Some of these findings include characteristics such as stable, tough minded, extroverted (Bartram, 1995), logical, outgoing, and attention to detail (Picano, 1991). Chidester, Kanki, Foushee, Dickinson, & Bowles (1990) found that personality factors contributed to crew effectiveness and that goal orientation, independence and intrapersonal personality characteristics were predictors of team performance in aerospace environments (Fitzgibbons, Davis & Schutte 2004). Most of these studies have focused on the military and commercial pilots, but there has been less research done concerning personality profiles of student pilots, specifically student pilots enrolled in an academic aviation flight program.

Kreienkamp (1983) conducted a study to see if there was a significant relationship between the similarity of flight instructor and student pilot perceptive styles and the performance of the student pilot. Kreienkamp used the MBTI to determine personality preferences among thirty-two subjects for his study. He found that only the extrovert-introvert differences between male student pilots and their flight instructors compared with student pilot flight training time were statistically significant (Krienkamp, 1983). These results indicated that personality types may be a useful variable in instruction. In 1994, Kreienkamp produced a similar study to determine if students and instructors with the same personality type increased performance. Kreienkamp (1994) used thirty-five private pilot subjects for this particular study. The hypothesis that student pilots who are matched with their flight instructors on the basis of perceptive similarity will learn to fly in less time was rejected.

Research conducted in 1986 and 1987 at the University of North Dakota (UND) also used the MBTI to determine if matching student and instructor personality profiles was an advantage to training pilots more efficiently. The researchers concluded that students who were matched with instructors of similar personality profiles excelled early in training, but after initial flight training, the differences disappeared (Deitz & Thoms, 1991). Another study (Roen, 1991) involved 222 student pilots enrolled in the Center for Aerospace Sciences at UND, which is one of the largest aviation programs in the United States offered for professional pilots. The findings of this study were that 21.1 percent reflected the ESTJ profile, 11.7 percent were ISTJ, and 10.3 percent were ESTP.

Statement of the Problem

Due to the growth and popularity of the MBTI, the instrument has been used for years in career/occupational counseling (McCaulley, 1990). For many high school students or adults looking to make an occupational change, choosing a career can be a difficult choice. Personality profiling can help individuals obtain a better understanding of them and perhaps help them make better career decisions. In *Do What You Are* (Tieger & Barron-Tieger, 2001) the authors identify different occupations and associate them with personality types that would suit various careers and jobs. Current research shows that there is a relationship between personality type and job satisfaction (Miller, 1992). Past research identifies technological careers as having a prominent personality type or types (Tieger & Barron-Tieger, 2001). More research concerning personality type preference for pilots could aid individuals who are interested in professional pilot training and better inform university flight training programs with respect to student pilot recruitment and retention.

RESEARCH QUESTIONS

Is there a statistically significant common personality type among student pilots who were admitted into the Aviation Flight Program at Southern Illinois University Carbondale?

Is there a statistically significant common personality type combination among student pilots who were admitted into the Aviation Flight Program at Southern Illinois University Carbondale?

METHODOLOGY

The purpose of this study was to determine if there is a statistically significant common personality type or common combinations of type within the personality profiles among students who enrolled in the Aviation Flight Department at Southern Illinois University at Carbondale (SIUC). The study was conducted using eighty-three students in the Aviation Flight Program. These students were all in their first semester at SIUC and were either a student pilot or a private pilot. The individuals selected for the study were all enrolled in the private pilot ground school (AF 200) as well as one of two beginning flight courses, AF 199 or AF 201. The Aviation Flight Department uses a combination of high school grade point average (GPA), high school class rank, and American College Testing (ACT) scores as the selection criteria. Currently, admittance requirements include a high school GPA of 3.0, a class rank in the upper third of the graduating class and an ACT score of 24. These standards are slightly higher than those for general admission to SIUC, but comparable to other flight programs across the country (D. Jaynes, personal communication, June 21, 2005).

Measures

The instrument used to determine the personality profile of the participants was the Myers Brigg Type Indicator (MBTI) Form M (Myers et al., 1998). The MBTI is a 93 item self report instrument that measures psychological type based on the preferences described in Jungian theory (Kahn, Nauta, Tipps, Gailbreath & Charttrand, 2002). The MBTI uses responses from 47 word pairs and 46 phrases to describe one's personality preferences among the four dichotomies; Extraversion-Introversion (E-I), Sensing-Intuition (S-N), Thinking-Feeling (T-F), and Judging-Perceiving (J-P) (Kahn et al., 2002). The Form M was used within the limits specified by Consulting Psychological Press, Inc. and was administered by a certified professional from Southern Illinois University Carbondale. There is a wealth of validity and reliability data that exists for the MBTI (Capraro & Capraro, 2002; Cohen, Cohen & Cross1981; Carlyn, 1977; Harrison, 1967; Stricker & Ross, 1962; Thompson & Borrello, 1986).

A demographic questionnaire was also given independently of the MBTI to establish that the students who participated in this study met the requirements for the Aviation Flight Program at SIUC. Demographic data such as age, ACT score, high school GPA and high school class rank were asked of the students in this questionnaire.

Procedures

All students entering the Aviation Flight Program at SIUC are required to take AF 200, Primary Flight Theory. For the fall semester of 2005, there were three sections of this course offered. Eighty-five students were enrolled in AF 200. Of these eighty-five students, eighty-three participated in this study.

Each student in AF 200 was given a letter stating the purpose of the study. The study was strictly voluntary and all information was confidential. Students were then given the MBTI by a qualified professional to determine the personality preferences of each individual. The demographic questionnaire was given to the students at the same time. This questionnaire and the resulting data were independent from the data received from the MBTI. Both the MBTI and the questionnaire were administered in a classroom setting in mid semester. Students were assured that their participation would not influence their training program.

Data Treatment

The first portion of the data that was evaluated was the 16 MBTI personality types of the study population relative to the MBTI types of the general population. Because the percentages of the personality types vary among the general population, further statistical analysis was conducted to compare the study population relative to the general population. The general population data was retrieved from The Myers Briggs Foundation website (The Myers Briggs Foundation, 2006).

To determine whether there was a statistically significant difference between the MBTI types of the Aviation Flight student population and the general population, a chi-square (χ^2) distribution was conducted. In the χ^2 distribution, the observed (*O*) frequencies (number of each MBTI personality type in the study population) were compared to the expected (*E*) frequencies (percentage of each MBTI personality type in the general population). The critical value (χ^2cv) of 24.996 was obtained by determining that the degree of freedom equal to 15 at the .05 level (Hinkle, Wiersma & Jurs, 1988). To determine which MBTI preferences were major contributors to any statistical significance, the standardized residual was computed for each of the categories. When a standardized residual for a category is greater than 2.00, one can conclude that it is a major contributor to the χ^2 value. The standardized residual is defined as $R = O – E / \sqrt{E}$ (Hinkle et al., 1988).

To further evaluate the data, the combination groupings that were studied were the sensing-intuition (S - N) and the judger-perceiver (J – P). A χ^2 distribution was conducted looking at the NP, SP, SJ, and NJ combinations of the study population relative to the general population. The critical value (χ^2cv) of 7.815 was obtained based on a degree of freedom equal to 3 at the .05 level (Hinkle et al., 1988). To determine which MBTI combinations were major contributors to any statistical significance, the standardized residual was computed for each of the categories.

Finally, a χ^2 distribution was conducted looking at the scores of each individual dichotomy of the study population relative to the general population. The critical value (χ^2cv) of 3.841 was obtained by using a degree of freedom equal to 1 at the .05 level (Hinkle et al., 1988). To determine which MBTI dichotomies were major contributors of any statistical significance, the standardized residual was computed for each of the categories.

RESULTS

The first research question was: Is there a statistically significant common personality type among student pilots who were admitted into the Aviation Flight Program at Southern Illinois University Carbondale? All of the sixteen MBTI personality types were represented among the population except for INFJ. The most represented personality types among the aviation students were ENFP (13.25%), ISTP (12.05%), ISTJ (10.84%) and ENTP/INFP (9.64%). These personality types relative to the total population differ in many ways. The highest percentage of the general population fall within the personality types ISFJ (13.8%), ESFJ (12.3%), ISTJ (11.6%), and ESTJ (8.7%) (see Figure 1) (The Myers Briggs Foundation, 2006).

There is a statistically greater percentage of aviation flight students with the types ISTP, ENTP, INFP and INTJ relative to the average percentage of the general population. Conversely, the types ISFJ, ESFJ and ISFP were found to be statistically under represented in the student population relative to the general population. In Table 2, the results of the χ^2 analysis on all sixteen types indicated that these seven types had a statistically significant departure from the general population. This finding would indicate that these personality types are drawn to aviation as a career.

The second research question was: Is there a statistically significant common personality type combination among student pilots who were admitted into the Aviation Flight Program at Southern Illinois University Carbondale? Of the four dichotomies, the combination groupings that were studied were the sensing-intuition (S - N) and the judger-perceiver (J – P). The percentages of these two groupings among the Aviation Flight students were NP (37.35%), SP (30.12%), SJ (18.07%), and NJ (14.46%).

Table 2. *Calculation of χ^2 for MBTI scores of Aviation Flight Students relative to general population*

Type	O	E	$(O – E)^2$ / E	R
ISFJ	2	11.45	7.80	-2.79*
ESFJ	1	10.21	8.31	-2.88*
ISFP	1	7.30	5.44	-2.33*
ISTP	10	4.48	6.79	2.61*
ENTP	8	2.66	10.75	3.28*
INFP	8	3.65	5.18	2.28*
INTJ	6	1.74	10.40	3.22*
ISTJ	9	9.63	0.04	-0.20
ESTJ	3	7.22	2.47	-1.57
ESFP	7	7.06	0.00	-0.02
ENFP	11	6.72	2.72	1.65
ESTP	7	3.57	3.30	1.82
ENFJ	4	1.99	2.02	1.42
INTP	4	2.74	0.58	0.76
ENTJ	2	1.49	0.17	0.41
INFJ	0	1.25	1.25	-1.12
Total	83	83.17	67.22 = χ^2	

*Note. Critical value = 24.996. O = Number of Aviation Flight Students. E = General Population. R = Standardized residual. *Denotes statistical significance @ (.05).*

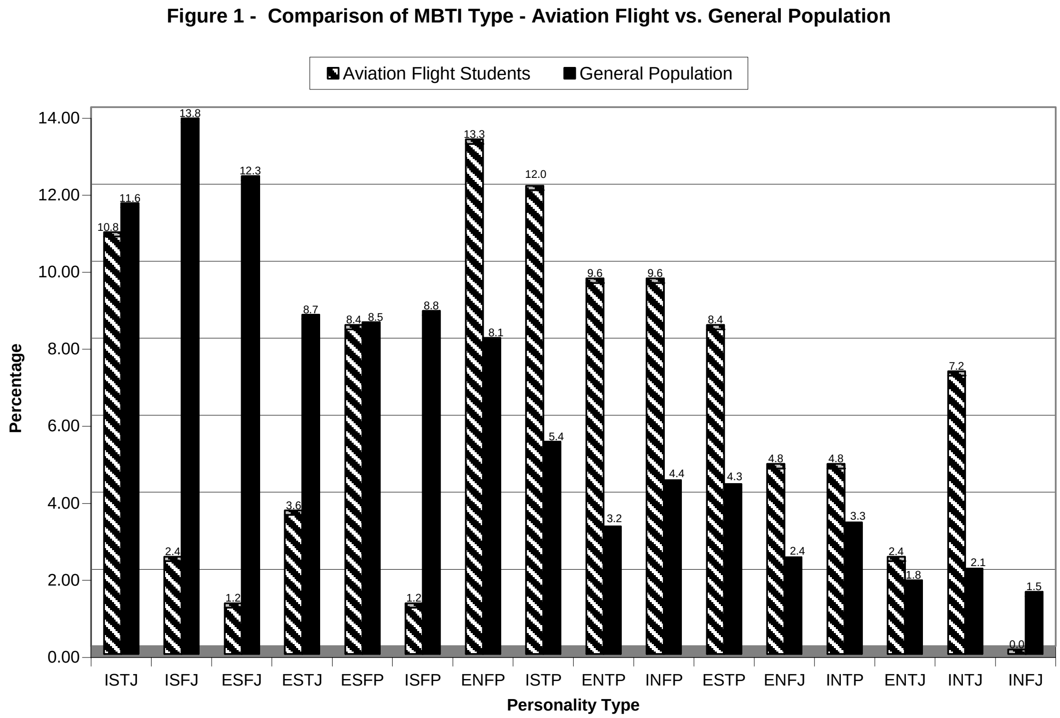

Figure 1. Comparison of MBTI Type – Aviation Flight vs. General Population

The percentages of the total population within these two groupings were NP (19%), SP (27%), SJ (46.4%) and NJ (7.8%) (see Figure 2). The results of the χ^2 analysis on the four combinations indicated that three of the four combinations of the student's types had a statistically significant departure from the general population. In Table 3, the NP, which was over represented among the students and SJ, which was under represented among the students had the greatest departure of the groupings from the general population. This finding would indicate that the NP preference is drawn more to aviation as a career.

Table 3. *Calculation of χ^2 for MBTI two letter combinations of Aviation Flight Students relative to general population*

Type	O	E	(O – E)² / E	R
NP	31	15.77	14.71	3.84*
SP	25	22.41	0.30	0.55
NJ	12	6.47	4.72	2.17*
SJ	15	38.51	14.35	3.79*
Total	83	83.16	34.08 = χ^2	

*Note. Critical value = 7.815. O = Number of Aviation Flight Students. E = General Population R = Standardized residual. * Denotes statistical significance @ (.05).*

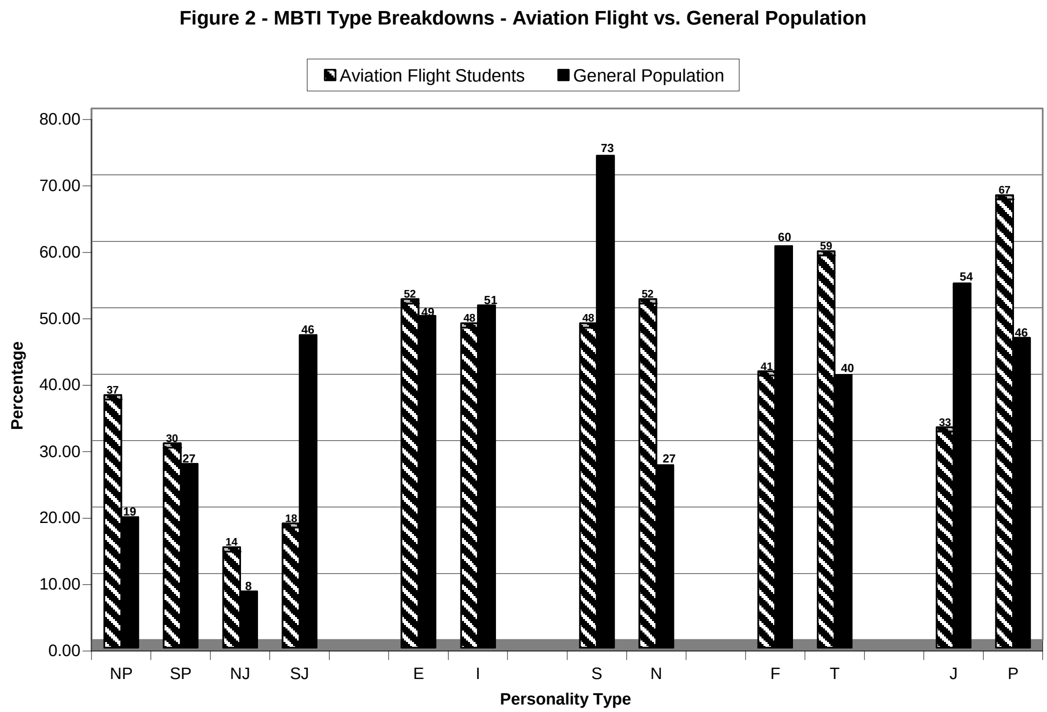

Figure 2. MBTI Type Breakdowns – Aviation Flight vs. General Population

Finally, the data were used to investigate each of the four individual dichotomies. The percentages for the study population were as follows E (51.81%), N (51.81%), T (59.04%) and P (67.47%). The percentages of the total population were I (50.9%), S (73.4%), F (59.8%) and J (54.2%) (see Figure 2). In Tables 4, 5, 6 and 7, the results of the χ^2 analysis on each of the four dichotomies indicated that three of the four dichotomies of the student's types had a statistically significant departure from the general population, with the S – N and J – P dichotomies having the greatest variance.

Table 4 *Calculation of χ^2 for MBTI (E – I) preference of Aviation Flight Students relative to general population*

Type	O	E	$(O – E)^2$ / E	R
E	43	40.92	0.11	0.33
I	40	42.25	0.12	0.35
Total	83	83.17	0.23	= χ^2

*Note. Critical value = 3.84. O = Number of Aviation Flight Students. E = General Population. R = Standardized residual. * Denotes statistical significance @ (.05).*

Table 5. *Calculation of χ^2 for MBTI (S – N) preference of Aviation Flight Students relative to general population*

Type	O	E	$(O – E)^2$ / E	R
S	40	60.92	7.19	-2.68*
N	43	22.24	19.37	4.40*
Total	83	83.16	26.55 = χ^2	

*Note. Critical value = 3.84. O = Number of Aviation Flight Students. E = General Population. R = Standardized residual. * Denotes statistical significance @ (.05).*

Table 6. *Calculation of χ² for MBTI (T – F) preference of Aviation Flight Students relative to general population*

Type	O	E	$(O - E)^2 / E$	R
T	49	33.53	7.14	2.67*
F	34	49.63	4.92	-2.22*
Total	83	83.16	2.06 = χ^2	

*Note. Critical value = 3.841. O = Number of Aviation Flight Students. E = General Population. R = Standardized residual. * Denotes statistical significance @ (.05).*

Table 7. *Calculation of χ² for MBTI (J – P) preference of Aviation Flight Students relative to general population*

Type	O	E	$(O - E)^2 / E$	R
J	27	44.99	7.19	-2.68*
P	56	38.18	8.32	2.88*
Total	83	83.17	15.51 = χ^2	

*Note. Critical value = 3.841. O = Number of Aviation Flight Students. E =General Population. R = Standardized residual. * Denotes statistical significance @ (.05).*

The separate demographic questionnaire was given independently of the MBTI and the results indicated that the students had an average age of 19.6, average ACT score of 23.9 and an average high school grade point average of 3.3 on a 4.0 scale. These results met the requirements for admission into the Aviation Flight Program at SIUC.

DISCUSSION

The results of this study did not find any personality type that comprised a statistical significant percentage of the study population. This study focused on the statistical significance of the personality types of the student population relative to the general population.

The data revealed that there were seven of the personality types that had a significant variance between the student population and the general population. The over represented ISTP, ENTP, INFP and INTJ types suggest that these personality types are drawn to the aviation industry and specifically to the Aviation Flight Program at SIUC.

In Gifts Differing (Myers, 1980), Myers references a study that was conducted by Laney (1949) that analyzed preferences separately concerning college fields of study. The study revealed that the NT combination was the highest percentage for the sciences at 57%. Next was NF at 26% and then ST at 12% of the study population. Although all of the types that were over represented in this study are different from each other, there are some commonalities among them. The ENTP and INTJ both have some similar characteristics. Both of these individuals would be attracted to careers in logic and would focus their attention on future possibilities (Tieger & Barron-Tieger, 2001). They would also want to use their abilities in theoretical and technical development. The INFP individuals would also turn their attention to future possibilities and use their abilities in theoretical development. It is likely that the INFP individuals would not be as interested in focusing on logic and technical development. The ISTP individuals would be more interested in facts rather than possibilities and would use their abilities in technical fields that deal with facts (Myers, 1980).

In Laney’s (1949) study, SF individuals only accounted for 5% of the population that chose science as a field of study in college. ISFJ, ESFJ and ISFP types were found to be under represented in the student population. These three types also have some similarities among them. The SF individuals tend to focus their attention on facts and enjoy occupations that provide practical help and service for people (Myers, 1980). This study confirmed the data presented by Laney (1949).

The combination grouping that this study focused on was the S – N function and the J – P grouping. The S – N dichotomy was chosen because it refers to the way an individual will acquire or access information. This is an important function for pilots as they tend to have to absorb a lot of information in a short period of time (Rose, 2001). The J – P dichotomy was chosen because it reflects whether an individual relies more on the judging process or the perceptive process in dealing with the outside world. This is an important dichotomy for pilots as they are confronted with situations that require them to make effective and efficient decisions (Rose, 2001).

The groupings that had statistical significance compared to the general population were the NP, NJ and SJ combinations. The NP and the NJ were over represented among the students, where as the SJ grouping among the student population was under represented relative to the general population. In the aviation industry, a pilot may find both an S preference and an N preference useful. A pilot could use the S preference to excel in the use of checklists, the routine of details and the use of skills that are learned through repetition (Tieger & Barron-Tieger, 2001). A pilot could use the N preference to solve new problems and enjoy learning new skills.

Pilots may use their senses on a daily basis when needing to remember a large number of facts and details. The pilot that prefers intuition, however, should be aware of these facts and details but may more easily be able to look at the big picture and anticipate future events (Myers, 1998).

The judger and perceiver types may also excel in different areas (Tieger & Barron-Tieger, 2001). A pilot with a J preference may enjoy working with a plan and following it, where as a P preference may be better at adapting to new situations and multi tasking. The characteristics of both the judger and perceiver could be useful in a career as a pilot, however, the pilot preferring perception may find it easier to adapt to the normal work activities within the job. The job requires the ability to adapt quickly and multi-task because a pilot is often dealing with a constantly changing work environment (Rose, 2001).

The NP and NJ had a higher number among the study population as compared to the general population. The SJ had the lowest percentage of the student population, where as the NP had the highest percentage among all the combinations.

Finally, the student population for each individual dichotomy had a higher preference for the E, N, T and P. Of these, the N, T and the P were over represented among the Aviation Flight students when compared to the general population. The higher thinking preference in the student population suggests that pilots with a thinking preference will like the analysis of the job and putting things in logical order as well as, tend to make their decisions on an impersonal basis and reprimand people when necessary (Myers, 1998).

CONCLUSIONS

The purpose of this study was to determine if there is a statistically significant common personality type or common combinations within the personality profiles among students who enrolled in the Aviation Flight Department at Southern Illinois University at Carbondale (SIUC). The findings of Roen's (1991) study revealed that 21.1 percent reflected the ESTJ profile, 11.7 percent were ISTJ, and 10.3 percent were ESTP. The results from Roen's study were not supported by this study. The results of this study indicated that the most common personality types were ENFP (13.25%), ISTP (12.05%), ISTJ (10.84%), ENTP (9.64%) and INFP (9.64%). When looking at these data compared to the general population, it was determined that there was no statistically significant difference among the types ENFP and ISTJ. Further analysis determined that the personality types of ISTP, ENTP, INFP and INTJ were found to be statistically significant and were over represented when compared to the general population.

When the different personality types were analyzed further, the data suggested that among the student population, the NP and NJ combinations were found to be statistically significant and were over represented when compared to the general population. In addition, the N, T and P preferences were also found to be statistically significant and were over represented among the student population.

RECOMMENDATIONS

While these data results, at first glance, did not indicate a significant number of any particular personality types, there were personality types and combinations that did show some statistical significance. This study focused on student pilots that were interested in aviation as a career. Further studies similar to this should be conducted increasing the number in the study population. Similar studies should be conducted correlating the subjects MBTI score to their ACT score and grade point averages to aid in effective recruitment for flight schools.

It is recommended that future studies examine the personality preferences of pilots at different levels to explore if the correlation between success rate and personality preferences has a statistical significance. The MBTI could be a valid and useful tool for career counseling and assessment for the Aviation Flight Department at SIUC and other flight training departments. Future studies using the MBTI could aid those individuals who are thinking of becoming professional pilots as their career choice.

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