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COLLEGIATE AVIATION REVIEW

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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 annually by the University Aviation Association. Papers published in this volume were selected from submissions that were subjected to a blind peer review process, and were presented at the 2005 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.

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>
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>
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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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Collegiate Aviation and September 11, 2001: A Survey of Current Issues

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ABSTRACT

Issues of importance to the collegiate aviation community as a result of September 11, 2001 are still surfacing. With that in mind, the researchers felt it of great importance to determine what continuing effects from September 11th collegiate flight programs might be experiencing. The researchers identified and surveyed 140 two-year and four-year collegiate flight programs in the United States from July to August 2004. Results show that 84% of schools surveyed report the September 11, 2001 terrorist attacks directly affected their collegiate flight program. A majority (86%) reported increased insurance premiums and a majority also agreed that insurance costs are a primary threat to their collegiate flight program. Due to the increase in flight insurance premiums, 70% reported increased student flight costs to offset this increase in operating expenses. Other issues addressed in the survey include general student enrollment, international student enrollment, increased security measures, student costs, and reduction in fleet size.

INTRODUCTION

There are approximately 275 postsecondary institutions offering aviation programs in such disciplines as flight training, management, and maintenance (US Department of Education, 1998). Currently, collegiate aviation is the primary source of pilots to serve the commercial aviation industry and the need for these pilots is to remain high in the foreseeable future (Green, 2003). More than 85% of all pilots hired by the major airlines have college degrees of some kind (Phillips, 2003).

However, as a result of the terrorist attacks in September 2001, the outlook for the aviation community has been uncertain. When the United States shut down the National Airspace System (NAS), the majority of commercial and general aviation aircraft were grounded, airports across the nation were closed, and passenger demand for air travel decreased. Collegiate flight training was temporarily shut down as well. This intensified the economic crisis collegiate flight training faced prior to September 11, 2001, exemplified by exponential increases in insurance costs and higher fuel costs (National Association of Flight Instructors, 2001). As a result, financial woes worsened for these flight programs when restrictions kept their planes on the ground. It took up to two months after the terrorist attacks before some flight programs fully reopened. Years later, flight programs, airlines, and others in the aviation community are still in survival mode (La Corte, 2002).

When the National Airspace System was shut down on September 11, 2001, most collegiate flight programs took the loss much like the rest of the nation's general aviation community. The temporary setback of visual flight rules (VFR) flight training operations (private pilot certification) was unwelcome during the approximately eleven days that VFR operations were prohibited across the nation. Collegiate flight schools were unable to conduct 90 to 100% of their daily flight training operations, interrupting the education of more than 10,000 college students pursuing a degree in professional pilot studies (National Association of Flight Instructors, 2001).

Average daily losses during this time period ranged from $1,000 in revenues for the smaller schools to upwards of $10,000 for the largest collegiate flight schools (Boatman, 2001). While these schools posted daily losses, their fixed costs (mortgage, insurance, and aircraft payments) continued at the rate of thousands of dollars per day. This loss in flight revenue could hardly have come at a worst time. Collegiate flight schools already faced insurance premium increases of up to 50% for the year, and few, if any, insurance companies were able, or willing, to offer relief from premium payments during this crisis (Boatman, 2001).

RESEARCH METHODOLOGY

Clearly, the aviation industry has undoubtedly experienced turbulent times and may face significant restructuring in the next few years. This research study was designed to explore the effects of current trends and issues, including the September 11 terrorist attacks, on collegiate flight programs across the nation.

The sole source of data for this research study was 140 collegiate flight programs located across the United States. The participating flight programs were 4-year public and private universities and 2-year public and private colleges offering comprehensive aviation curricula. Only those collegiate flight programs awarding college degrees in aviation disciplines (Associate or Bachelor's) were selected by the researchers to participate in the study.

The quantitative measure used in this study consisted of a research questionnaire administered electronically to each of the 140 collegiate flight schools. The 54-question research instrument was developed to collect demographic and financial data regarding the individual collegiate flight programs and to assess the responses of the participants (deans, flight center managers, chief flight instructors, etc.) regarding student enrollment, financial and security concerns as a result of recent issues and trends affecting the aviation community. Respondents were also asked to give nominal and ordinal responses to a series of statements using scales related to their collegiate flight program. The research instrument also offered respondents an opportunity to provide any additional comments they felt would be appropriate to this study. All responses and comments were kept anonymous.

In disseminating the research instrument, the researchers were interested in learning the views of these collegiate flight schools regarding four specific topics:

(1) What are the characteristic profiles of the collegiate flight programs representing both the two-year and the four-year institutions across the nation?
(2) What are the financial accountabilities of the collegiate flight programs?
(3) What are the security concerns and/or issues facing the collegiate flight programs across the nation?
(4) What were the overall effects of the September 2001 terrorist attacks on the collegiate flight programs?

RESULTS

The research instrument, *Collegiate Aviation and September 11, 2001: A Survey of Current Issues*, was electronically mailed to 140 collegiate flight programs located in the United States. Eighty completed instruments were received from the 140 flight schools that were initially mailed a research instrument. The 80 research instruments returned by the collegiate flight programs yielded an overall response rate of 57 percent.

Table 1 presents data that characterizes the educational institutional affiliation of the 80 collegiate flight programs responding to the instrument.

The type of academic degrees that flight students can earn in the responding collegiate flight programs are presented in Table 2. As shown in the table, forty-two percent of the flight schools offer an Associate's degree. Furthermore, thirty-eight percent of all responding flight schools offer a Bachelor of Science degree. Lastly, twenty percent of the flight programs offer both academic degrees.

Table 1. *Educational Affiliation of Each Responding Collegiate Flight Program*

Educational Institution	Number of Respondents	Percent of Respondents
4-year institution	46	57%
2-year institution	34	43%

Table 2. *Academic Degrees Offered by Each Responding Collegiate Flight Program*

Academic Degree	Number of Respondents	Percent of Respondents
Associate	33	42%
Bachelor of Science	30	38%
Both	16	20%

Sixty-eight percent of the collegiate flight programs responding to the survey have provided flight training for more than 15 years. Thirty-four of the 80 responding flight schools have actually been in operation for more than 30 years. The response rate of the 80 flight schools that stated how many years they have been in operation are presented below in Table 3.

Table 3. *Total Number of Years Respondents Have Been in Operation*

Number of Years Collegiate Flight Programs Have Been in Operation	Program Response	Percent of Response
0 – 15 Years	26	32%
16 – 30 Years	20	25%
31 – 45 Years	20	25%
Over 45 Years	14	18%

Each collegiate flight program was asked how many full-time students are currently enrolled in their flight program. Table 4 identifies the flight school's responses regarding enrollment of full-time flight students.

Table 4. *Full-time Flight Students Enrolled in Each Responding Collegiate Flight Program*

Number of Full-time Students Enrolled in Each Collegiate Flight Program	Program Response	Percent of Response
1 – 100 Full-time Students	46	57%
101 – 250 Full-time Students	27	34%
251 – 500 Full-time Students	4	5%
Over 500 Full-time Students	3	4%

As shown in Table 4, fifty-seven percent of the collegiate flight schools responding to this study indicated they have at least 100 full-time flight students enrolled in their program. About one-third of the respondents stated they have 101 to 250 full-time students. Nine percent of the flight programs have full-time enrollment of over 250 students. Two follow-up questions on the research instrument asked the flight schools how many full-time female and international students are currently enrolled in their flight programs. The majority of responding collegiate flight programs, 93 percent, stated that 20 percent or less of full-time students are female; and 92 percent of the flight programs indicated that only 20 percent or less of their full-time students are from foreign countries.

The collegiate flight programs were asked to approximate the typical flight costs for a student earning a private pilot certificate in their flight program. This information is presented in Table 5. The flight costs were sub-grouped into four separate categories: $0 - $5,000; $5,001 - $7,500; $7,501 - $10,000; and more than $10,000. Approximately 85 percent of the 80 flight programs reported the flight costs for a student earning a private pilot certificate from their flight school is less than $7,500. Five collegiate programs, or 6 percent, indicated the flight costs for a private pilot certificate is more than $10,000 at their school.

Table 5. *The Flight Costs for a Student Earning a Private Pilot Certificate*

Student Flight Costs for Earning Private Pilot Certificate	Number of Respondents	Percent of Respondents
$0 - $5,000	37	47%
$5,001 - $7,500	30	38%
$7,501 - $10,000	7	9%
Over $10,000	5	6%

A statement in the research instrument asked the respondents what percent of their flight students receive some form of campus-based financial assistance. Approximately three-fourths, 74 percent, stated that at least 50 percent of their students received financial assistance to assist them with their flight costs. Furthermore, 68 percent of flight programs offer aviation internships and/or scholarship opportunities to assist their student pilots with flight training costs.

Table 6 indicates the average age (manufacture date) of each responding collegiate flight program's aircraft fleet. Almost half (47 percent) of the respondents have aircraft that are between 11 and 20 years old, and 9 percent of collegiate flight programs responding to the survey have fleets that are over 20 years old

Table 6. *Average Age of Respondents' Aircraft Fleet*

Average Age (Manufacture Date) of Aircraft Fleet	Number of Respondents	Percent of Respondents
1 – 5 Years	10	14%
6 – 10 Years	22	30%
11 – 15 Years	26	36%
16 – 20 Years	8	11%
Over 20 Years	7	9%

A follow-up question asked each flight program how they typically acquire their aircraft fleet. Seventy-three percent of the flight schools indicated they purchase new aircraft. One of the 4-year flight schools responding to the survey commented, "We purchase a mix of new and used aircraft since some of the aircraft we use such as the Cessna 310 are not available as new aircraft." When asked where the schools acquire the capital for purchasing aircraft, 40 percent of the flight programs receive allocations from their college or university and 35 percent use revenues from their flight program to purchase new aircraft. A responding 2-year school stated, "We acquired our fleet of aircraft after leasing them for a year and then purchasing them on a grant. We do not have means to replace aircraft other than from grants." Lastly, approximately two-thirds (66 percent) of the flight programs reported that the city or county owned the airport where the school operates their collegiate flight training. Only 12 percent of the flight schools responding to the study stated that their college or university owns the airport.

The Likert-type research instrument statements regarding the perceptions of the collegiate flight program respondents are presented in Table 7. The respondents indicated their perceptions with these statements on four-point Likert scales.

Table 7. *Responses of Collegiate Flight Programs Regarding the Effects of the September 11, 2001 Terrorist Attacks on Collegiate Aviation*

Number of Responding Flight Programs - Percent of Total Respondents

Likert-Type Statements	**SA**	**A**	**D**	**SD**
The effects of the September 11, 2001 terrorist attacks have created a negative public perception of collegiate flight training programs in the U.S.	2 2%	24 30%	38 48%	16 20%
The proposed new security measures at general aviation airports (flight centers) will bring more costly changes to our collegiate flight program.	13 16%	45 57%	18 23%	3 4%
Our institution needs to do more to improve security at our collegiate flight center.	4 5%	22 28%	47 59%	6 8%
There will be a decline in international students in our collegiate flight program due to increased scrutiny placed on these students studying at U.S. colleges and universities.	14 19%	38 51%	21 28%	2 2%
Insurance costs are a primary threat to our collegiate flight program.	19 25%	31 40%	24 31%	3 4%
Fuel costs are a primary threat to our collegiate flight program.	20 26%	40 53%	15 20%	1 1%
The current cost of flight training at our collegiate flight school has an effect on the ability of the typical college student to pursue an aviation career (pilot) at our institution.	35 44%	31 40%	12 15%	1 1%
The lack of financial assistance available to flight students is a primary threat to our collegiate flight program.	27 34%	22 28%	27 34%	3 4%
Our institution/aviation department makes efforts to develop the interest of individuals from underrepresented groups (minorities and women) in undertaking a career in aviation.	20 26%	54 69%	4 5%	0 0%

Note: The abbreviations used in the table are as follows: SA – Strongly Agree; A – Agree; D - Disagree, and SD – Strongly Disagree.

Of those flight program respondents indicating a preference to the statement, "the effects of the September 11, 2001 terrorist attacks have created a negative public perception of collegiate flight training programs in the U.S.," 32 percent of the flight schools agreed, compared to 68 percent who disagreed with the statement. Regarding this statement, one of the flight schools added, “Only the media creates negative public perception.”

<u>Security Measures</u>

Seventy-three percent of the collegiate flight programs agreed with the statement that "the proposed new security measures at general aviation airports (flight centers) will bring more costly changes to our collegiate flight program."

Seventy percent of the responding flight schools agreed with the statement "there will be a decline in international students in our collegiate flight program due to increased scrutiny placed on these students studying at U.S. colleges and universities." In support of this statement, one respondent said that screening of flight students is critical in the prevention of the misuse of aircraft and terrorist incidents. Fearing that flight schools have the potential to become training grounds for terrorists in the future, several states are seeking to restrict flight instruction and require background checks for international students. Going one step farther, some state lawmakers have even suggested that students should be barred from taking flight classes if they have been convicted of serious crimes (Hinnant, 2002).

Insurance and Fuel Costs

Two-thirds, 65 percent, of the flight schools agreed that, "insurance costs are a primary threat to our collegiate flight program" and approximately 80 percent agreed with the statement, “Fuel costs are a primary threat to our collegiate flight program.” A 4-year flight school commented, “Fuel costs have not changed that much, insurance costs are out of control. They dictate how you can operate your flight program. We live close to a nuclear facility and that has had an impact also.” Agreeing with the respondents, Stephen Gurr concurs that the economy has had the biggest impact on flight school in the two years since September 2001. And spiraling insurance costs and high fuel prices are big reasons why many flight schools have gone out of business in the past three years. Gurr reports that the owner and CFI of an air service company witnessed his insurance costs on a Cessna 172 jump from $2,500 a year to $6,000 a year in just three years.

Collegiate flight programs are in fact feeling the pain of these rising costs. The head flight instructor of a large collegiate flight program believes some of the rising operating costs, particularly insurance, stem from the threat of terrorism. Insurers believe there is a higher risk that something is going to happen to an aircraft, so naturally they want to levy that risk on the owner (Gurr, 2003). However, one of the responding 4-year schools to this study added, “Our insurance cost has increased only ten percent. Increases were more due to new aircraft than due to impacts of 9/11.”

Financial Assistance

Lastly, only 16 percent of the responding collegiate flight programs disagreed with the statement that, "the current cost of flight training at our collegiate flight school has an effect on the ability of the typical college student to pursue an aviation career (pilot) at our institution." In comparison, an overwhelming 84 percent of flight schools agreed that current flight costs has an effect on the ability for students to pursue a flight program at their institution. One of the responding 4-year schools stated, “Most financial aid at our institution is utilized to pay tuition costs first, about $18,000 year; thereafter, flight costs are subsidized by student loans.” Another 4-year flight school added, “The absurdly low limits on federally-subsidized loans are a major barrier for our students. These loans do not even cover 50 percent of in-state tuition and room/board, no less flight training costs.”

DISCUSSIONS AND CONCLUSIONS

The economic viability of the general aviation community was traumatized during the week of September 11, 2001. The terrorist attacks left aviation schools with many negative perceptions and financial burdens. During the shutdown, the income of the nation’s approximately 2,400 general aviation flight schools, including collegiate flight schools, was effectively zero (National Association of Flight Instructors, 2001). And yet, collegiate flight programs had to continue to meet their financial obligations such as rent, electricity, and insurance for both the facilities and the planes (Poynor, 2001).

While many other businesses throughout the nation resumed productive commerce only a few weeks after the terrorist attacks, the general aviation community has not yet recovered. A flight training program on Long Island has lost about 35 percent of its business. Several students have quit and inquiries from potential students have dropped to zero (Lombardo, 2001). Moreover, many flight schools have gone out of business since September 2001 though the actual number is somewhat elusive (Lombardo, 2001). However; a Washington DC lobby group for general aviation and flight schools estimates that 25 percent of the nation's flight schools have gone out of business since the September 11 terrorist attacks (Gurr, 2003). Six collegiate flight programs asked to participate in this study responded they no longer offer flight training at their institutions. One of the 2-year schools remarked, "Our college no longer has an aviation program. It was cancelled due to low enrollment and budgetary constraints." A second 2-year school added, "We have since closed our flight program. We are now struggling to keep our Aviation Management program alive."

During his 2001 testimony, Phillip Poyner stated once closed, most flight schools will not reopen. The financial returns are so small that once capital has left the flight training schools it is unlikely to return. Given this dismal scenario, at some point in the future the dissolution of more flight programs across the nation may occur. As a result, we will be training fewer pilots and without pilots in the pipeline, the commercial airlines and other civil aviation employers will run short of pilots in a relatively narrow amount of time. Poynor supports this statement by indicating that approximately 30 percent of all commercial airline pilots will retire by 2007.

Poynor's remarks and comments from several of the responding flight schools are significant because approximately 85 percent of all pilots hired by the airlines have college degrees. Plus, most corporate pilots flying for Fortune 500 companies hold college degrees. Therefore, college-educated pilots tend to have better flying jobs than those without higher education (Phillips, 2003). Furthermore, the National Academy of Sciences believes that collegiate aviation is the major source of training student pilots because it has the potential to produce pilots specifically trained to the standards recognized by the commercial air carriers (US Department of Education, 1998).

This study asked collegiate flight programs if the September 11, 2001 terrorist attacks directly affected their flight programs. An overwhelming 84 percent of respondents stated their flight programs were directly affected by the attacks. Furthermore, 75 percent of the flight schools indicated their insurance costs have increased as a result of the terrorist attacks. As a result of increased insurance costs, 70 percent of the responding flight programs stated they increased student flight costs to offset this increase in operating expenses. Lastly, only 60 percent of the collegiate flight schools reported their flight programs have returned to normal operations since the September 2001 terrorist attacks.

Though many of our collegiate flight programs are still struggling, some in the industry say things are beginning to improve. In Utah, a flight school and charter operator was shut down for three days after the 2001 attacks. His charter operation lost approximately $6,000 a day and the flight instruction program lost about $2,500 a day. The owner said his student enrollment remains fairly constant only because his company provides flight training for one of Utah's community colleges (Lombardo, 2001). A responding 4-year school stated, "Training in the Baltimore/DC area (where our 2+2 program with a community college operates) was shut down completely for over four months after 9/11. Since then, it has resumed normal operations."

As time has progressed and healing has occurred, there are many collegiate flight programs coming back to levels that are reasonably close to where they were before September 2001. One of the 4-year schools responding to this study stated, "We will be back (slightly beyond) to 2001 levels with the number of currently paid applicants for the fall 2004 entering class. We will be up 6 students from 2001." Another 4-year school added, "We are normal in our operations, but our enrollment has not returned to the levels we had for the fall 2001 enrollment." And yet, there is that final comment from one of the responding 2-year flight schools, "Here is a news flash. No one will ever be back to normal after 9/11."

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Scenario-Based Private/Instrument Syllabus versus Traditional Maneuver-Based Syllabi: A Preliminary Descriptive Analysis

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ABSTRACT

The Aerospace Department at Middle Tennessee State University and the NASA Langley Research Center entered into a cooperative agreement in 2003. The project is named the SATS Aerospace Flight Education Research (SAFER) and is part of NASA's Small Aircraft Transportation System (SATS) initiative. The SATS project envisions a future flight environment that employs light aircraft to transport people and cargo from point to point using small, under utilized airports, instead of the major gridlocked airports. The aircraft used in the SATS vision would take advantage of a range of emerging technologies including glass cockpits, new structures, and new engines. But with the understanding that the best aircraft and the best systems are still only as good as its operator, MTSU Aerospace set out to explore how pilot training might be different in the SATS environment. The SAFER project therefore takes beginner pilots and completes their initial Visual Flight (VFR) and Instrument Flight (IFR) flight training in technically advanced aircraft to determine how best to educate the next generation of pilots in the next generation of aircraft. The availability of information from an automated flight deck can be easily adapted to scenario-based training, so the SAFER researchers decided to incorporate scenario, rather than strictly maneuver-based training as the core of the training syllabus. This approach instantly begs the question: If you train using a scenario-based method, will the students also develop the "stick and rudder" skills that are also so important for pilots to master? The early results from the SAFER project indicate that piloting skills (stick and rudder) are being mastered despite the scenario-based method, and that decision making skills are being increased.

INTRODUCTION

Light airplanes with advanced avionics and flight management systems are on the market today, but inquiry into how best to teach using this equipment either does not exist or is very limited. These advanced systems have reached the market before thorough testing of "best practices" has been conducted and already several "automation induced" accidents have occurred (General Aviation TAA Safety Study, 2003). The SAFER project is one attempt to do the testing and make discoveries to prevent additional accidents. Specifically, the SAFER project has two primary objectives: 1) to learn what old topics of instruction are becoming obsolete with the introduction of advanced systems, and 2) to learn what new topics/problems will arise as we begin learning in "glass." In 2004, flight training began within the SATS Aerospace Flight Education Research (SAFER) project. Students were taught in Technically Advanced Aircraft (TAA), using a FAA approved, scenario based syllabus that leads to a single Private Pilot and Instrument Rating practical test.

THE RESEARCH QUESTIONS

The researchers of the SAFER project are in the preliminary stages of the data collection. The project is on going and the final report of findings will come at the conclusion of the project. The researchers are gathering data to help answer some of the basic research questions: If you teach people to fly from the very beginning using scenario-based training rather than maneuver-based training, will "stick-and-rudder" skills suffer? Will scenario-based training produce pilot who are better prepared to operate safely in the real world flight environment?

METHOD

The researchers utilized a qualitative approach as outlined by Bogdan and Biklin (1998), which includes an intense data collection process. Observations were taken from many angles, including primary observations, coding and analysis, record keeping, and journal writing on the part of students, instructors, coordinators, and researchers. The data presented in this paper represents just one form of data acquisition used by the SAFER researchers and should be considered a sub-set of the total data being collected within the project. For this analysis, the subjects had recently completed the scenario-based training in Garmin G-1000 equipped Diamond DA-40 aircraft and were given a post syllabus completion, evaluation flight. The students had received a private certificate with instrument rating having amassed less than 104 hours total time and without the normal divisions between the two certificates/ratings.

All the students of the SAFER project are college students majoring in Aerospace at Middle Tennessee State University. To become eligible for the SAFER project students had to meet two criteria. First, they must have already been accepted into the program's flight laboratory, which requires a 2.5 cumulative college GPA, or a 2.8 high school GPA for incoming freshman students. Second, the students must have had less than five flight hours of experience with a flight instructor. These students were also enrolled in a separate section of AERO 2230, which is the Private Pilot Fundamentals course. In this special SAFER section of the course, a new approach was utilized. Instead of the traditional private pilot curriculum, the course taught decision-making skills. The course content included the analysis of NTSB accident reports and hazardous pilot attitudes. Students prepared themselves for the regular FAA Private Pilot and Instrument Rating knowledge tests with their individual flight instructors, in weekly study sessions, and on their own. Fourteen students formed the first cohort of SAFER students. The training began in September 2004 as the fall semester started. At the time of this writing, nine of the fourteen students have completed the program, having passed the single practical tests to become Private and Instrument pilots. The second cohort began in January 2005 as the spring semester started.

THE EVALUATIVE FLIGHT

After receiving the private license with instrument rating, the students were asked to participate in a flight designed to assess a variety of skills. The performance of the students would then be compared at a later time to students who had received the instrument rating in the traditional fashion. The evaluative flights were conducted under Visual Meteorological Conditions (VMC), with the researcher acting as Safety Pilot.

Students were given 10 minutes preparation time. The scenario was as follows:

1. The initial instruction was to depart Airport A and proceed to Airport B (about 50 nm). Soon after departure, the researcher deactivated both screens of the G-1000. The student was therefore forced to precede using dead reckoning and pilotage across an area containing few landmarks and roads. Upon arrival at Airport B, the student was instructed to execute a touch and go and climb out, departing to Airport C.
2. As soon as the student reached altitude, the researcher failed the engine, requiring the student to execute a simulated emergency landing.
3. As the student climbed out from the simulated landing, he/she was instructed to don a vision-limiting device and go on instruments, at which time the researcher reactivated the screens. The student was instructed to proceed to Airport C and shoot the SDF approach, with the researcher acting as ATC.
4. On the way to Airport C, the researcher required to the student to execute steep turns to 45 degrees under the hood. This was followed by recovery from very unusual attitudes, which went nearly to the edge of what is defined as aerobatic flight. These were done with little set-up and some urgency from the researcher, as if to avoid an obstacle or allow the researcher to see something on the ground.
5. The student was, of course, required by this scenario to set the avionics up for the new destination. As soon as the

student depicted the approach final course on the screen, the researcher, as ATC, required vectors that ensured a very dis-advantageous intercept course, that is, one which would require a very steep turn to intercept from an oblique angle. The student was then instructed to conduct a touch and go after raising the hood at one mile distance from the touch-down point.

6. Following departure from Airport C, the student was instructed to fly to the missed approach hold and fly the published hold, while under the hood. This involved a 180 degree turn from the departure course and setting up the avionics while climbing out. After the second turn around the hold, the student was instructed to depart to Airport D.
7. Soon after turning to Airport D, the student was contacted by the researcher as ATC and told to report ready to copy an amendment to clearance. The amendment instructed the student, for reasons of national security, to intercept the nearest segment of a nearby Standard Terminal Arrival Route (STAR) to a Class C airport. The instructions were to first proceed to the nearest STAR transition and then follow the STAR procedure to the Class C airport.
8. The student, upon intercepting the STAR, or not, was allowed then to return to the origin of the flight, Airport A, and execute the GPS approach. The student was allowed the remove the hood at one mile from the touch down point and land.

This flight addresses a number of issues, which a pilot might encounter in real life (Parasuranman, 1997). These include changing destinations and clearances, failed equipment, emergencies, stick and rudder skills, and maintaining safe attitudes while engaged in a number of potentially distracting activities**.** This preliminary report will address only stick and rudder skills.

THE TRAINING SYLLABUS

Five airplanes were taken from the MTSU flight training fleet for exclusive use in the SAFER project. Each was equipped with the Garmin G-1000 system and autopilot. The features of the Garmin G-1000 system make it possible to blend the world of visual flight and the world of instrument flight – but that is not the traditional way that students are taught today. Students are taught visual flying first and pass a series of tests to obtain the Private Pilot Certificate. The Private Pilot then takes on additional training and testing to become Instrument Rated and this allows the pilot to fly in and through the clouds. The Primary Flight Display of the G-1000 provides a representation of the horizon that is far advanced from basic attitude gyro indications.

Part of the cooperative agreement with NASA called for the SAFER project to work in conjunction with the FAA Industry Training Standards (FITS) initiative. The FITS group had previously developed a generic flight training syllabus that combined the training for both Private Pilot and the Instrument Rating into one. The SAFER team took the generic FITS combination syllabus and rewrote it for specific use at MTSU. In time, the syllabus was approved by the FAA under Part 141 and added to MTSU's existing Air Agency Certificate. The MTSU version of the FITS syllabus (2004) became the first combination Private and Instrument Course for Technically Advanced Aircraft ever approved by the FAA.

The syllabus is unique in two other important ways. First, the entire combination Private and Instrument course is scenario based. Traditionally, pilots are trained using a series of maneuvers that the student masters with drill and practice. The SAFER syllabus still teaches basic skills, sometimes referred to as "stick and rudder" skills, but instead of drill and practice, the maneuver is incorporated into an overall scenario lesson. The very first lesson of the SAFER syllabus is a flight to another airport – a mission, rather than a set of maneuvers. The second unique feature of the SAFER syllabus is that it has no minimum flight time requirements. Traditionally trained students must meet several minimum flight time requirements to move from one step to another and to receive FAA pilot certification. It would be possible for a pilot to have achieved an acceptable performance level in a particular area of training, but still be required to take additional training just to reach the minimum flight time number. Students in the SAFER project are judged by performance only, not flight time. When students complete each lesson of the SAFER syllabus they are recommended for testing regardless of how many or how few flight hours they have accrued. At the time of this writing, nine of the original (Fall 2004) fourteen students of the SAFER first cohort have completed the SAFER syllabus and have passed the combined Private Pilot and Instrument Rating practical test. The student who had the lowest time at completion had 74.5 flight hours and the highest had 104.1. The average time to complete was 88.74 flight hours.

THE FAA EXEMPTION

A major problem for the SAFER students is that they are training in a time of transition. The syllabus that they use and the airplane that they use are all new, but the FAA testing is old. Today, the Code of Federal Regulations 14, Part 61.65(a) (1) (2005) requires that an applicant for the Instrument Rating, already be the holder of the Private Pilot Certificate. But the SAFER syllabus bypasses the Private Pilot test when students would otherwise be eligible to take it. Instead, the SAFER students remain as student pilots until the day that they take the combination test and become Private Pilots and Instrument Pilots all at once. So the SAFER syllabus, is in fact, in violation of the Federal Aviation Regulations. To remedy this problem, the SAFER researchers petitioned the FAA for relief from 61.65(a) (1) and on December 10, 2004, the FAA granted an exception to this rule for the SAFER project. FAA exemption number 8456 (2004) allows the SAFER students to take a single practical test to gain both Private Pilot and Instrument Pilot privileges. The exemption came with a new Practical Test Standard (PTS) that is to be used by a pilot examiner when administering the combination test. The exemption has only been granted to MTSU and the SAFER project and extends until December 1, 2006.

The exemption has not eliminated all "old versus new" roadblocks to the training. The SAFER students still are required to take two knowledge tests that are administered via computer. The two tests contain questions that are not applicable to technically advanced aircraft. The new PTS that came along with the exemption is better than two separate tests, but still requires many drill-and-practice type maneuvers that do not match well with the SAFER scenario based syllabus. This forces the SAFER students to step out of the role of the scenario and occasionally revert back to pure maneuver practice simply to meet the requirements of the test. Using the old form of testing with the new form of training has become a very real impediment to the students that lengthens the time of training and pushes instructors to "teach to the test" rather than "teach for the real world" as the SAFER project intends to do.

RESULTS

The stick and rudder skills addressed by the evaluative flight may be described as follows:

a. The failed G-1000 trip to Airport B causes the pilot to navigate, approach, and land without instrumentation of any kind.
b. The simulated emergency causes the pilot to maneuver to land without instrumentation of any kind.
c. The ATC instructions to intercept the SDF invite the pilot the engage in a very steep turn under IMC to get the inbound course.
d. The climb out from Airport C invites the pilot to be distracted while rapidly setting up the avionics under IMC and executing a 180 degree turn.
e. The unusual attitudes and steep turns are a direct measure of the pilot's ability to respond to sudden needs to maneuver under IMC.

It may be said that the whole scenario was set up to invite pilots with fewer than 100 hours total time to engage in a series of activities wherein the possibility of an upset, tight spiral, or stall could be anticipated.

The outcomes indicate that these students, despite having been trained with scenarios rather than maneuvers as the emphasis, still have a high degree of stick and rudder skills. At no time did any pilot in fact become upset, get near stall conditions, or enter even an incipient tight spiral. Examples follow:

a. When the researcher suddenly yelled, “Man, look at that, it’s a Pitts just below us. I got to look at that. My airplane” and entered a steep turn to 45 degrees bank with 15 degrees down nose, the students returned the aircraft to straight and level without comment or incident when the researcher said, “OK, your airplane” while still in the unusual attitude.
b. No student could be induced to accept the steep intercept angle on the SDF. All either maneuvered to avoid the angle or requested an amendment from ATC.
c. Students flew and landed with avionics failed and blank screens using pilotage and dead reckoning without any discernable discomfort.
d. Students maneuvered for a forced landing with blank screens without discernable discomfort.
e. No student had any difficulty in simultaneously setting up the avionics, turning, climbing, finding the published hold and flying it given no warning of the need until about 100 feet off the ground going in the opposite direction.

CONCLUSIONS

In order to successfully complete this evaluative flight, students with fewer than 100 hours total time were required to fly entirely from outside reference and land, maneuver for a forced landing from outside reference only, recover from steep turns and very unusual attitudes under simulated instrument conditions, and fly under distracting conditions under simulated instrument conditions. The purpose was to mimic as closely as possible the stick and rudder skills that a pilot might encounter in the real world. No pilot failed to perform safely, and no pilot succumbed to distractions.

It appears from these data that the teaching of formal stick and rudder skills such as turns-around-a-point or rectangular course may be of little utility if they are subsumed into the day-to-day reality of scenario training. The pilots in the SAFER Project do not perform worse than their contemporaries who have received formal, repetitive maneuver training; rather, they perform as well or better. Further, their ability to cope with changes, amendments, and demands for performance seems more than up to the various tasks.

The formality of formal maneuvers appears to be some of the problem. The Practical Test Standard (PTS) requires a down wind entry for turns-around-a-point, for instance, and sets standards for altitude, roll out, and so on. However, when SAFER students are presented with turns around the end of an emergency landing field, they perform very well.

The evidence at this point tends to support the claim that all the time and money spent on formal maneuver training in traditional syllabi appears to be immaterial when applied to scenario training in TAA. SAFER students perform admirably in the real world to the extent that the evaluative flights were able to mimic it and appear, in addition, to cope on levels more associated with two or three hundred hours total time, rather than 85 to 90-hour pilots. The SAFER researchers believe that the concerns expressed in reference to stick and rudder skills are unfounded, but work continues to evaluate a larger sample size.

FINAL THOUGHTS AND RECOMMENDATIONS

The SAFER researchers should not be characterized as “anti-maneuver.” We fully advocate the strong teaching of skills that will lead to excellent “stick-and-rudder” control of the airplane in all flight circumstances. But our research has led us to believe that these essential pilot skills can be acquired within scenarios that mean something to the student rather than repeated drill and practice maneuvers that have no real-world context. It appears that the art of landing an airplane, for example, still requires several practice repetitions beyond the number received within the scenarios alone. Consequently, the movement from maneuver-based to “mission-based” training is a spectrum rather than a single step.

The biggest impediment to implementation of the scenario-based training approach is the current method in which pilots are tested. Technology improvements have been made rapidly while the pilot testing procedures have remained relatively unchanged (The most recent Practical Test Standards for the Instrument Rating does require some scenario-based training, but no further guidance is given to examiners, applicants, and instructors). The data collected to this point is preliminary, yet the researchers are compelled to call for sweeping reform of pilot testing in light of what has been discovered. We understand that maneuvers are easier to grade, but they do not prepare the pilot for real-world challenges found in today's flight environment. A flight testing procedure that grades pilot skills while immersed in real-world scenarios would be a better evaluation of a pilot's readiness for operations within the national airspace system. Scenario-based testing would require a shift in approach and evaluation techniques. Examiners would need to grade pilots based with the understanding that in any given situation there may be an array of "correct" decisions, and each could insure a safe outcome. The Practical Test should incorporate all skills necessary for a pilot to safely complete a flight from one airport to another, but eliminate maneuvers that would not otherwise be normally required during that flight.

To make this shift in testing methodology a reality, additional data will be needed. The SAFER research is ongoing and additional

Research should be undertaken. The FAA will soon be forced to make changes or find themselves in danger of being completely behind the technology and methods of the times. It is our hope that this research, and others, will help make the transition possible and timely.

CONTINUING SAFER RESEARCH

In the fall of 2004, the first SAFER cohort began flying and using the combination Private/Instrument syllabus which is both FITS accepted and FAA Part 141 approved. The first cohort completed every lesson in an airplane. In the spring of 2005 the second cohort of SAFER students began, also using the combination syllabus, but those students had access to a DA40 / G-1000 flight training device to complete all ATD lessons from the syllabus. In the fall of 2005, the third cohort of SAFER students will begin. The third cohort will fly in the TAAs but will use a traditional instrument syllabus, rather than the combination syllabus. Data and analysis from the second and third cohorts will be available when completed

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**Exit Exams for College Flight Programs:
Redundant Activity or Certification of Competency?**

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ABSTRACT

A wide variety of training organizations prepare prospective pilots for Federal Aviation Administration (FAA) certification. Students enrolled in collegiate flight training programs also complete several FAA certifications; however, their graduation is contingent upon completion of an academic curriculum rather than standardized exit examinations that measure competency for professional flight duties within the aviation industry. Since establishment in 1988, the Council on Aviation Accreditation (CAA) has provided a measurement of collegiate flight program quality and attempted to promote curricular standardization; however, the number of college flight programs currently accredited remains relatively small. This paper presents the results of a survey that addressed issues related to the establishment of a standardized college flight program exit examination. Many flight program administrators currently believe that existing FAA certifications provide a solid foundation for program graduates and that grooming to meet professional industry standards is the responsibility of the hiring airline/operator. Survey findings suggest an interest in the establishment of four-year flight program exit examinations, but respondents expressed a concern about the form of such exams and how to address those who fail. The findings described in this paper were analyzed to evaluate support in the aviation education community for standardized exit examinations as well as to promote a dialogue between aviation industry and flight program administrators on the utility of exit examinations.

INTRODUCTION

Professional pilot competency is an aspect of the aviation industry that is frequently taken for granted by the traveling public. However, an accident or incident that results from pilot error or the appearance of aircrew incompetence quickly results in significant media coverage of air carrier operations and frequently leads to substantial loss of revenues. Initial and recurring Federal Aviation Administration (FAA) flight examinations are designed to certify aviation competence of new and experienced pilots. A lengthy track record of aircraft mishaps attributed to pilot error, however, brings into question the accuracy of FAA evaluations as the sole measurement of professional competency. Many professional pilots are graduates of two- and four-year college flight programs that require a number of FAA flight certifications as well as traditional college coursework. The resources and curriculum associated with college programs vary widely and requirements for program completion vary accordingly. The lack of standardized program expectations and ongoing concern over pilot competency in a more complex and technologically advanced flight environment has prompted interest in some form of exit examination to certify a minimum level of competency for professional flight employment.

Various forms of exit examination are designed to certify competency in a desired area of knowledge and commonly used in secondary education as well as for admission to post-secondary academic programs. Exit examinations are a common part of the board certification process for many professions. The FAA has established Practical Test Standards, which define the criteria for final certification or exit examination for all certificates and ratings issued under Federal Aviation Regulations (FARs). Certifying a certain level of competency is the end goal of pilot examiners and FAA Practical Test Standards provide guidelines by which applicants are to be judged by examiners. Under current regulations, individuals who fail part of a flight certification test are required to receive remedial training on the area or areas that were found to be deficient and must then present an endorsement from a qualified instructor before a certification retest may be attempted. There is currently no limit to the number of times an applicant may attempt to perform an unsatisfactory maneuver during rechecks. As a result, a relatively weak applicant may eventually be successful in completing the maneuver and obtaining the desired certificate or rating. This marginal applicant receives the same certification documents as an applicant who was successful on the first attempt.

On January 27, 2005, the National Transportation Safety Board recommended that the Federal Aviation Administration "require all Part 121 and 135 air carriers to obtain any notices of disapproval for flight checks for certificates and ratings for all pilot applicants and evaluate this information before making a hiring decision, and conduct a study to determine whether the number of flight checks a pilot can fail should be limited and whether the existing system of providing additional training after a notice of disapproval is adequate for pilots who have failed multiple flight checks" (NTSB, 2005, p. 3). This recommendation was in response to a recent air carrier accident that was a result, in part, from poor training and multiple retests by the pilot involved. In this particular case, the accident pilot had received nine rechecks during the course of professional certification (NTSB, 2005). Although many Part 121 and 135 operators question an applicant's pass/fail rates during the job application process, potential employers are currently not privy to the number of times a specific flight certification test was failed. While making this information available to commercial operators may seem like a legitimate step, such legislation may lead flight training providers to "teach the test" rather than trying to provide a broad and well-rounded introduction to the aviation environment. Wright (2002), an FAA flight standards manager, views pilot certification, type ratings, and flight instructor/pilot examiner qualifications as "oriented towards passing the knowledge and practical tests rather than outlining a scenario-based training and testing approach" (p. 13).

The majority of flight training is completed under the requirements of FAR Parts 61 and 141. After flight training, an applicant must successfully complete a certification exam to demonstrate proficiency in the required areas for the desired pilot certificate or rating. The methods by which examiners are qualified and exams are administered under Parts 61 and 141 are different. For Part 61 and 141 schools without examining authority, Designated Pilot Examiners (DPE) are selected through a National Examiner Board process that screens DPE applicants and serves as a clearinghouse for local Flight Standard District Offices (FSDO) when a need appears in a specific geographic location. All DPEs are selected directly by the FSDO that has jurisdiction over a geographic area where the DPE will provide services. Part 141 schools with examining authority, on the other hand, have a Chief Instructor approved by the FSDO, similar to the way DPEs are certified. Chief Instructors, however, have the authority to designate Check Instructors who pass certain proficiency tests and are then approved by the FSDO. Differences in the way these examiners are selected and certified, may lead to unequal scrutiny of applicants during certification exams.

Another difference between Part 61 and 141 schools is the way certification exams are administered. According to FAR 61.43 (FAA, 2005a), all applicants must demonstrate satisfactory proficiency and competency within the approved standards. This regulation further states that if an applicant fails any area of operation, that applicant fails the practical test. Reference to FAR 141.67 (FAA, 2005b) reveals that tests given by a flight school which holds examining authority must be approved by the FAA and be equal in scope, depth, and difficulty to requirements established in Part 61. On the surface, it would appear that there is little difference between the requirements of these sections; however, examiners at Part 141 schools with examining authority have the ability to discontinue a certification exam if an applicant fails to perform satisfactorily in a given area without issuing a Notice of Disapproval or "Pink Slip." On the other hand, Designated Pilot Examiners are required to issue a Notice of Disapproval for any unsatisfactory area. An Aircraft Owners and Pilots Association staff member (AOPA, personal communication, April 5, 2005) notes that Part 141 school examiners may stop an evaluation at any time, allow the student to be given remedial training, and then retest. In this instance, no documentation is completed or sent to the FAA until all testing is completed. It is not the purpose of this paper to make a determination of which system produces better pilots (Part 61 or 141 training), but to highlight standardization issues for discussion.

In an effort to formally accredit and promote the quality of college and university aviation programs, the Council on Aviation Accreditation (CAA) was established in 1988 (CAA, 2005a). The goals of CAA accreditation are to “stimulate collegiate aviation program excellence and self improvement; establish uniform minimum educational quality standards; and increase the credibility, integrity, and acceptance of collegiate aviation programs within institutions of higher education and aviation communities” (CAA, 2005b). Certain aviation program content areas must be covered to meet CAA standards. Various aspects of a college program are evaluated through self-assessments by the host school and through external assessments by a CAA review team. Flight education is one such aviation program that can be accredited. A recent CAA initiative is to shift criteria for future accreditation from content-based assessment to outcomes-based assessment. While CAA has provided a viable avenue for aviation program standardization, to date only 16 of 87 potential associate and bachelors aviation flight education degree programs have been accredited and some have declined participation in the current CAA accreditation process (CAA, 2005c; University Aviation Association, 2003).

Professional and educational competency exams are not new. In the medical field, new doctors must pass medical board exams; new lawyers must pass the bar exam; accountants must pass CPA (Certified Public Accountant) exams, and the list goes on. In aviation, the National Business Aircraft Association offers a comprehensive exam to certify corporate aviation managers. Likewise, the American Association of Airport Executives provides certification at two levels: the Certified Manager and Accredited Airport Executive. In graduate education, doctoral degree candidates must pass their preliminary exams (summary oral and/or written questions regarding their course subject areas) and similarly, many masters degree candidates must defend their theses or directed projects.

A recent initiative established to ensure the preparedness of pilots to enter this career field is the Professional Aviation Board of Certification (PABC). This independent, non-profit organization strives to enhance aviation and public safety through its education, assessment, and research activities (Wolfe, 2005). Stakeholders in this endeavor include educators, employers, government agencies, aircraft manufacturers and support services, pilots, and the public. PABC 's focus is to provide a clear and comprehensive description of industry-defined expectations for entry-level professional pilots, thereby enabling both pilots and educators to reduce the cost of effective career preparation. In addition to this initiative, PABC plans to develop and ultimately administer an examination to address employer expectations. The test will provide a rigorous and scientifically validated assessment of the knowledge, skills, and capabilities that today’s flight crew needs to be successful during an employer’s initial training program. The PABC certification examination will differ from that of the FAA by both addressing a wider array of subject matter and assessing the depth of a pilot’s capability to apply his/her knowledge in addressing a variety of practical scenarios. Passing such a test will provide both the pilot and the employer with an invaluable credential. Successful completion will provide a clear indication of a pilot’s motivation and capabilities in subject areas that employers have signified are important. Employers may then expect the certified pilot to be academically ready to enter initial training, thereby reducing the time and cost of that training program.

The focus of collegiate aviation programs is to produce a safe and proficient professional pilot who has completed the requirements for a college degree. However, attained knowledge and skills can degrade over the course of a four-year degree program. Accordingly, it seems prudent to assess mastery of requisite subject areas at program completion. This is especially true in aviation, where newly minted professional pilots may not only endanger themselves, but, in commercial service, could also cause harm to others. This likelihood does not apply to most academic majors.

While the exit exam may present an inviting prospect for aviation program enhancement, there are concerns with its implementation. Aviation program curricula could be restructured in response to exit exam competency expectations, but such change will be no less difficult to address than acceptance of accreditation standards currently being considered by institutions with limited resources and/or specialized program requirements. Most aviation curricula already contain a large percentage of technical courses that are carefully tied to current resources and that allow little flexibility for significant change. Another issue is how to develop and maintain confidential, standardized exit examinations that meet the needs of the aviation industry. Different air carriers, for example, have different expectations for prospective employees and may not want to share their special needs with competitors. Finally, it is unclear what process might be used to address students identified on exit exams as weak or unacceptable. How many times and how frequently could they retake a written exit exam? How would practical flying skills be evaluated? Currently, weak college students may obtain minimum passing grades and still graduate with their peers. Unlike military or aviation industry personnel, a weak or unstable student in higher education cannot be summarily dropped from the program without due process and/or retraining opportunities. A poorly performing collegiate aviation student may be identified for a period of probationary continuation and reevaluation, however such students are not normally dismissed until a significant pattern of poor performance or misconduct has been established at the college/university. Also, classroom grades do not always correlate with practical pilot skills. If exit exams are to be used, educators must carefully consider all the implications of application and possible failure. Flight program administrators, regulatory agencies, and the aviation industry all have a vested interest in this issue.

METHODOLOGY

A phone survey (Fanjoy & Wirth, 2003) was developed to assess methods of measuring professional pilot competency upon completion of collegiate flight programs. The survey was designed to identify forms of professional pilot exit examination currently in use, answer the question of whether support was present for the development of a standardized exit examination, assess what form such an examination might take, and determine what actions would be appropriate if a prospective graduate did not successfully complete the examination. The survey was administered to key faculty members or administrators of four-year aviation degree programs to include the department chair, aviation program director, or chief flight instructor. To keep the sample size reasonable, only those schools listed in the University Aviation Association's *Collegiate Aviation Guide (2003)* with flight training-related degree programs were surveyed. The sample was further restricted to programs with four-year baccalaureate flight degrees, since such programs presumably provide more comprehensive preparation for professional flight employment. An attempt was made to collect information from each of the 42 schools listed in the *Collegiate Aviation Guide* that offer four-year aviation flight degrees. The authors were able to obtain survey information from 29 of 42 schools for a response rate of 63%.

FINDINGS

Respondents were advised of the purpose of the current study, received assurances of confidentiality, and then given the survey questions. The first question asked whether the school's aviation department used a comprehensive measurement to assess overall competency of flight students who were approaching graduation and if so, what methods were used. Some respondents were initially unsure what constituted a comprehensive measurement. The researchers told them that this question addressed any form of exit exam that measured student preparation for a professional flight career. All of the respondents stated that their program did not currently administer a formal exit exam. However, seven respondents stated their program uses a capstone course during the senior year of education that they believed served the same purpose as an exit exam. Four respondents stated that their program required completion of the Certified Flight Instructor (CFI) certificate, and were confident that the CFI served as an accurate measure of professional pilot competency. Respondents from nine schools were emphatic that the series of FAA evaluations (private and commercial pilot certification, instrument rating, etc.) built into their four- year programs provided an approved validation of aviation competency. The remaining nine respondents had no further comment to this question.

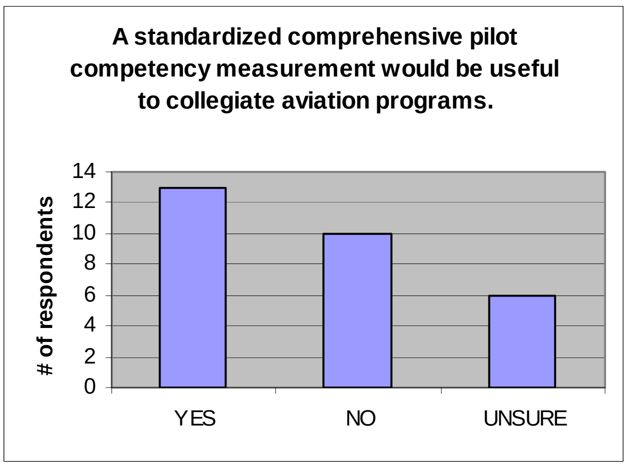

Figure 1. Standard measurement utility

The second question addressed the utility of a standardized, comprehensive pilot competency measurement for collegiate aviation programs and what form such a measurement might take (see Figure 1). Although thirteen respondents thought a standardized, comprehensive measurement was a good idea, ten did not, and six were unsure. Several respondents who were opposed to the idea were concerned with the measurement format and whether it would accurately address the variety of resources and curricula among diverse flight programs. Their stance was that standardization beyond anything required by current FAA evaluation standards might have a negative impact on the strengths of their current program format. Those who supported the measurement suggested a variety of possible formats to include: combined oral/practical/written (9), oral/practical (5), standardized capstone course (3), ATP written and simulator evaluation (1), mandated CFI completion (1), and some method of tracking progress after graduation (1) (see Figure 2).

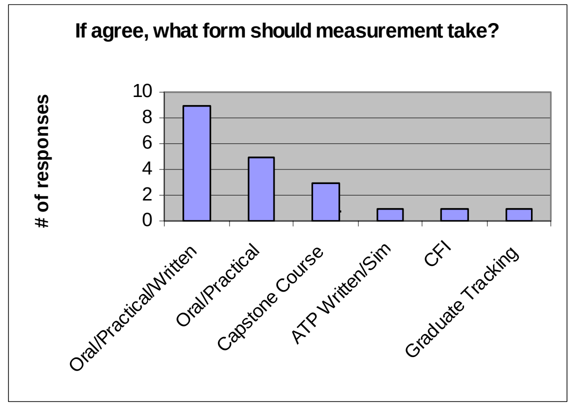

Figure 2. Exit exam measurement methods

The third question addressed how to handle students who did not meet a prescribed measurement standard (see Figure 3). Would they be allowed to graduate? Was additional training required? How should the progress of such students be addressed in a collegiate environment? Several respondents (10) indicated support for additional training and retest to address comprehensive measurement failures. Eight of those surveyed said that recognition with a special certificate should be provided for successful measurement rather than penalize those who do not meet a standardized result. Four said that progress of those who fail should be monitored for potential program elimination; however, these respondents also noted that flight faculty may be unable or unwilling to eliminate flight students who are participating in an academic curriculum. Three respondents said that if the student has passed required FAA certifications and met the college academic requirement for graduation, any further certification of professional competency should be the responsibility of the future employer. One suggested option was to allow students who did not meet the standard to switch majors. This option has been used with some success at several institutions, but may have a negative impact on the gaining department or cause the flight program to be seen as elitist. The last question asked if the respondent would support an effort to develop a standardized measurement to assess CAA-accredited, four-year degree flight programs. Ten respondents said yes, eleven said no, and three said they needed more information. Three said they would support this initiative if it affected the program and not individual students. Two said they could only support such a measurement if it was met with industry-wide support.

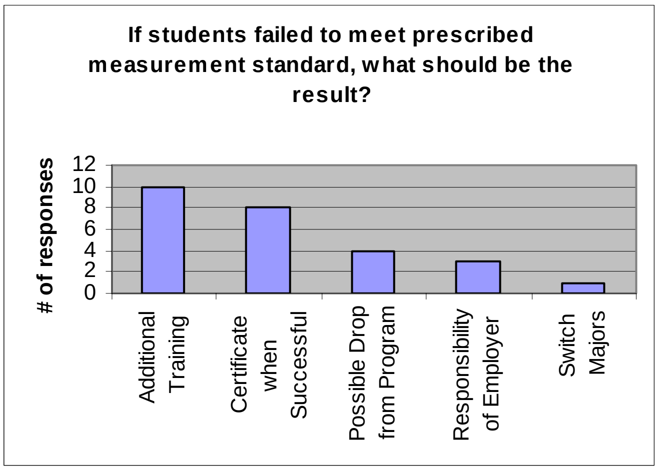

Figure 3. Exit exam failure options

DISCUSSION

The survey conducted during the present research reflects some college flight program administrator support for a standardized professional pilot educational exit exam. However, survey respondents expressed great concern with the design and implementation of such a test. The need for an exit exam measurement seems appropriate given the current level of responsibility and degree of expertise associated with operation of airline and corporate aircraft in passenger service. Historically, the "gold standard" for professional pilot employment has been appropriate FAA certification and significant flight time experience. When a prospective pilot employee has met these criteria, it has become the responsibility of the employer to add final polish with training in appropriate equipment and company operations/procedures. Due to the technical complexity of modern aircraft and changing nature of the operational flight environment, however, expectations have never been greater for competency of college flight program graduates. Financial drain related to costly resources and market competition may have led many operators to assign a lower priority to training. The expectations of both collegiate flight program administrators and the aviation industry seem to be that the other will take necessary steps to make up training shortfalls.

The FAA is not chartered to determine a professional level of competence. Instead, FAA certifications measure an ability to safely operate aircraft within the minimum level of competency described by the certification standards. Prospective employers supplement this "threshold level" of certification with other criteria, such as total flight time and educational degrees. Although several survey respondents for the present study felt that FAA certifications appropriately addressed their program needs, this position may reflect resource limitations or limited interaction with prospective employers.

It seems appropriate that collegiate flight program administrators revisit the expected competency of their program graduates. Should they be able, for example, to assume duties in a modern turbine aircraft with minimal training? Should such a measurement of competency be based on program resource constraints or on an industry standard? Is a common industry standard possible for college flight program graduates? Graduates of bridge programs, as well as those from programs with advanced aircraft and simulator training resources seem more likely to be hired by regional carriers, yet the question remains as to their preparation. Should there be an established standard that will lead to acceptance of aviation competency by all employers? Such questions must be resolved through open discussion between college program educators and industry representatives.

If a standardized exit exam can be developed, two other issues must be addressed. The first is an appropriate response to exit exam failures in a college academic environment. Most students have a significant financial investment in such programs. Is it ethical after four years of investment to deny a college degree to students who complete all curricular requirements but fail an exit exam? Should retakes be allowed? If so, how many and how often? Guidelines used by other professional certifying organizations may be instructive in this area. Some survey respondents suggest a special certificate should be issued for successful completion of a standardized exit exam, rather than penalties for those who fail. Such certification should not be tied to degree-program completion but should receive favorable consideration by all aviation employers. Others suggest that retraining be provided until such a time that special certification can be awarded. The issue of exit exam measurement in a college context is not an easy one to resolve. A second issue is how to address the development and security of such examinations? Should this activity fall under the purview of a certification agency such as the University Aviation Association, Council on Aviation Accreditation, or Professional Aviation Board of Certification? What curricular impact might be expected for participating programs? Should participation in a standardized exit exam program be mandatory to insure employment? Should there be a practical component to exit examinations? How would that type of evaluation be addressed across the wide spectrum of equipment resources present at flight training institutions? For an exit exam standard to be accepted, it will require industry support and acceptance by a broad base of flight program administrators.

Many college flight programs have taken steps to address the issue of desired professional pilot competency. Some survey respondents indicated they have a capstone course during the senior year that addresses industry specific issues in a classroom context. It is unclear how such courses provide a measurement of individual expertise, but certainly important information is provided to students. Some schools require flight instructor certification with the expectation that during such training, students will acquire experience and knowledge above and beyond that required for simple aircraft operation. One respondent cited a local program requirement for seniors to successfully complete the Air Transport Pilot written examination. This method seems to address the highest level of FAA knowledge-based competency testing, but may not offset a practical equivalent or advanced equipment competency. Many respondents stated that they just did not have the resources to provide more than the basic, FAA-certified, commercial pilot level of competency. All respondents seemed to embrace the ethical responsibility to prepare program graduates for commercial employment, but felt helpless to do so with resource constraints and the wide variety of industry expectations.

CONCLUSIONS

Exit examinations that assess professional pilot competency are an important issue for both college program administrators and airline/corporate operators. College program administrators want to produce a competent graduate with a well-rounded education who will be highly prized by prospective employers. Prospective employers want to hire top-quality, professional pilots who inspire confidence in the traveling public and easily adapt to the operation of company equipment and procedures. Both entities must deal with resource limitations and current pressure on aviation industry operations. Many college aviation programs have depended upon FAA certification as a measure of graduate competency, which may not be sufficient to establish a professional level of performance. In light of these factors, it seems crucial that a dialogue be initiated between aviation industry officials and flight program administrators to determine the practicality and importance of a professional pilot competency standard and how such a standard might be implemented. Further research into competency examinations used in other professional fields may provide additional insight to this important issue.

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An Analysis of the Strategic Planning Process at Large Hub Airports in the United States

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ABSTRACT

The focus of this research study was to test the theory of strategic planning in relation to the nation's 31 large hub airports. Strategic planning is reported to increase an organization's performance, operations, and overall effectiveness. Strategic planning has been used in the private and public sectors for decades. Airports are an often over-looked industry falling uniquely between the public and private sectors. The 31 large hub airports have a significant impact on the nation's economy and are the main catalyst for air transportation in the United States. Therefore, it is prudent to study this industry, and to determine the overall effectiveness of strategic planning for airports. The research indicates that large hub airports regularly engage in strategic planning and the plans they have developed and implemented have had a positive impact on the airport's overall performance and effectiveness.

INTRODUCTION

The purpose of this research was to determine whether the largest 31 public-use airports in the United States have engaged in the strategic planning process, and to ascertain the overall effectiveness of strategic planning in response to the current (2000-present) aviation economic crisis. Strategic planning has been used in the private business sector for decades and has been utilized recently in public sector organizations. Strategic planning is said to increase an organization's financial performance and longevity (Bryson & Einsweiler, 1987). Assuming that strategic planning is effective and enhances sustainability, it appears that public organizations should adopt the process of strategic planning (Poister & Streib, 1999).

There are obvious differences in the private and public sectors but many aspects of the strategic planning process are germane to both types of organizations. The federal government, as well as many state governments, has mandated that strategic planning be tied to performance metrics for all of its agencies (Government Accounting Office, 2004). This research takes an in-depth view of the nation's 31 largest airports to determine whether or not these organizations have initiated strategic planning, and if they have, to what extent has the process impacted performance and operations.

Airports straddle a unique ownership/management structure; a large majority of public-use airports in the United States are owned and operated by cities and counties. Many airports have undergone a transformation in ownership to quasi-government entities called airport authorities (Wells, 1999; Wells & Young, 2004). Many people regard airports as public utilities; but on the contrary, airports are federally mandated to be self-sufficient and most do not usually receive any type of tax monies from their municipality (Wells & Young, 2004). The management structures at airports do not follow any political mandate or local agenda and are run as a separate business enterprise (Rosado, 1997).

This study will identify which of the largest airports in the United States regularly undergo strategic planning processes. Of those airports, the research will present information relating to which jurisdictional type of airport ownership possesses the greater freedom to engage in strategic planning, and whether there is greater stability in airports that utilize strategic planning in lieu of the Federal Aviation Administration's (FAA) master planning mandate (FAA, 1985).

The next question will determine the flexibility of an airport's strategic plan and how the plan responded to the economic uncertainty beginning in 2000, including the events of 9/11. The financial downturn that followed the events of 9/11 was the worst in history for the airline and airport industry (Air Transport Association, 2002). Consumer confidence was shaken, and in turn, profitability and passenger spending was at an all-time low for the industry (Air Transport Association, 2002). This study will determine whether or not the nation's large hub airports have a flexible strategic plan in place, or if they had to develop and implement a new plan based on the events of the last three years.

This research focuses on the area of public and private organizations and the importance of strategic planning. As with many private entities, strategic planning should be viewed as a "best business practice" and should be used by all entities, regardless of profit motive or public service.

BACKGROUND

Strategic planning has been defined in a variety of ways by many researchers (Bozeman & Straussman, 1990; Koteen, 1991; Nutt & Backoff, 1992), and scholars and practitioners use slightly different definitions of the strategic planning process. However, the basic premise of strategic management includes three main processes: planning, resource allocation, and control and evaluation (Vinzant & Vinzant, 1996).

Bryson (1988a) has described strategic planning as a disciplined effort to produce fundamental decisions and actions that shape and guide what an organization is, what it does and why it performs these actions. Strategic planning systems are part of an approach that uses functional divisions and operating units to develop detailed plans within the overall organization's plan for the future (Poister & Streib, 1996).

Most of the theory and practice of strategic planning has been carried out in the private sector-- more specifically in the "for profit" sector. The initial area of public sector strategic planning was focused on the military (Bryson & Roering, 1987). Strategic planning was then broadened to include the private sector and has been used to find the best fit between an organization and its surrounding environment (Bryson & Roering, 1987). Most public sector organizations look to the private sector successes and try to adapt these methods to the public sector. With the ongoing public scrutiny of municipal agencies, the use of strategic planning has been gaining momentum within the public sector (Poister & Streib, 1999).

Bryson and Roering (1987) suggest that strategic planning techniques developed in the private sector can help government entities become more effective, especially with their rapidly changing environments. Strategic planning has been mandated at the federal level by the Government Performance and Results Act of 1993 (GPRA), and many state governments have enacted similar statutes pertaining to strategic planning (Poister & Streib, 1999).

This brings to the forefront the concept of municipal strategic planning. According to Poister and Streib (1999) "In the ongoing rush of activities, competing demands for attention, and the pressure of day-to-day decisions, focusing on a viable and responsive strategic agenda as the central source of direction, initiatives and priorities is of fundamental importance" (p. 309). Municipal governments are under increasing stress stemming from the financial arena and citizens demanding more accountability and increased level of services from their local governmental units. One potential public management approach to reducing financial stress, while increasing accountability to the public, and using consumer input is to use strategic planning. Beckett-Camrata (1998), Bryson (1995), and Streib and Poister (1990) have long argued that the government's uses of strategic planning benefits the public organization (Beckett-Camrata, 2003).

Airports are quasi-government entities because their ownership lies with cities, counties, states, and independent authorities. Large grants to public airports come through the Aviation Trust Fund, which is authorized by Congressional action and is administered by the Federal Aviation Administration (Wells, 1999; Wells & Young, 2004). In order to qualify for federal funding the airport must have a current Airport Master Plan, which is a twenty-year capital investment (infrastructure) plan. The master plan is designed to address large capital investment, or construction projects (FAA, 1985).

Due to their independence from municipalities, many airports are operated as a public, “for profit” entity. As part of the FAA grant assurances, every airport that accepts public grants must strive to maintain self-sufficiency. Congress has also legislated that any and all monies derived from airport operations, cannot be diverted from the airport (FAA, 1999b). Along with legislating revenue diversion, most cities and counties do not financially support its airport’s activities with general tax funds (Wells, 1999; Wells & Young, 2004).

An airport should be viewed as an integral part of the total transportation system, consisting of physical components, owners and operators, controlling authorities, and the rules (federal and state) under which they operate (Caves & Gosling, 1999). Equilibrium is hard to achieve in the airport area because of unsynchronized changes and different variables that influence the operation, as well as obvious tensions between the stakeholders (Caves & Gosling, 1999). One can conceptualize strategic planning that encompasses all stakeholders and makes it possible to resolve conflicts and find overall operating efficiencies (Caves & Gosling, 1999).

The FAA advocates strategic planning and sees it as a “thinking tool” to evaluate options and “what if” scenarios. It should be useful in developing and defending priorities and should be a corollary to business and marketing plans (Caves & Gosling, 1999). Therefore, it seems airports should follow the best business practices derived from private business enterprises as well as instituting strategic planning processes.

PURPOSE OF THE STUDY

Because of the significance that strategic planning processes hold for leadership and management practices, this study may provide both theoretical and practical insight into the short- and long-term operations of commercial airports. The air transportation industry has been characterized as having a financial performance profile earmarked by extreme shifts of “boom and bust” (Kane, 2003). The most recent “bust” cycle provides an opportunity to investigate the organization and management of major airports via the strategic planning lens; this may provide a better understanding of the strengths and weaknesses of strategic management within the quasi-governmental sector. Additionally, the results of this investigation may contribute to the improvement of commercial airport performance and stimulate further research in airport management during an era of significant transformation.

RESEARCH QUESTION

The main research question will explore the relationship between strategic planning and airport ownership, performance, and operations. This research explored whether or not the largest 31 public-use airports in the United States have engaged in the strategic planning process and it also ascertained the overall effectiveness and flexibility of strategic planning in response to the current (2000-present) aviation economic crisis. Effectiveness and flexibility were reported by the respondents as determined by their particular situation.

METHODOLOGY

The data was collected as a cross-section of airport attitudes toward airport strategic planning. A survey was sent out to the entire population at the same time and the responses were measured, but at a single point in time. The data collection was accomplished via a self-administered questionnaire. The participating airports in this research were bounded by those airports categorized by the FAA as large hub airports, serving at least one percent of the total U.S. traveling public for the preceding calendar year. The contact information is readily available via the FAA’s webpage, as well as the American Association of Airport Executives (AAAE) directory.

This research study adapted a 1990 survey used to assess strategic planning use in U.S. cities with populations from 25,000 to one million by Gregory Streib and Theodore Poister of Georgia State University. After reviewing current survey instruments previously used in gathering strategic planning information, a quantitative survey instrument was used. This instrument has been replicated by Streib and Poister over time and has demonstrated acceptable levels of validity and reliability. Although the current research adapted the instrument for use in hub airports, the integrity of the survey items remained intact. Nonetheless, the survey results were evaluated for acceptable validity and reliability.

The survey uses a 5 point rating (a Likert scale) yielding interval data; along with yes/no, or nominal data questions to be used for basic demographic information about the airport for categorization or grouping, and technical questions about the strategic planning processes employed by the entity. The technical questions were used to find descriptive information on the degree/level of strategic planning in use, as well as the overall satisfaction and effectiveness of the plan.

Certain ownership and management questions were asked to evaluate what typology of ownership best lends itself to effective strategic planning. The final stage of the instrument asked whether or not the airport followed their strategic plan on or around 9/11 and whether or not the airport stayed the course or changed their strategic plan in response to the terrorist events. A cover letter and survey was sent to the respective airport executives. There were no control groups utilized in this research study. The initial survey was distributed to each airport executive. Several airport executives filled the survey out personally, and others delegated the task to personnel in the airport planning department. Stakeholders outside airport management were not queried.

DATA ANALYSIS

In analyzing the survey results, descriptive statistics were used. The survey data were analyzed for the frequency distributions of certain coded data dealing with strategic planning and demographic data. Appropriate correlation analyses were used to examine any possible differences in the respondents' perceptions of strategic planning.

Cross tabulations and analysis of variance (ANOVA) were also utilized. Similarities and differences were discussed to determine which model of airport ownership is the most flexible and will lead to the most positive strategic planning.

Twenty-three of the possible 31 large hub airports responded to the survey, (74% of the total population). Of the 23 airports that responded, 26% enplaned between 7-11 million passengers; 52% enplaned between 12-20 million passengers; and 22% enplaned 21-40 million people per year. The largest group of respondents is reflected in the 12-20 million-passenger range, which is to be expected, as there are few airports that enplane more than 20 million passengers each year (see Table 1)

Table 1: *Large Hub Airport Passenger Enplanements*

	# of Airports	Percent	Cumulative Percent
7-11 Million	6	26.1	26.1
12-20 Million	12	52.2	78.3
21-40 Million	5	21.7	100.0
Total	23	100.0	

As shown in Table 2, the airports represented all of the FAA's regions, except Alaska, with heavier concentration in the eastern (5) and southern (5) regions. This is attributable to the higher number of large hub airports in the New York and Florida areas. The three large hub airports in New York City are all owned and operated by the Port Authority of New York/New Jersey, two surveys were answered by the strategic planner and the third survey was completed by the airport's general manager.

The predominant form of ownership for those airports that responded was city-owned, at 43%; other forms included airport authority 22%; port authority (includes waterways) 13%; county-owned nine percent; state-owned nine percent and one airport that is municipally owned, but independently operated at four percent as reported in Table 3.

Table 2: *Respondent Airports by FAA Designated Regions*

	# of Airports	Percent	Cumulative Percent
New England	1	4.3	4.3
Eastern	5	21.7	26.1
Southern	5	21.7	47.8
Great Lakes	1	4.3	52.2
Central	2	8.7	60.9
Southwest	2	8.7	69.6
Western Pacific	4	17.4	87.0
Northwest Mountain	3	13.0	100.0
Total	23	100.0	

Table 3: *Respondent Airport by Type of Ownership*

	Frequency	Percent	Cumulative Percent
City-owned	10	43.5	43.5
County-owned	2	8.7	52.2
State-owned	2	8.7	60.9
Airport Authority	5	21.7	82.6
Port Authority	3	13.0	95.7
Municipal-owned/independently operated	1	4.3	100.0
Total	23	100.0	

The Federal Aviation Administration mandates that airports undergo master planning, which equates to a long-term capital improvement infrastructure plan. Any airport that wishes to apply for federal funds is required to compile such a plan. Of the 23 airports that responded, 18 have a master plan, four airports do not have a current master plan and one airport did not respond to the question. Of those same airports, 18 have a working strategic plan and five do not, as shown in Figures 1 and 2.

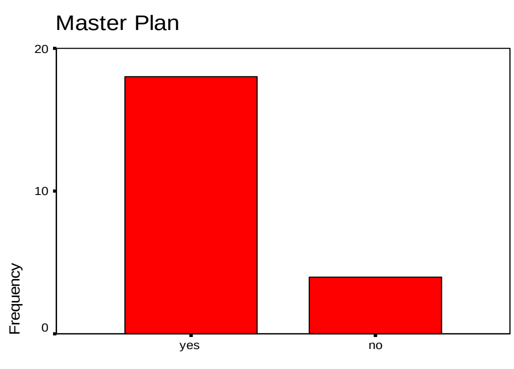

Figure 1: Airports with a Master Plan

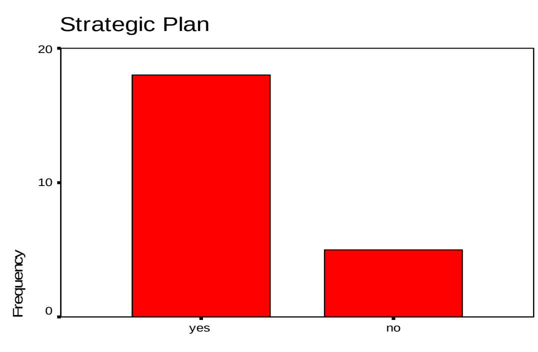

Figure 2: Airports with a Strategic Plan

Airports were also asked how long there had been strategic planning within their entity; two airports reported less than one year of strategic planning; five airports reported they had been planning for one to three years; six airports had undergone strategic planning for four to six years; and the majority, eight airports, had been engaged in strategic planning for more than six years. Two airports did not report this data; it would seem plausible to assume that these two airports do not have a strategic plan in place. See Figure 3 for the strategic planning breakdown, including airports reporting less than one year.

The airports were asked to what extent they were satisfied with the implementation and achievement of the strategic planning goals and objectives. Fifteen airports reported that they were satisfied or very satisfied with results thus far; five airports were not sure to what degree they were satisfied; one airport was dissatisfied; and two airports did not answer the question (see Figure 4).The next question asked was how much the overall effectiveness of the airport had improved as a result of strategic planning. Sixteen airports, or 70%, indicated there was moderate to significant improvement with the strategic plan in place. Five airports, or 21% of the sample size, indicated minimal to no improvement and two airports did not answer the question (see Table 4)

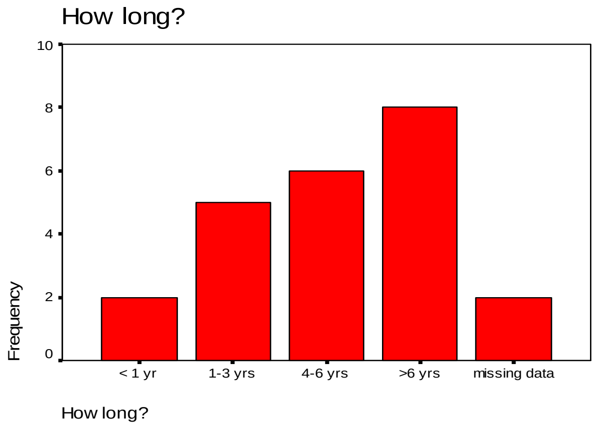

Figure 3: Length of Time an Airport has been Engaged in Strategic Planning

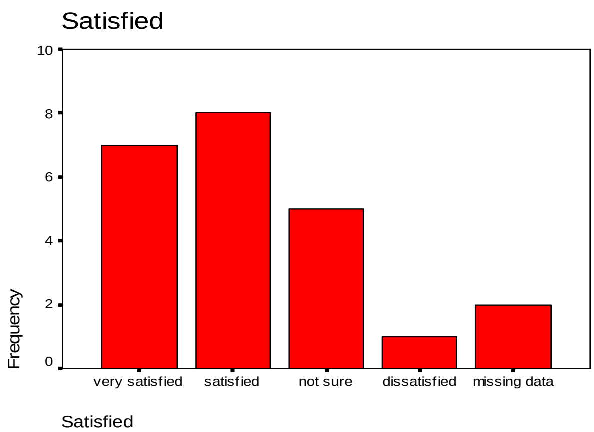

Figure 4: Satisfaction of Implementation and Achievement of Strategic Plan

Table 4: *Improved Overall Effectiveness with Implementation of Strategic Plan*

	Frequency	Percent	Cumulative Percent
No improvement	3	13.0	13.0
Minimal improvement	2	8.7	21.7
Moderate improvement	6	26.1	47.8
Significant improvement	10	43.5	91.3
missing data	2	8.7	100.0
Total	23	100.0	

The airports were asked whether the strategic plan that was in place during the economic downturn of 2000 and the terrorist events of 9/11/01 was flexible enough to guide the airport during the past four years. Three airports, or 13% of the sample, did not answer the question, but as seen in Figure 5, 12 airports or 52% of the responding airports, agreed or strongly agreed that the strategic plan in place during the events of 2000 was flexible enough to steer the airport through this difficult economic period.

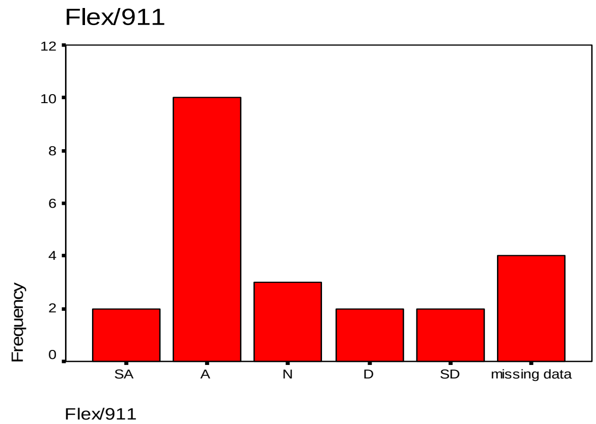

Figure 5: Flexibility of Strategic Plan with 9/11

Cross tabulations were used on several of the survey questions to compare two classification variables. The first two variables chosen were the type of airport ownership structure and whether or not the airport has a strategic plan in place. Table 5 depicts the ownership structure compared to the strategic plan variable. The municipally owned airports (city/county) account for the bulk of the respondents and also carry out the most strategic planning. Nine of 12 municipally owned airports engage in strategic planning. Of the authority-run airports (airport and port), six of eight engage in strategic planning compared to 100% of the state-run airports.

Table 5: *Cross Tabulation of Airport Ownership and Strategic Planning*

	Strategic Plan		Total
Ownership	yes	no	
City	8	2	10
County	1	1	2
State	2		2
Airport Authority	3	2	5
Port Authority	3		3
Municipally owned/independently operated	1		1
Total	18	5	23

The next cross tabulation is a combination of whether or not the airport has a strategic plan, and if there has been improved effectiveness as a result of implementing the plan. Of the 18 airports with a strategic plan, 16 report moderate to significant improvement. Of the five airports that do not have a strategic plan, three airports report no improvement, and two airports did not answer the question (see Table 6).

Table 6: *Cross Tabulation of Strategic Plan and Improved Effectiveness*

		Improved Effectiveness none	minimal	moderate	significant	missing data	Total
Strategic Plan	yes		2	6	10		18
	no	3				2	5
Total		3	2	6	10	2	23

The next cross tabulation performed looked at the variables of ownership and how long it has been engaged in strategic planning. Eight of the 23 airports have been engaged in strategic planning for more than six years. Six airports have been using strategic planning for four to six years and five airports have been planning for one to three years, with two airports utilizing the planning process for less than one year and two airports who did not report their status. The ownership type does not seem significant for those airports that have been engaged in planning any longer than any other airport, as shown in Table 7.

Table 7: *Cross Tabulation of Airport Ownership and Length of Strategic Planning*

		How long? < 1 yr	1-3 yrs	4-6 yrs	>6 yrs	missing data	Total
Ownership	City	2	2	2	3	1	10
	County		1	1			2
	State			2			2
	Airport Authority		1	1	2	1	5
	Port Authority		1		2		3
	Muni/independent operated				1		1
Total		2	5	6	8	2	23

The final cross tabulation ran three separate variables: number of passengers, whether or not the airport has engaged in strategic planning, and financial performance of the airport. According to federal guidelines, all public-use airports that receive government financial subsidies must submit an income statement each year that is accessible through the Federal Aviation Administration's web page. This is carried out through the FAA's Airport Compliance Division, AAS-400, and can be accessed via www.faa.gov/arp. According to the FAA, "The Airport Financial Reporting Program is an outgrowth of the FAA Authorization Act of 1994, which requires commercial service airports to file annual financial reports with the FAA" (FAA, n.d.). The airport financial reporting website is maintained by Crown Consulting, and the host site is http://cats.crownci.com.

Financial information relative to the specific airports that filled out the survey was accessed via http://cats.crownci.com/ reports/rpt127.cfm. Net income/loss was used as the financial measure, including aeronautical revenue, non-aeronautical revenue (terminal) and non-operating revenue, along with operating expenses, non-operating expenses and depreciation. An airport's financial instruments were not used in the calculation, as every airport has a unique bonding situation.

Table 8 shows the relationship between those airports with a strategic plan in place and the number of passenger enplanements, as this can affect revenues and expenses, along with each airport's specific net income/loss situation. The analysis shows that the number of passengers processed by the airport is particularly important in relation to gross revenue. This type of report follows the government format for financial reporting, rather than the usual format used by private enterprises. The airport reports operating and non-operating revenues, less the operating and non-operating expenses, with the remainder is referred to as "net," which could mean revenue or loss not specifically tied to income. The airport's financial instruments are not utilized to calculate this number.

Of the 18 airports that engage in strategic planning, 11 report net revenue of more than 50 million dollars; the five airports that do not engage in strategic planning report net revenue of zero to 50 million. Two airports reported a negative "net" for the year 2003. Of those airports that had higher net revenue, seven enplane between 12 and 20 million passengers per year, and four enplane 21 to 40 million passengers per year.

Table 8: *Cross Tabulation of Passengers/Strategic Plan/Financial Performance*

			Strategic Plan		Total
Financial Performance			yes	no	
- Revenue	Passengers	12-20 M	1		1
		21-40 M	1		1
	Total		2		2
0-$50M	Passengers	7-11 M	2	4	6
		12-20 M	3	1	4
	Total		5	5	10
$50-100M	Passengers	12-20 M	4		4
		21-40 M	1		1
	Total		5		5
$100-150M	Passengers	12-20 M	2		2
		21-40 M	1		1
	Total		3		3
>$150M	Passengers	12-20 M	1		1
		21-40 M	2		2
	Total		3		3

A one-way analysis of variance (ANOVA) test was conducted on the Likert Scale data in the survey, the dependent variables were: passenger enplanements (three groups), region where the airport resides (nine groups), and ownership structures (six groups) these data were analyzed with the Likert scale questions on the instrument. The ANOVA revealed no significant difference between any of the groups. The level of significance ranged from .608 to .680 for the number of passengers enplaned per the Likert Scale questions in the survey. The level of significance for the groups based on ownership structures and the Likert Scale questions ranged from .542 to .804, and the variable of airport region and the Likert Scale questions level of significance was .795 to .902. This observation is quite strong for the size of the sample. However, the overall number of airports nationwide is much larger than this sample.

The fact that there are no significant differences between groups is assumed to mean that there is no difference between size of airports, their specific location in the United States and what type of ownership structure exists. Basically, regardless of size, location and ownership, all large hub airports are operated about the same. Most airports report satisfaction with strategic planning and a belief in the process, so there is obviously a positive link between planning and performance. No factors were identified as to why one airport would engage in strategic planning and another would not.

GENERAL CONCLUSIONS

As expected, the majority (52%) of the airports that were represented in the data set were city- or county-owned. This is the predominant form of ownership in the United States as reported by the federal government and Wells and Young (2004). However, a close second type of ownership is the airport/port authority, semi-independent ownership structure, representing 35% of the respondents.

An interesting point to note is the number of airports that have a working master plan, as mandated by the FAA for receipt of funding, was the same as those airports that reported having an operating strategic plan. Seventy-eight percent of the airports reporting have a master plan and strategic plan in place. In Berry and Wechsler's survey of 1995, 60% of state agencies reported using some form of strategic planning, and Poister and Streib (1994) reported that nearly 60% of municipal managers were engaged in some form of planning. The obvious trend is that strategic planning initiatives are increasing with time.

When asked how long the airports have been engaged in strategic planning, four airports reported they were engaged in their first effort, and one airport reported there was no strategic planning process in place. As anticipated by state government mandate, the two airports that are owned by their respective state do have a strategic plan in place. To answer the first question of the research, the majority of large hub airports engage in strategic planning, some through mandate, but the majority voluntarily.

Sixty-one percent of the airports reported being engaged in strategic planning for four years or more. This would signal that most airports began the strategic planning initiative slightly before the economic downturn of 2000. Airports seem to lag behind private and public entities in their initiation of the strategic planning effort. Sixty-five percent of the airports reported being satisfied or very satisfied with their strategic planning efforts to date. The other 35% were unsure, dissatisfied or simply did not answer the question. It would appear that more than half of the airports are satisfied with their efforts, while the remainder may be quite new to the process, as 39% of the airports have either had a strategic plan for less than three years or did not answer the question. Those that did not answer the question could indicate an airport without a strategic plan or a plan that is not effective.

Seventy percent of the respondents report they have experienced moderate to significant improved effectiveness upon implementation of their strategic plan. Thirteen percent reported no improvement, and nine percent of the group reported minimal improvement, or did not answer the question. It appears that the airports that have a strategic plan up and running for more than four years have seen moderate to significant improvement in the effectiveness of their operation.

However, the flexibility of the plan to meet the needs of the airport for the economic downturn of 2000 and the events of 9/11 did not have resounding numbers when compared to earlier questions. Fifty-two percent of the group felt that their plan was flexible enough to guide the airport through the next few years, while 11 airports (48%) did not agree with the statement and chose neutral or disagree, or left the question unanswered.

In order to determine which ownership structure lends itself best to strategic planning, it appears that those airports not engaged in strategic planning are evenly distributed between city, county and airport authority ownership types. An expectation of the study was that more independent authority ownership structures were more likely to take on strategic planning. As earlier identified, those airports under state ownership are actively engaged in strategic planning.

It appears that the longer the airport is engaged in strategic planning, the higher the satisfaction is achieved. Of the eight airports engaged in strategic planning for more than six years, only one airport is dissatisfied with the strategic plan. Therefore, 88% of the airports that have been engaged in strategic planning for more than six years are satisfied or very satisfied with their plan. Five airports reported they were unsure of their satisfaction level with their plan, and four of those airports have been planning four years or less. It seems obvious that the longer the strategic plan is in place, the higher the level of satisfaction.

When researching whether there were differences among the airports based on their passenger enplanements, region of the United States or ownership structure, it appears from the ANOVA tests that no significant difference exists between the groups; therefore, it safe to say that whether the airport enplanes seven or 40 million, resides in the New England area or the Western Pacific, and is owned by a city, state or independent authority, the large hub airports in the United States are similar in operation and performance. Correspondingly, Streib and Poister (1990) reported that strategic planning did not vary significantly by city size or form of government.

The final analysis is self-reported effectiveness. Since there is no one best definition of effectiveness, the airports were asked to describe their concept of effectiveness. The answers ranged from reaching the mission and vision of the organization to improving the bottom line. Most airports want to control their cost structures while offering superior customer service to passengers and tenants, and accomplishing established goals and objectives. There again, it appears that effectiveness has different meanings to different organizations, and each organization must define what effectiveness will mean in a particular situation. It is not a term that can be predefined for any one organization, as there is no universal fit. "Porter says effectiveness resides in strategy" (Mintzberg, 1991, p. 54).

Mintzberg (1994) and Bryson (1995) say there is no one perfect strategic planning process that fits all and most organizations need to find their specific niche or fit. As Caves and Gosling (1999) indicate, equilibrium is hard to achieve in the airport area, because of unsynchronized changes and different variables influencing the operation, and obvious tensions between the stakeholders.

Finally, to answer the research questions posed earlier, the data clearly indicates that the majority of large hub airports engage in strategic planning and that their plan has proven to be flexible enough to guide the airport through difficult economic times. Most airports indicated their strategic plan is effective. Since there is no single standard measure of effectiveness available, each airport, with its set of individual circumstances, stated their own definition of plan effectiveness. As each organization charts its own strategic plan, so must each organization define its overall plan effectiveness.

RECOMMENDATIONS

The information gathered in this study illustrates the importance of strategic planning and the subsequent implementation of the plan. Regardless of airport ownership structure, the overall importance of a solid strategic plan is evident. The majority of airports surveyed reported that their strategic plan is flexible and has improved the organization's overall effectiveness. The past four years have been economically challenging for the aviation industry, therefore strategic planning becomes a necessity for an airport to remain self-sufficient.

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Employment at Commercial Service Airports in the USA: Survey Results

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ABSTRACT

The purpose of this research was to ascertain the size and scope of employment at US commercial service airports (CSAs) by: (1) determining the number of full-time and part-time employees employed directly by the operating entities of CSAs; (2) determining the total number of employees employed at these CSAs, including those working not only for airport operators, but also for airport tenants; and (3) comparing the findings to figures found in literature. A literature review was conducted, and all 510 US CSAs were contacted by phone and/or mail and asked to complete a five-question survey. A response rate of 95.1% (n = 485) was obtained. Survey results indicate there are 45,067 full-time and 2,558 part-time employees directly employed by commercial service airport operators. Additionally, when airport tenants are taken into account, survey results indicate 1,154,660 people are employed at CSAs. This study provides more detailed airport employment data than that which is available in current sources, such as the US Department of Labor. It also provides a larger sample size and more comprehensive analysis than previous recent studies, such as the one reported in the November/December issue of *Airport Magazine*.

INTRODUCTION AND PURPOSE

There are 19,576 landing sites in the United States as of January 2004 (Federal Aviation Administration [FAA], *Report to Congress*, p. 1). However, only 510 of these airports are classified as commercial service airports (CSAs). CSAs are defined in the Federal Aviation Administration's (FAA) National Plan of Integrated Airport Systems (NPIAS) as "public airports receiving scheduled passenger service and having 2,500 or more enplaned passengers per year" (FAA, *Report to Congress*, p. 5). These CSAs are economic engines for their surrounding communities.

Because industry-specific employment data can be used to gauge the well-being of any given industry, it is important to remain up-to-date with employment numbers and trends. The total impact of civil aviation on the US economy exceeds $900 billion annually, which represents approximately 9% of the nation's gross domestic product (Dri-Wefa, 2002, p.4). CSAs are a vital part of the aviation industry; therefore, tracking employment at these airports is one way to judge the state of the industry. However, a complete data set regarding employment at individual CSAs could not be found in the extant literature. Because an extensive data set regarding the number of employees employed directly by operating entities and by tenants of individual CSAs is not available on a nationwide basis, further study is warranted. Therefore the purposes of this study are:

1. To conduct a literature review of sources available on airport employment to provide a more complete understanding of the data currently available related to CSA employment.
2. To conduct a survey of the size and scope of employment at CSAs by:
   - determining the total number of employees directly employed by operating entities of CSAs.
   - determining the total number of employees employed at these CSAs, including those working not only for airport operators, but also for airport tenants such as airlines, concessionaires, and freight forwarders.

Definitions

Throughout this report, the following definitions were used:

1. Commercial service airport – "Public airports receiving scheduled passenger service and having 2,500 or more enplaned passengers per year" (FAA, *Report to Congress*, p. 5)
2. Enplaned passengers – See enplanements

3. Enplanements – Paid passenger departures or "boardings" (FAA, *Report to Congress*, p. 5). There were 650,808,785 enplanements in the U. S. in Calendar Year 2003. (United States Department of Transportation, Bureau of Transportation Statistics, n. d.)
4. Large hub airport – "Airports that each account for at least one percent of total US passenger enplanements" (FAA, *Report to Congress*, p. 7)
5. Medium hub airport – "Airports that each account for between 0.25 percent and one percent of the total passenger enplanements" (FAA, *Report to Congress*, p. 7)
6. Non-hub primary airport – "Commercial service airports that enplane less than 0.05 percent of all commercial passenger enplanements but more than 10,000 annual enplanements" (FAA, *Report to Congress*, p. 7)
7. Non-primary commercial service airport – "Commercial service airports that have from 2,500 to 10,000 annual passenger enplanements" (FAA, *Report to Congress*, p. 7)
8. NPIAS – National Plan of Integrated Airport Systems (FAA, *Report to Congress*, p. v)
9. Small hub airport – "Airports that enplane 0.05 percent to 0.25 percent of the total passenger enplanements" (FAA, *Report to Congress*, p. 6)
10. General aviation airport – "Communities that do not receive scheduled commercial service or that do not meet the criteria for classification as a commercial service airport may be included in the NPIAS as sites for general aviation airports…." (FAA, *Report to Congress,* p. 8)

LITERATURE REVIEW

Employment at CSAs is discussed in various sources. Among them are federal and state government documents, trade journals, and airport Web sites. These sources are further classified as:

● documents that provide individual airport operating entity employment figures.

● documents that provide total on-airport employment figures.

● national studies that provide broad-based airport employment statistics.

Literature Reporting Employment by Airport Operating Entity

Sources that provide CSA operating entity employment data on an airport-by-airport basis include state and local economic impact studies and individual airport Web sites. Some states have compiled data regarding CSA operating entity employment in state aviation studies. A statewide airport analysis completed for the North Carolina Department of Transportation, for example, reported both full and part-time employees employed by the airport operator (Hartgen, Bondurant, Dakai, Morris, & Stuart, 1997); as is the case with many such studies, this report discussed not only CSAs, but also general aviation airports.

In addition, economic impact statements conducted for individual airports may include CSA operating entity employee counts. An economic impact report summary carried out by San Jose International Airport revealed that 194 people were employed by the airport's administration (San Jose International Airport, 1986, p. 3).

Furthermore, several CSAs list operating entity employment figures on their respective Web sites. These statistics are often found on Web pages titled "Airport Facts," "Fast Facts," or "About the Airport." For instance, Lambert St. Louis International Airport's Web site stated that the airport employs 550 City of St. Louis employees (*General Information about Lambert*, p. 6). Other Web sites, such as that of Baltimore/Washington International Airport, offered operating entity employment figures for the number of allocated positions as well as the number of filled positions (*General Statistics BWI Facts and Figures*, Employment section). It is not only the large hub airports that list employment information; even smaller airports, like Gallatin Field in Bozeman, Montana, provide their operating entity employment figure

(*Gallatin Field Airport Fact Sheet*, 2004, Employment section).

Because of the dynamic nature of Web pages, it is straightforward to obtain up-to-date airport employment figures, provided that CSAs update their Web pages on a regular basis. However, a significant number of CSAs do not provide operating entity employment information on their Web pages, and some do not even have a Web site. Another limitation is that CSAs rarely have the need to break down operating entity employees in terms of full-time and part-time employees on their Web sites, so those aspects of each airport's employment remain unknown.

Literature Reporting Total On-Airport Employment

Numerous sources, such as state and local economic impact studies and airport Web sites, give an account of total on-airport employment. Note that these sources are identical to those that report employment by CSA operating entity, as described above. Indeed, a few of these sources provide both CSA operating entity employment and total on-airport employment figures. However, documents containing total on-airport employment numbers are more commonly found in literature.

Many of the state publications that report total on-airport employment take the form of aviation or airport economic impact studies. Some sources show total on-airport employment on airport-by-airport basis, whereas others only provide aggregates. For example, the Illinois Department of Transportation's Division of Aeronautics released a study in 1996 in which 119 CSAs and non-CSAs in Illinois were surveyed for various data, including employment figures. In this report, total on-airport employment, in terms both of full-time and part-time employees, was reported on an airport-by-airport basis for the majority of Illinois CSAs (Jamison, 1996). Similar airport-by-airport economic impact reports that showed CSA on-airport employment were conducted for Florida (Wilbur Smith Associates, 2000) and Washington (Washington State Department of Transportation Aviation Division).

On the other hand, various state publications list total on-airport employment without specifying employment figures for individual airports. A pamphlet issued by the New Mexico Department of Transportation's Aviation Division stated that there were 4,580 full-time on-airport jobs at New Mexico CSAs in 2002 (New Mexico Department of Transportation Aviation Division, 2003, Commercial Aviation section). Vermont's Agency of Transportation published a similar document, stating there are a total of 8,500 employees at its two CSAs (Vermont Agency of Transportation, Commercial and General Aviation Section). Similar documents are available from Arizona (Arizona Department of Transportation Aeronautics Division, 2004); Georgia (Georgia Department of Transportation, 2004); and Iowa (Swenson & Eathington, 2000).

Yet another category of state documents that provide total on-airport employment are those that include employment based on total economic impacts rather than just direct economic impacts; these employment figures incorporate not only employment segments supporting aviation activity (total on-airport employment), but also employment due to indirect impacts and economic multiplier effects, as spending re-circulates within the airport's region. Thus, these CSA employment numbers take into account a broader spectrum of employees and are much larger than the ones mentioned previously. For example, Colorado's CSAs were reported to produce a total impact of 260,803 jobs on the Colorado economy in 2003 (Colorado Department of Transportation Aeronautics Division, 2003, p. 6). Studies completed for Missouri (Missouri Department of Transportation) and Texas (Texas Department of Transportation) reported CSA employment numbers in a similar fashion.

Additionally, some CSAs individually commission economic impact studies, which often include total on-airport employment figures. A 2003 study performed for Wichita's Mid-Continent International airport, for instance, stated that a total of 15, 006 existed at the airport (Harrah, Gallagher, & Townsend, 2003).

The final group of sources that discuss total on-airport employment are the respective Web sites of CSAs. Again, as for operating entity employee numbers, total on-airport employment figures are usually found on Web pages entitled "Airport Facts," "Fast Facts," or "About the Airport." Newark Liberty International Airport's Web site, for example, states that "over 24,000 people are employed at the airport" (Port Authority of New York and New Jersey, Employment and Economic Impact section). Many other airports list total on-airport employment numbers on their Web sites, such as Palm Springs International Airport, Little Rock National Airport, and Cincinnati/Northern Kentucky International Airport.

Overall National Studies

Some publications describe CSA employment on a broader level; they do not break down employment on an airport-by-airport basis or even by state. Rather, they provide aggregate data related to CSA employment. These sources include federal documents, national studies, and national trade journals.

One of the most comprehensive sources of employment statistics is maintained by the United States Department of Labor's Bureau of Labor Statistics (BLS). The BLS tracks employment related to airports in two categories: airport operations (North American Industry Classification System Code 48811) and airport operations specialists (Standard Occupational Classification Code 53-2022). However, neither of these sources provides CSA-specific data. For example, the North American Industry Classification System Code 48811 (NAICS 48811) "comprises establishments primarily engaged in (1) operating international, national, or civil airports or public flying fields or (2) supporting airport operations (except special food service contractors), such as rental of hangar space, air traffic control services, baggage handling services, and cargo handling services" (United States Census Bureau, p. 1). In 2003, the BLS reported a total of 112,923 employees working for federal, state, and local government agencies and private entities in the NAICS 48811 classification (United States Bureau of Labor Statistics [BLS], *Quarterly Census of Employment and Wages*). The problem with this data, however, is that it not only fails to specify the number of employees employed directly by CSA operating entities, but it also includes employment at non-CSAs, which distorts the employment information. Even if the BLS kept track specifically of CSA operating entity employment for their internal use, this data is not available to the public, since the BLS does not release "microdata" in order to protect the confidentiality of respondents (R. Stephens, personal communication, March 2, 2005).

Furthermore, the BLS Standard Occupational Code 53-2022 estimated that in November 2003, there were 4,670 people employed as airfield operations specialists, defined as those who "ensure the safe takeoff and landing of commercial and military aircraft" (BLS, *Occupational Employment and Wages*, p. 1). Again, these employees may or may not be employed by CSAs, and because airfield operations specialists are not the only employees employed by operating entities of CSAs, this number is an underestimate of CSA operating entity employment. Therefore, the data provided by the BLS is either too broad or too narrow, and it does not adequately reflect CSA employment, which renders it not applicable to this study.

Next, national aviation studies also discuss airport employment in a general manner. For example, a study carried out by Wilbur Smith Associates entitled *The Economic Impact of Civil Aviation on the U.S. Economy* showed that aviation had a direct impact of 2,165,728 jobs and an indirect impact of 5,632,945 jobs in 1993 (1995, p. 5). The combined impacts total 7,798,673 jobs, which accounted for approximately 88.2% percent of 1993's total civil aviation-related jobs (Wilbur Smith Associates, p. 5). Note that these figures take into account an economic multiplier effect, as described earlier.

In addition, a study conducted by Airports Council International-North America (ACI-NA) in 2002 regarding the impact US airports have on local regions found that there are 1.9 million on-airport jobs at US airports and 4.8 million jobs created in local communities, which result in $190 billion in earnings (Airports Council International-North America [ACI-NA], 2002, p. 1). The study also projected that U.S airport related employment will be 9.9 million in 2013 (ACI-NA, p. 2). This growth is projected to correspond with the increase in outputs and earnings of the airports (ACI-NA, p. 3). The study showed the significance commercial service has on airport employment. For example, it highlights the example of Baltimore/Washington International Airport (BWI), where 12,030 jobs result directly from airport activity, totaling $358 million in wages and salaries in 2000; of the total jobs, 10,465 jobs, or 87%, were generated by commercial service activities (ACI-NA, p. 10). At a smaller airport—Blue Grass Airport in Lexington, Kentucky—commercial service activities also accounted for the majority (57%) of the 1,760 jobs it contributed to the local economy in 2001 (ACI-NA, p. 11).

The Airports Council International's *Fifth Annual Economic Survey* stated that in North America, 43,000 people are directly employed by airport operators and that there are 1,106,000 jobs on airport sites ("That Was Then…," 2001, p. 42) Note that this number includes CSAs outside of the US as well. Similarly, in September 2004, the International Civil Aviation Organization provided somewhat similar numbers in its *Thirty-Fifth Assembly Session Economic Commission Working Paper* presented by the ACI. It estimated that in North America, 42,000 employees are directly employed by airport operators and 2 million jobs are at on-airport sites (International Civil Aviation Organization, 2004).

Moreover, trade journals contain various articles regarding CSA employment. For instance, two recent articles published in AAAE's *Airport Magazine* described CSA employment by hub category. Page (2004, p. 24) reported an average number of CSA operating entity employees at large, medium, small, and non-hub CSAs at 606, 276, 81, and 27 employees, respectively. Although this survey provides recent data regarding CSA operating entity employees, it does not list data on an airport-by-airport basis. Furthermore, the survey was based on only 188 responses (Page, 2004). The January/February 2005 issue of *Airport Magazine* showed that airport jobs are dependent on the size of the airport (Page, 2005). That study provided equations for estimating the optimum number of airport staff. While the relationship between airport size and number of employees may be logically obvious, this study helped explain the variance in the employment figures at different airports.

Moreover, prior studies regarding aviation employment reported approximately 2.1 million aviation employees in the US (NewMyer, Kaps, & Sharp, 1997; NewMyer & Owen, 2003). However, these studies were generic in nature, as they focused on obtaining an overall US aviation industry employment estimate. The 2003 study by NewMyer and Owen reported a total of 37,088 persons employed directly by the operating entities of the 100 busiest CSAs; however, the remaining 400 CSAs— a vital segment of the nation's airport system—were excluded in that survey.

Literature Review Conclusion

This study was warranted because of several limitations with existing CSA employment data. First and foremost, a complete set of data regarding the number of people employed by CSA operating entities—and by airport tenants—is not available on an airport-by-airport basis. Many inconsistencies exist within the existing literature. For example, in economic impact studies, some state documents provide airport-by-airport-breakdowns of both CSA operating entity employment and total on-airport employment, whereas others only provide total on-airport employment. Similarly, some airport Web sites list employees employed by the operating entity, others list total on-airport employees, and still others do not provide any employment count whatsoever.

Next, the data available in literature was not collected at the same time, so it is difficult to compare data sets, and one cannot expect to arrive at accurate conclusions about CSA employment trends. Furthermore, much of the data is no longer current. National tragedies such as the terrorist attacks of September 11, 2001, and local events such as the closing of a major regional business can affect employment at CSAs, so it is imperative that current data be used.

Another issue in using the data in literature to reach conclusions about CSA employment is that the methods of data collection differed from study to study. Some studies provided employment estimates, while others extrapolated data based on trends. Some studies provided CSA employment numbers based on the total economic impact of the airport, whereas others merely provided direct airport employment.

Thus, after reviewing literature, it was found that no detailed and same-date CSA employment data was available in an airport-by-airport method. Because the employment numbers were inconsistent in their methods and dates of collection, a specific number of CSA operating entity employees and total on-airport employees could not be firmly established.

METHODOLOGY

In order to have a systematic approach to collecting and recording data, the study used the FAA's 2002 enplanement data as its primary source of CSAs (FAA, *Passenger boardings*). This provided the study with a set of 509 CSAs ranked by enplanements, as well as other information—such as location identities and hub classification which would be useful in analyzing the data collected. To obtain a more recent data set, the FAA 2002 enplanement ranking was compared to the CSAs included in the 2005-2009 NPIAS (FAA, Report to Congress). All the CSAs in the 2002 enplanement ranking were included in the NPIAS dataset with the exception of Charlevoix Municipal Airport (CVX). CVX was therefore added to the enplanement list, resulting in a total of 510 CSAs contacted for this study. However, because CVX was not a CSA in 2002, it was not included in any of the data analyses that dealt with enplanement data.

The collection of data for this research entailed contacting airport personnel at CSAs. Therefore, as is required by research policy at Southern Illinois University Carbondale (SIUC), an approval to conduct research involving human subjects was obtained from the SIUC Human Subjects Committee in 2004, prior to beginning the study. An extension of the approval was granted on October 14, 2004, effective through November 21, 2005.

The data collection was undertaken between September 30, 2004 and March 30, 2005. During this period, there were two approaches to the collection of data. First, the study started out with a phone survey. Airport personnel were asked questions from the study's questionnaire (see Appendix A). This was conducted for about a month, during which approximately 125 CSAs were contacted, most of which were called more than once. Approximately 50 responded. Due to the low response rate, expense, and time consumed, the researchers opted to switch to a mail survey in order to collect the data needed.

After obtaining contact names and addresses from sources such as airport Web sites, the AAAE print and online directories (American Association of Airport Executives, 2003), and the *World Aviation Directory & Aerospace Database* (Jackman, 2004), the surveys were mailed. Due to the time, it took to gather contact information of appropriate airport personnel, the surveys in the first mailing were sent in batches during the week of October 18, 2004. However, the first mailing did not include any non-continental US CSAs because contact information was not yet in hand. These CSAs were located in Hawaii, Alaska, Puerto Rico, Guam, American Samoa, and the Northern Mariana Islands, and surveys for these CSAs were sent as soon as contact information was obtained. Depending on contact information available, surveys were addressed to a variety of airport personnel, such as airport managers, airport directors, human resource managers, and public relations managers. Additionally, because some operating entities were known to run multiple CSAs—such as the majority of Alaskan CSAs—only one person may have been contacted to provide employment data for those CSAs.

As responses were received, the data set was updated. A second mailing was completed during the week of December 15, 2004. A third mailing was sent during the week of January 21, 2005 and a final mailing sent during the week of February 7, 2005. These mail surveys gave CSAs the option to respond by mail (return envelopes were enclosed with each survey), fax, e-mail, or phone. However, majority of the responses were received by mail. Representatives at nine airports responded by fax and data for 78 airports was received by e-mail. (Note that 71 of these e-mail responses were obtained from one source in Alaska.) Despite the study's reliance on mail surveys, phone surveys were not completely abandoned.

Phone surveys were continued throughout the mailing process, especially to follow-up on mail responses that were not clear. Furthermore, after all mailings were completed, an additional 34 CSAs responded to the survey by phone.

Data collection was completed during the week of April 1, 2005. The study had an extremely robust response rate of 95.1%. As shown in Figure 1, out of the 510 total CSAs surveyed, 485 responses were received and only 25 CSAs (4.9%) did not respond.

It is also important to note that all of the top 100 airports ranked by 2002 enplanements responded to the survey, as shown in Figure 2. Only two airports ranked within the top 200 CSAs did not respond to the survey. The remaining 23 airports that did not respond were among airports ranked lower than position 200 based on enplanements.

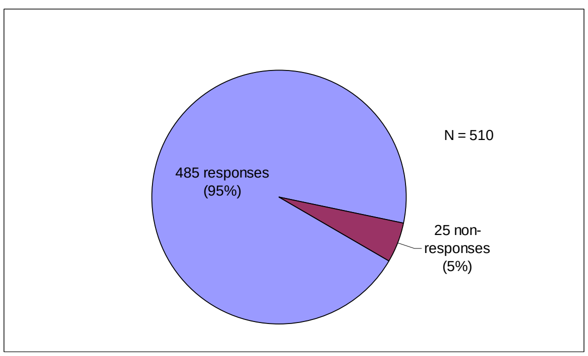


Figure 1. Overall response rate: operating entity employment

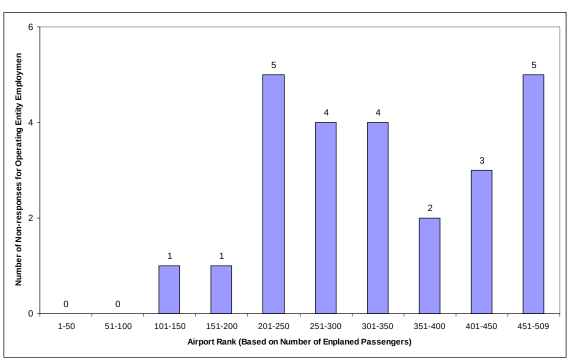


Figure 2. Distribution of non-responses for operating entity employment

Assumptions and Guidelines Used in Analysis

In recording the responses received from CSAs, the following guidelines were used in order to maintain a systematic study:

1. Unless otherwise noted by the respondent, the employment statistics provided were assumed to be current and accurate as of the day the survey was completed.
2. If a range of employment statistics was given instead of a single figure, the low employment estimate was used.
3. If multiple surveys were received from any given CSA, the survey completed by the person of higher organizational rank was used.
4. Contract positions were included in operating entity employment numbers.
5. Seasonal employment numbers were combined with part-time employment numbers to make a category of part-time and seasonal operating entity employees.
6. When recording the responses for the type of operating entity in the "other" category, similar responses were batched together. For example, aviation commission and airport commission were all reported as airport commissions.
7. CSAs opting to have their employment numbers remain confidential were noted, and their numbers will not be disclosed but will be included in statistical analyses.

Limitations

Despite the wide representation this study has due to its high response rate, the study also has its limitations, as is expected with any study. Below are some of these limitations.

1. The data reported as survey results are self-reported data and can not be independently verified for each airport.
2. Because the survey data were collected over a six month period of time spanning the end of 2004 and early 2005, no one date can be attributed to the results.

3. Question 5 in the survey (See Appendix A) did not specifically instruct the respondent to include or not data reported in Question 4. Therefore, the reported overall airport employment figures may or may not include airport operating entity employment data in a consistent fashion.
4. Though updated by the NPIAS 2005-2009 list, the 2002 FAA enplanement ranking list is the base of this study. When the study was started, this was the most recent enplanement data available.
5. The study may have understated the results because:
   A. Some CSAs did not include their total on-airport employment numbers. Out of the top 100 airports ranked by enplanements, eight did not provide their total employment figure. This includes San Antonio International, TX (ranked 48); Kahului, HI (56), Tulsa International, OK (71); A.B. Won Pat Guam International, GU (75); Lihue, HI (78), Hilo International, HI (92); Pensacola Regional, FL (96); and Harrisburg International, PA (97). There were also twenty three other CSAs ranked between 100 and 509 that did not provide total on-airport employment.
   B. Eight airports reported being seasonal airports; their employment numbers fluctuate and may increase significantly during peak seasons. Half of these seasonal airports are located in Colorado.
   C. Seven airports reported their employment numbers using full-time equivalents rather than an actual employee head count.
   D. Ten airports reported employment statistics from previous years.
   E. Five airports listed on the FAA 2002 enplanement ranking list no longer have commercial service. These airports are: Kileen-Fort Hood Regional, TX (ranked 208); Ellington Field, TX (265); Groton-New London, CT (411); Los Alamos, NM (440); and Smith Reynolds, NC (498).

SURVEY RESULTS AND ANALYSIS

Overall Results

Respondents were asked to provide the number of employees employed by the airport operating entity, and of the 95.1% who responded to the survey question, a total of 47,625 employees are reported to be employed by operating entities of CSAs. Of this total, 45,067 (94.6%) are full-time employees and 2,558 (5.4%) are part-time employees. The top 20 CSAs in terms of airport operating entity employment are shown in Figure 3. As noted in the figure, there are four airports that employ 1600 or more full and part time employees: Los Angeles International (LAX), Miami International (MIA), Dallas/Fort Worth International (DFW) and Chicago O'Hare International (ORD). The LAX total of 2,460 employees far and away is the leading number of operating entity employees at any one airport. Note that the top 20 airports ranking by operating entity employees employ a total of 20,833 employees, or 43.7% of the total reported by all respondents.

Based on an 89.2% response rate for the survey question regarding the total number of employees working at the airport (on-airport employees), there are 1,154,660 employees reported to be working at CSAs. This number includes businesses at the airport, such as airlines, concessionaires, fixed base operators (FBO's) and freight forwarders. Figure 4 shows the top 20 airports ranked by their reported on-airport employment. Three of the reporting airports indicated that they had 40,000 or more on-airport employees each. These airports were Hartsfield-Jackson Atlanta International Airport (ATL) at 48,000, Chicago O'Hare International Airport (ORD) at 45,000, and Dallas/Fort Worth International Airport (DFW) at 40,000. The top 20 airports listed in Figure 4 employ 557,982 or 48.3% of the total reported on-airport employees. See Appendix B for additional data regarding employment at various categories of top 20 airports.

	Airport Name	Operating Entity	Total Operating Entity Employees	Full-time Operating Entity Employees	Part-time Operating Entity Employees	Total Reported Employees Working at Airport
1	Los Angeles International	City	2,460	2,250	210	37,500
2	Miami International	County	1,692	1,648	44	37,700
3	Dallas / Fort Worth International	Airport District or Authority	1,608	1,600	8	40,000
4	Chicago O'Hare International	City	1,600	1,600	0	45,000
5	San Francisco International	Other: Airport commission	1,277	1,183	94	23,304
6	Ronald Reagan Washington National	Airport District or Authority	1,147	1,116	31	9,735
7	General Edward Lawrence Logan International	Port District or Authority	1,124	1,093	31	15,000
8	McCarran International	County	1,120	1,100	20	15,120
9	George Bush Intercontinental	City	1,000	900	100	30,000
10	Denver International	City	950	950	0	25,000
11	John F. Kennedy International	Port District or Authority	800	800	0	35,000
12	Seattle - Tacoma International	Port District or Authority	800	723	77	19,017
13	Philadelphia International	City	782	754	28	22,000
14	Detroit Metropolitan Wayne County	Airport District or Authority	718	706	12	18,171
15	Hartsfield-Jackson Atlanta International	City	700	700	0	48,000
16	Orlando International	Airport District or Authority	665	618	47	16,600
17	Phoenix Sky Harbor International	City	657	654	3	31,000
18	Washington Dulles International	Airport District or Authority	585	554	31	18,504
19	Salt Lake City International	City	584	576	8	14,000
20	Tampa International	Airport District or Authority	564	564	0	7,000
	TOTALS		**20,833**	**20,089**	**744**	**507,651**

Figure 3. Top 20 airports based on total operating entity employment

	Airport Name	Total Reported Employees Working at Airport	Full-time Operating Entity Employees	Part-time Operating Entity Employees	Total Operating Entity Employees	2002 Passenger Boardings
1	Hartsfield-Jackson Atlanta International	48,000	700	0	700	37,720,556
2	Chicago O'Hare International	45,000	1,600	0	1,600	31,706,328
3	Dallas / Fort Worth International	40,000	1,600	8	1,608	24,761,105
4	Miami International	37,700	1,648	44	1,692	14,020,686
5	Los Angeles International	37,500	2,250	210	2,460	26,911,570
6	City of Colorado Springs Municipal	36,985	116	2	118	1,038,027
7	John F. Kennedy International	35,000	800	0	800	14,552,411
8	Phoenix Sky Harbor International	31,000	654	3	657	17,271,519
9	George Bush Intercontinental	30,000	900	100	1,000	15,865,479
10	Denver International	25,000	950	0	950	16,943,564
11	Minneapolis - St Paul International	25,000	532	11	543	15,544,039
12	Lambert - St Louis International	25,000	500	0	500	12,474,566
13	Newark Liberty International	24,000**	*	*	*	14,553,843
14	San Francisco International	23,304	1,183	94	1,277	14,736,137
15	Philadelphia International	22,000	754	28	782	11,954,469
16	Louisville International - Standiford Field	20,801	171	9	180	1,740,526
17	Memphis International	20,000	300	0	300	5,231,998
18	Seattle - Tacoma International	19,017	723	77	800	12,969,024
19	Washington Dulles International	18,504	554	31	585	7,848,911
20	Detroit Metropolitan Wayne County	18,171	706	12	718	15,525,413
	TOTALS	**581,982**	**16,641**	**629**	**17,270**	**313,370,171**

*Note: Newark Liberty International Airport's numbers are not included because they requested confidentiality.
**Obtained from http://www.panynj.gov/aviation/ehisfram.htm

Figure 4. Top 20 airports based on total number of reported employees working at airport

Employees by Operating Entity

The purpose of this section of the article is to discuss the distribution of employees at commercial service airports (CSAs) by their type of operating entity. The reason for this type of analysis is that states, over the years, have subdivided themselves into many different forms of local government entities. In addition to the states, many of these local government entities have become airport operating entities. The survey asked respondents to report their operating entity by the categories shown in Figure 5. Based on the study's 95.1% response rate, it was determined that cities and airport districts/authorities operated most of the CSAs, 26% and 25%, respectively, as shown in Figure 6. The remaining 49% of the CSAs are operated by various entities such as states, which operate 18%; counties/parishes/boroughs , which operate 13%; and port districts/authorities, which operate only 7%. "Other" entities operate 11% of the CSAs, and a detailed listing of these "other" operating entities is listed in Figure 7.

Operating Entity
City
County
Port District or Authority
Airport District or Authority
State
Other

Figure 5. Operating entities as listed on survey

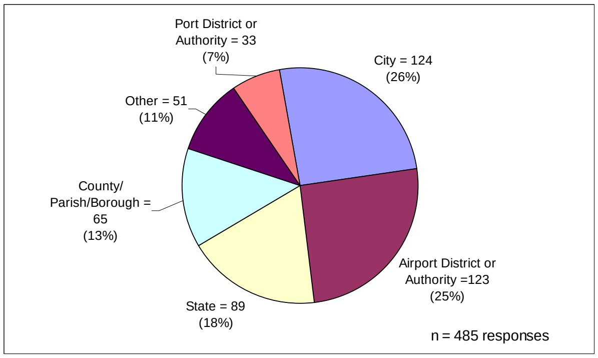


Figure 6. Results by airport operating entity

Of all operating entities, Figure 8 shows that the largest number of total operating entity employees were reported at city airports (16,116) followed by airport authorities/airport districts (13,593). Figure 9 illustrates the average number of employees by airport operating entity type, which shows that an average of 162 employees work at 33 port authority/port district airports while an average of 130 employees work at 124 city airports and an average of 111 employees work at 123 airport authority or district airports.

Operating Entity	**Airports Reporting This Operating Entity**		**Operating Entity**	**Airports Reporting This Operating Entity**
Airport commission	18		Unattached board of the City of New Orleans	1
Airport board	5		Aviation commission	1
Joint city and county	5		Combined city and borough	1
Private company	4		Unified city-county government	1
Quasi-private company	2		Township	1
Town	2		Development authority of former United States Air Force base	1
University	2		Economic development corporation	1
Airport board created by city/county joint resolution	1		Multi-mode transportation authority	1
City/county joint powers board	1		Park district	1
Joint powers board	1		University and airport authority	1
		Total	**51**	

Figure 7. "Other" operating entities (as submitted by respondents)

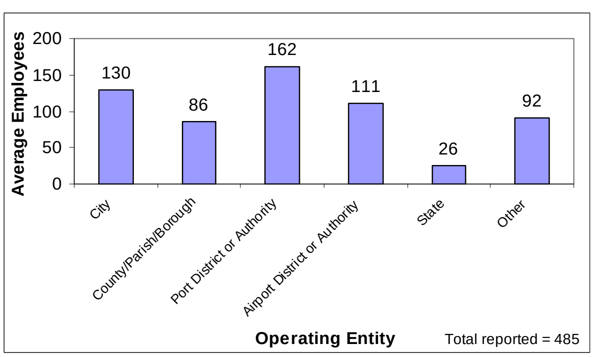


Figure 8. Total (full-time and part-time) operating entity employees

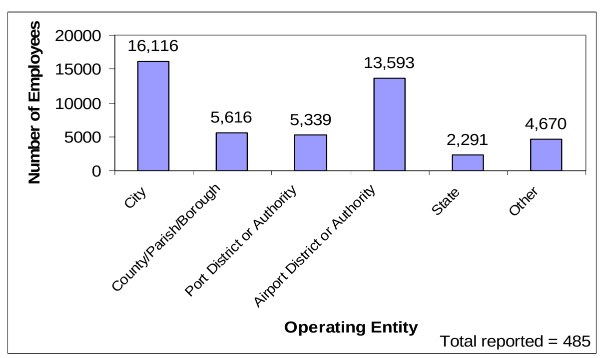


Figure 9. Mean total (full-time and part-time operating entity employment

Total Number of Employees Working at Airports

In the survey, respondents were asked for the total number of employees (at the airport) employed by the entity that operates their given airport. As depicted in Figure 10, CSAs run by cities had the highest total number of on-airport employees at 443,228. Airports operated by airport districts or authorities had the second highest total while those CSAs operated by states had the least total on-airport employment.

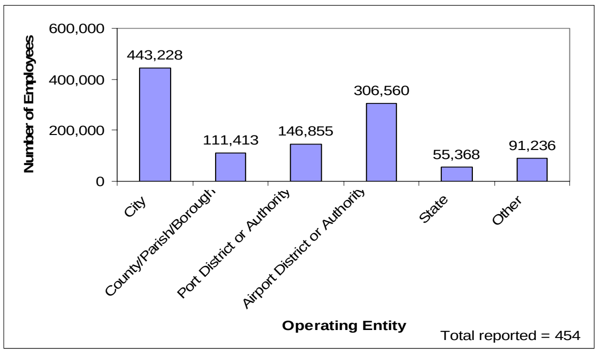


Figure 10. Total reported number of employees working at airport

In an attempt to illustrate how the data might be used to estimate airport employee productivity, Figures 11 (by airport classification) and 12 (by airport enplanement rank) show the average passengers per employee working at the airport while Figures 13 and 14 show the average passengers served per operating entity employee at a given category of CSA, as calculated from the survey results. In these analyses, the employees at the large hub airports or top 50 airports ranked by enplanements cater to considerably more passengers than the airports not in the top 50 CSAs. However, as shown in Figure 11, there is not a large difference in the average passenger departures per total on-airport employee at small hub CSAs versus non-hub CSAs. This is because there was a large number of non-hub CSAs that reported having large numbers of total on-airport employees. For instance, the following non-hub CSAs reported having greater than 1,500 total on-airport employees: St. Petersburg-Clearwater International (PIE), Fort Wayne International (FWA), Lincoln Municipal (LNK), Montgomery Regional (MGM), and Greater Peoria Regional (PIA).

On the other hand, Figure 12 shows a lower average number of passenger departures per employee in the airports ranked between 51 and 100 compared to those between 101 and 150. The understatement on the airports ranked between 51 to 100 airports is because some CSAs in this category did not provide their employment figures, and the information was not available to the study through other sources.

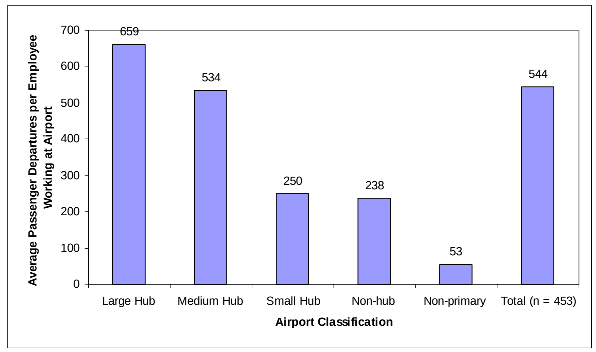


Figure 11. Average passenger departures per employee working at airport (based on airport classification)

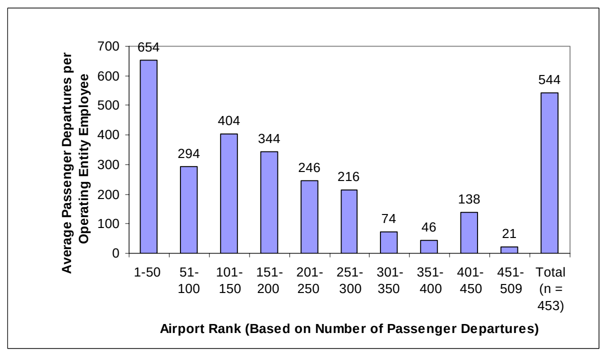


Figure 12. Average passenger departures per employee working at airport (based on enplanement rank)

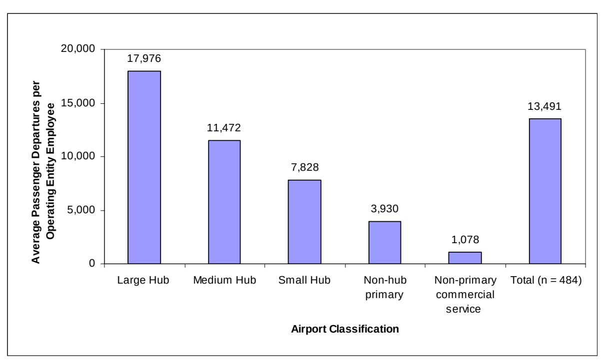


Figure 13. Average passenger departures per operating entity employee (based on airport classification)

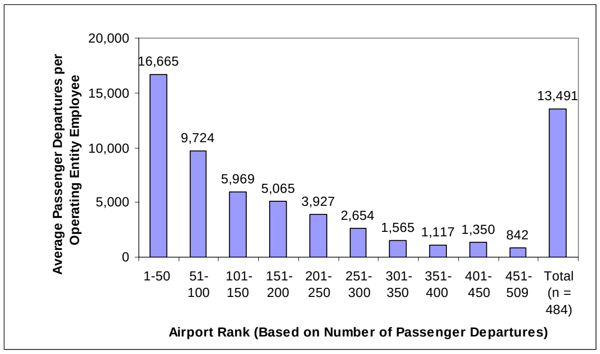


Figure 14. Average passenger departures per operating entity employee based on airport rank)

Furthermore, after obtaining the number of calendar year 2003 aircraft operations, (Airports Council International, *Traffic Movements*) for the top 10 airports (based on enplanements), a comparison in Figure 15 shows the passengers served per operating entity employee and the number of aircraft operations per operating entity employee. Note that the employment numbers do not have a direct relationship with the airports' operations in regards to enplaned passenger and aircraft operations. However, as shown in Figure 15, both values are illustrated to have identical trends.

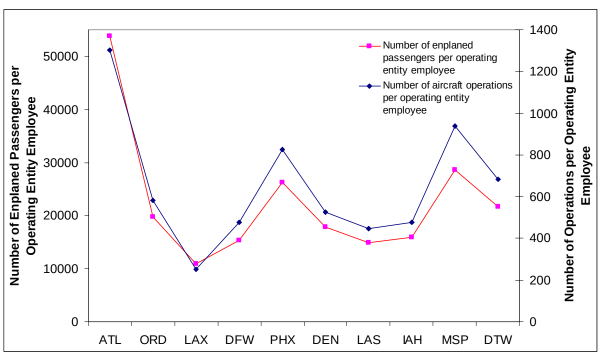


Figure 15. Aircraft operations and enplaned passengers vs. operating entity employees at the top 10 airports

Commercial Service Airport Employment Survey Results Compared to Other Sources

It should be noted again that the data reported on in this study are self-reported data provided by the airport operating entities. It is assumed that these data are correct since they have been provided by the airport operating entities themselves. However, there is no way to absolutely verify the accuracy of the data reported. This is particularly true of the data reported for "the total number of employees working at the airport (ALL employees, including those employed by airlines, FBO/s, concessions…." (See Appendix B). These data must be considered estimates and not hard data.

The results obtained from this study can be compared to employment data provided by various sources in literature. First, as stated in the literature review, the US Department of Labor maintains statistics regarding airport operations employees. In 2003, the BLS reported a total of 112,923 employees working at US airports (United States Bureau of Labor Statistics [BLS], *Quarterly Census of Employment and Wages*). Additionally, the BLS estimated that there were 4,670 people employed as airfield operations specialists in 2003 (BLS, *Occupational Employment and Wages*, p. 1). The differences between both of the BLS figures and those collected in this study are: (1) the BLS figures include employment at non-CSAs, whereas this study strictly surveyed CSAs, and (2) this study provides data for both operating entity employees (47,625) and total on-airport employees (1,154,660), whereas the BLS numbers do not provide further details of their employment figures. Thus, the current study provides a more detailed account of CSA employment than the BLS.

Moreover, the data collected in this study can be compared to a recent report in *Airport Magazine* (Page, 2004). As shown in Figures 16 and 17, there are four airport hub classifications—large hub, medium hub, and small hub—for which the average number of operating entity employees was found to be greater in this study than that reported in *Airport Magazine*. Note that the sample size for the *Airport Magazine* study was only 188, compared to a more-than-double response rate of 485 in this survey. In addition, this study provides more comprehensive and detailed data, such as employment by type of operating entity, which the *Airport Magazine* study does not offer.

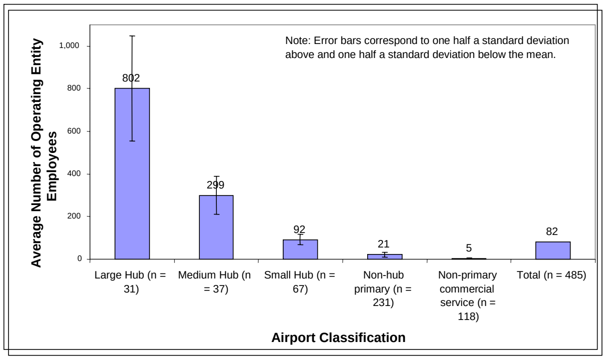
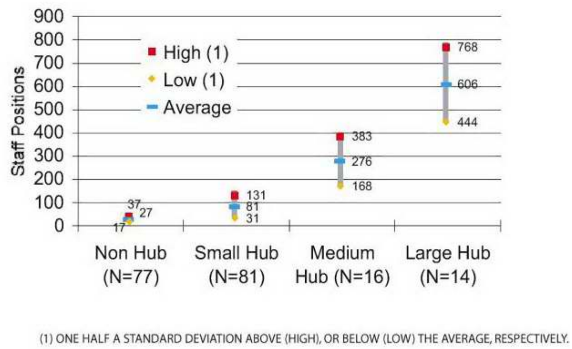


Figure 16. Average number of operating entity employees by airport hub category



Source: *Airport Magazine*, November/December 2004, p. 24

Figure 17. Average number of operating entity employees as reported in *Airport Magazine*

Finally, it should be noted that the data collected in this study compares favorably with other airport-related employment data reported by the ACI and others:

	Operating Entity Employment	Overall Employment
Current Study	**47,625**	**1,154,660**
ACI Study for ICAO (2004)	42,000*	2,000,000*
ACI Study (2002)	N/A	1,900,000
ACI Study (2001)	43,000	1,106,000
Wilbur Smith Study (1993)	N/A	2,165,728**

*Figures for all of North America
**Figures for all of aviation, not just airports

CONCLUSIONS AND RECOMMENDATIONS

As is elaborated in the literature review, sources that provide statistics on economic impacts of airports are numerous. Some CSAs have individual economic impact studies, which help to show the significance that CSAs have to regional development. However, a breakdown of the employment at these airports showing employment by airport operating entities is unavailable within these prior airport economic impact studies. However, the current study reported on here provides some specific, self-reported data on airport operating entity employment at the CSAs.

From this study, it can be concluded that:

- there are approximately 47,625 full and part-time employees employed by the entities that operate CSAs in the USA, as reported by the respondents to this survey.
- the top twenty airports (ranked by operating entity employees) employ 20,833, or 43.7%, of the total.
- the top airport in terms of operating entity employees is LAX with 2,460 employees.
- a total of 1,154,660 people are employed at CSAs by all on-airport employers (operating entities, airlines, general aviation companies and others).
- cities and airport authorities are the most numerous airport operating entities present at CSAs, with 124 and 123 respectively, or 50.9% of the total reporting.

Further, this study shows that there is a diverse range of operating entities of United States CSAs. Some of the operating entities are defined by regional history; for example, most Alaskan airports are operated by the state because the state attempts to maintain access to various areas of its jurisdiction. Most airports in large cities are operated by the city governments as the cities attempt to develop economic gateways in their jurisdiction. There are exceptions to large cities such as New York City, in which its three big airports—Newark Liberty International Airport, La Guardia Airport, and John F. Kennedy International Airport—are run by a port authority. This is because the region's transportation has historically been dependent of the port system.

Most of the total on-airport employment, as well as a large percentage of the operating entity employment, are concentrated at the CSAs that are airline hubs. This mass employment helps to support the United States' hub-and-spoke airport system.

Recommendations

This study provides a simple methodology for studying employment at United States airports, from which further studies can be conducted at airports other than Commercial Service Airports. In addition, a more complex survey design could be instituted to collect information from multiple sources at the same airport, therefore increasing the overall validity of the results at specific airports. A future study could be conducted to analyze the impact that airport revenues and airport acreage have on airport employment. In doing so, the study could determine whether or not revenues and acreage are good predictors of employment at CSAs. Finally, comprehensive, all-inclusive models for estimating airport employee productivity along the lines of those presented in *Airport Magazine* could be calibrated using the results of surveys at all categories of airports.

Acknowledgements

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APPENDIX A

Airport Employment Survey

The purpose of this research is to update a study of aviation employment that was completed in 2003. One aspect of the research is to obtain an estimate of employment at commercial service airports in the USA. If you wish your airport's employment numbers to remain confidential, please inform us so that we may protect that confidentiality. In any case, Southern Illinois University Carbondale will not publish the names of those contacted for this survey.

1. Job title of person completing survey: ______________________________________

2. Airport name and associated city: ____

3. What is the operating entity of the airport?
   A. City
   B. County
   C. Port District or Authority
   D. Airport District or Authority
   E. State
   F. Other, please specify: ______________________

4. What is the total number of employees (at the airport) employed by the entity that operates the airport?
   Full-time employees: __________
   Part-time employees: __________

5. What is the total number of employees working at the airport (**ALL** employees, including those employed by airlines, FBOs, concessions, etc.)?
   ____

6. Comments: ____
____
____

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APPENDIX B

Additional Results—Operating Entity Analyses

Table B1. *Top 20 airports ranked by enplanements*

	Airport Name	2002 Passenger Boardings	Operating Entity	Full-time Operating Entity Employees	Part-time Operating Entity Employees	Total Operating Entity Employees	Total Reported Employees Working at Airport
1	Hartsfield-Jackson Atlanta International	37,720,556	City	700	0	700	48,000
2	Chicago O'Hare International	31,706,328	City	1,600	0	1,600	45,000
3	Los Angeles International	26,911,570	City	2,250	210	2,460	37,500
4	Dallas / Fort Worth International	24,761,105	Airport District or Authority	1,600	8	1,608	40,000
5	Phoenix Sky Harbor International	17,271,519	City	654	3	657	31,000
6	Denver International	16,943,564	City	950	0	950	25,000
7	McCarran International	16,600,807	County	1,100	20	1,120	15,120
8	George Bush Intercontinental	15,865,479	City	900	100	1,000	30,000
9	Minneapolis - St Paul International	15,544,039	Other: Airport commission	532	11	543	25,000
10	Detroit Metropolitan Wayne County	15,525,413	Airport District or Authority	706	12	718	18,171
11	San Francisco International	14,736,137	Other: Airport commission	1,183	94	1,277	23,304
12	Newark Liberty International	14,553,843	Port District or Authority	*	*	*	24,000**
13	John F. Kennedy International	14,552,411	Port District or Authority	800	0	800	35,000
14	Miami International	14,020,686	County	1,648	44	1,692	37,700
15	Seattle - Tacoma International	12,969,024	Port District or Authority	723	77	800	19,017
16	Orlando International	12,921,480	Airport District or Authority	618	47	665	16,600
17	Lambert - St Louis International	12,474,566	City	500	0	500	25,000
18	Philadelphia International	11,954,469	City	754	28	782	22,000
19	Charlotte / Douglas International	11,743,157	City	230	120	350	15,694
20	General Edward Lawrence Logan International	11,077,238	Port District or Authority	1,093	31	1,124	15,000
	TOTALS	**349,853,391**		**18,541**	**805**	**19,346**	**548,106**

*Note: Newark Liberty International Airport's numbers are not included because they requested confidentiality.
**Obtained from http://www.panynj.gov/aviation/ehisfram.htm

Table B2. *Top 20 city-operated airports ranked by enplanements*

	Airport Name	2002 Passenger Boardings	Full-time Operating Entity Employees	Part-time Operating Entity Employees	Total Operating Entity Employees	Total Reported Employees Working at Airport
1	Hartsfield-Jackson Atlanta International	37,720,556	700	0	700	48,000
2	Chicago O'Hare International	31,706,328	1,600	0	1,600	45,000
3	Los Angeles International	26,911,570	2,250	210	2,460	37,500
4	Phoenix Sky Harbor International	17,271,519	654	3	657	31,000
5	Denver International	16,943,564	950	0	950	25,000
6	George Bush Intercontinental	15,865,479	900	100	1,000	30,000
7	Lambert - St Louis International	12,474,566	500	0	500	25,000
8	Philadelphia International	11,954,469	754	28	782	22,000
9	Charlotte / Douglas International	11,743,157	230	120	350	15,694
10	Salt Lake City International	8,997,942	576	8	584	14,000
11	Chicago Midway International	7,878,438	207	0	207	9,915
12	Norman Y. Mineta San Jose International	5,248,193	388	5	393	6,707
13	Kansas City International	5,161,518	422	6	428	5,700
14	Cleveland - Hopkins International	5,146,975	450	0	450	10,000
15	William P. Hobby	3,819,306	237	0	237	5,907
16	San Antonio International	3,224,764	420	1	421	Unknown
17	Austin - Bergstrom International	3,186,381	375	15	390	3,600
18	Ontario International	3,092,677	390	18	408	5,000
19	Albuquerque International Sunport	2,973,093	260	5	265	3,400
20	Dallas Love Field	2,815,907	152	1	153	8,558
	TOTALS	**234,136,402**	**12,415**	**520**	**12,935**	**351,981**

Table B3. *Top 20 airport district or airport authority-operated airports ranked by enplanements*

	Airport Name	2002 Passenger Boardings	Full-time Operating Entity Employees	Part-time Operating Entity Employees	Total Operating Entity Employees	Total Reported Employees Working at Airport
1	Dallas / Fort Worth International	24,761,105	1,600	8	1,608	40,000
2	Detroit Metropolitan Wayne County	15,525,413	706	12	718	18,171
3	Orlando International	12,921,480	618	47	665	16,600
4	Cincinnati /Northern Kentucky International	10,316,170	366	53	419	15,000
5	Pittsburgh International	8,975,111	360	0	360	9,000
6	Washington Dulles International	7,848,911	554	31	585	18,504
7	Tampa International	7,726,576	564	0	564	7,000
8	San Diego International	7,392,389	273	1	274	5,000
9	Ronald Reagan Washington National	6,172,065	1,116	31	1,147	9,735
10	Memphis International	5,231,998	300	0	300	20,000
11	Raleigh - Durham International	4,198,873	245	0	245	4,500
12	Nashville International	4,009,959	398	15	413	3,113
13	Port Columbus International	3,283,639	350	20	370	5,000
14	Southwest Florida International	2,551,187	285	3	288	3,500
15	Jacksonville International	2,462,399	240	20	260	4,000
16	Burbank - Glendale - Pasadena	2,305,747	258	42	300	1,395
17	Reno / Tahoe International	2,170,828	218	11	229	2,900
18	Eppley Airfield	1,747,320	123	14	137	1,140
19	Louisville International - Standiford Field	1,740,526	171	9	180	20,801
20	Norfolk International	1,731,105	200	4	204	2,000
	TOTALS	**133,072,801**	**8,945**	**321**	**9,266**	**207,359**

Table B4. *Top 20 county-operated airports ranked by enplanements*

	Airport Name	2002 Passenger Boardings	Full-time Operating Entity Employees	Part-time Operating Entity Employees	Total Operating Entity Employees	Total Reported Employees Working at Airport
1	McCarran International	16,600,807	1,100	20	1,120	15,120
2	Miami International	14,020,686	1,648	44	1,692	37,700
3	Fort Lauderdale / Hollywood International	8,266,788	400	12	412	10,500
4	Sacramento International	4,260,514	434	0	434	3,915
5	John Wayne - Orange County	3,968,978	138	0	138	4,000
6	General Mitchell International	2,779,197	200	0	200	6,500
7	Palm Beach International	2,716,514	145	0	145	3,681
8	Greater Rochester International	1,176,736	100	1	101	2,000
9	Gerald R. Ford International	960,482	114	20	134	1,680
10	Dane County Regional - Truax Field	759,506	60	6	66	6,500
11	Myrtle Beach International	614,828	103	0	103	500
12	Westchester County	461,448	50	3	53	1,400
13	Austin Straubel International	359,230	24	0	24	400
14	Eglin AFB	324,962	32	0	32	Unknown
15	St Petersburg - Clearwater International	310,650	61	0	61	1,648
16	Key West International	272,440	23	1	24	500
17	Outagamie County Regional	259,624	25	2	27	1,200
18	Daytona Beach International	234,558	40	0	40	700
19	Kalamazoo / Battle Creek International	233,554	13	1	14	200
20	Rogue Valley International - Medford	219,569	35	15	50	1,000
	TOTALS	**58,801,071**	**4,745**	**125**	**4,870**	**99,144**

Table B5. *Top 20 port district or port authority-operated airports ranked by enplanements*

	Airport Name	2002 Passenger Boardings	Full-time Operating Entity Employees	Part-time Operating Entity Employees	Total Operating Entity Employees	Total Reported Employees Working at Airport
1	Newark Liberty International	14,553,843	*	*	*	24,000**
2	John F. Kennedy International	14,552,411	800	0	800	35,000
3	Seattle - Tacoma International	12,969,024	723	77	800	19,017
4	General Edward Lawrence Logan International	11,077,238	1,093	31	1,124	15,000
5	La Guardia	11,076,032	500	0	500	9,000
6	Metropolitan Oakland International	6,164,548	265	6	271	8,000
7	Portland International	5,978,025	280	27	307	8,963
8	Luis Munoz Marin International	4,607,290	285	0	285	16,912
9	Orlando Sanford	648,144	65	10	75	4,000
10	Saipan International	513,734	195	0	195	720
11	Cyril E King	512,986	44	0	44	80
12	Toledo Express	323,988	67	3	70	4,000
13	Tri - Cities	211,473	36	10	46	596
14	Henry E Rohlsen	179,581	37	0	37	Unknown
15	Craven County Regional	74,884	5	36	41	77
16	Bellingham International	70,517	14	0	14	149
17	Pangborn Memorial	41,858	8	0	8	50
18	Worcester Regional	37,298	22	1	23	46
19	Williamsport Regional	32,883	8	14	22	450
20	Walla Walla Regional	28,076	11	3	14	56
	TOTALS	**83,653,833**	**4,458**	**218**	**4,676**	**146,116**

*Note: Newark Liberty International Airport's numbers are not included because they requested confidentiality.
**Obtained from http://www.panynj.gov/aviation/ehisfram.htm

Table B6. *Top 20 state-operated airports ranked by enplanements*

	Airport Name	2002 Passenger Boardings	Full-time Operating Entity Employees	Part-time Operating Entity Employees	Total Operating Entity Employees	Total Reported Employees Working at Airport
1	Honolulu International	9,406,467	550	0	550	17,000
2	Baltimore - Washington International	9,367,499	542	0	542	15,100
3	Bradley International	3,221,081	100	0	100	4,500
4	Kahului	2,663,824	116	4	120	Unknown
5	Ted Stevens Anchorage International	2,388,563	350	22	372	12,000
6	Lihue	1,238,972	100	0	100	Unknown
7	Kona International at Keahole	1,200,897	77	0	77	2,494
8	Hilo International	712,162	*	*	*	Unknown
9	Fairbanks International	380,576	96	4	100	1,600
10	Grand Canyon National Park	337,189	15	0	15	325
11	Bethel	132,057	9	0	9	159
12	University of Illinois - Willard	117,503	26	7	33	357
13	Molokai	93,307	12	0	12	Unknown
14	Sitka Rocky Gutierrez	70,095	9	0	9	44
15	Lanai	64,583	9	1	10	Unknown
16	Kodiak	62,862	5	0	5	30
17	Ralph Wien Memorial	52,106	5	0	5	40
18	Nome	49,602	8	0	8	43
19	King Salmon	35,882	6	0	6	31
20	Dillingham	34,746	6	0	6	51
	TOTALS	**31,629,973**	**2,041**	**38**	**2,079**	**53,774**

*Note: Hilo International Airport's numbers are not included because they requested confidentiality.

Defining Aviation Management

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ABSTRACT

The term *aviation management* is widely used in academia and elsewhere, yet there is no accepted definition of the term. This short article discusses separately the meaning of the constructs *aviation* and *management* and ends proposing a definition of *aviation management.* The intent is to initiate a dialog that results in eventual agreement on the meaning of the term among members of academia.

INTRODUCTION

In a world that has developed a vast number of experts' attention on aviation the focus seems to be on how to get large numbers of people from one destination to another safely, quickly, cheaply and profitably. The technical and financial areas garner developmental effort and dollars. But, a critical phrase in the language of travel and transportation is being ignored. The vast industry lexicon does not provide a clear understanding of the term *aviation management*. The author's study demonstrates a staggering number of possible meanings.

This short article reflects on the meaning of the words *aviation* and *management* and the nexus *aviation management*. The intent is to spur and focus dialog within the aviation academic community to reach agreement, or at least consensus, on a definition for *aviation management*. Informal discussions around the coffee pot, formal debate in conferences and or exchanges of views in academic journals all have potential benefit of leading to such an accord. This article explains the desirability of members of aviation management academia attempting to provide a definition.

Aviation Management has become a generic expression in academia with as many definitions as the field has practitioners. About 56 colleges or universities offer a degree in aviation management. Available research suggests that any published definition of aviation management in academic literature is illusive or non-existent (Phillips, 2004). The term has become so generic and broad that to use it risks the potential of imprecisely defining the subject being addressed. Yet, when a prospective or current student asks, "What is aviation management?" there should be some consistency of response regardless of which university or campus the question is asked.

Industry, like academia, uses the term aviation management widely with no apparent consistent meaning. Some examples are:

- The head of an aviation consulting company was asked to define the term. He, the president, indicated he didn't have a "good explanation of the term" (S. E. Maloney, personal correspondence, April 1, 2005).
- Simpson (1991), writing from the perspective of a fixed base operator, suggests general aviation management is a post-World War II catch-all term which is hard to define precisely.
- Rodwell (1985) writes from the perspective of small business and defines aviation management as accepted theory in small business management as well as proven techniques in aviation practice.
- Richardson (1981) states that it is a generally accepted and proven managerial technique and procedure applying to the aviation setting.
- The United States Forest Service "Fire and Aviation Management" views its operation as "including operational personnel transport, research, forest rehabilitation, law enforcement support, aerial photography, infrared detection, and fire prevention and suppression" (USDA Forest Service, 2005) and goes on to state that Aviation Management is aviation technology used in fire management programs.

In summary, individuals and organizations in both academia and business use the term to suit their purposes without clear, consistent definition. There is no agreement or specificity as to what the term *aviation management* actually entails. Until our academy reaches some agreement, any definition becomes a well-educated and/or practical guess. This was recognized during the October 2004 University Aviation Association Toronto Fall Conference when the newly formed Aviation Management Committee indicated defining *aviation management* was a pending task (T. G. Flouris, November 28, 2004, personal correspondence).

AVIATION

This article discusses definitions of *aviation* and *management* separately and then links the two, ending with a proposed definition. First, a review of *aviation*:

- According to the *Oxford Dictionary* (2005), the oldest English lexicon in existence, the etymology of the word Aviation is rooted in the mid-nineteenth century deriving from the French language and having grown through custom and usage to assume the status of a noun that identifies the "flying or operation of an aircraft - owing its root to the Latin 'avis' (bird)" (p. 110).
- *Roget's New Millennium Thesaurus* (2005a) lists four nouns under the term aviation: (1) aviation, (2) air power, (3) flight, and (4) landing field. Explanation of these four terms lists forty-two separate substitute words or phrases.
- The Mariner's Museum offers a glossary for terms used to describe various historical events. *Aviation* is defined as "the science, business, or operation of aircraft" (mariner. org, 2005).
- The Air Force Association defines aviation as "a term applied to all phases of the manufacture and operation of aircraft" (afa.org, 2005).
- *WordNet*, a lexical database for the English language (Cognitive Science Laboratory Princeton University, 2005) provides three definitions:
  1. aviation, air power -- (the aggregation of a country's military aircraft)
  2. aviation -- (the operation of aircraft to provide transportation)
  3. aviation, airmanship -- (the art of operating aircraft)

  This 2005 version mysteriously omits a fourth definition used in 2003, 'travel via aircraft'. The reasons for omitting the "travel" component aviation from the 2005 version are speculative and curious.
- *Wikipedia*, the free online encyclopedia, broadens the definition even further stating: "Aviation or Air transport refers to the activities surrounding mechanical flight and the aircraft industry. Aircraft, include fixed wing (airplane) and rotary wing (helicopter) types, as well as lighter than air craft such as balloons and airships (also known as dirigibles.) There are two major categories of aviation: Civil aviation and Military aviation. Civil aviation includes both scheduled air transport and general aviation" (wikipedia.org, 2005).
- *Wikipedia* is considered a controversial source because definitions come from the worldwide public. This open forum concerning the difference between "aviation" and "air transport" resulted in a several year ongoing dialog (Talk: Aviation – *Wikipedia*, 2005). Participants identified 144 elements included in the term aviation.
- The National Center for Education (2005) provides a Classification of Instructional Programs. *Air Transportation* is positioned under Aeronautics/Aviation/Aerospace Science and Technology, General. This is defined as "a program that focuses on the general study of aviation and the aviation industry, including in-flight and ground support operations. Includes instruction in the technical, business, and general aspects of air transportation systems" (NCES, 2005, Classification of Instructional Programs [CIP 2000]).
- The Council on Aviation Accreditation's description of the

aviation core curriculum is illustrative of the varied views contained in the concept *aviation*. Core curricula for "…all students in a collegiate aviation program…" MUST include

a. Attributes of an aviation professional, career planning, and certification.
b. Aircraft design, performance, operating characteristics, and maintenance.
c. Aviation safety and human factors.
d. National and International aviation law and regulations.
e. Airports, airspace, and air traffic control.
f. Meteorology and environmental issues" (CAA, 2003, p. 12).

And, the above may be augmented by subjects that "SHOULD include a broad understanding of the components of the systems, insight into how these components function together, and an understanding of how these relate to the physical, economic, political and social environments with which these systems operate" (p. 12).

- The U.S. Department of Transportation, Bureau of Transportation Statistics (2005) provides a list of transportation expressions. Neither aviation nor aviation management are included.

The above definitions add a wide range of concepts and/or activities to the basic airplane operation offered by *Oxford* and include airships, helicopters and space travel. Omitted from the above are current critical aviation industry components such as frequent flyer programs, global distribution systems, air traffic control systems, etc.

Based on this background of inconsistency and equivocation the authors define *aviation* to be:

…the knowledge and practices associated with using an airborne vehicle for commercial, research, military or philanthropic purposes within the Earth's atmosphere.

This definition separates space travel from aviation. If aviation is on one end of a continuum and space travel another, there are instances in the middle of the continuum where the separation of the two is difficult. This overlapping middle of the continuum does not negate the validity of our view of "aviation" as a function conducted in the Earth's atmosphere and space-travel as more (pun intended) "rocket science."

MANAGEMENT

Management is a multipurpose term. A total of at least 39 synonyms exist including terms such as "administration," "command," "conduct," "control" and "top brass" (Roget's, 2005b). This suggests possible inconsistency in the use of the term. But, there is great consistency in how *management* – the process – is defined in basic management texts. Here are seven examples presented in alphabetical order of the lead author:

1. "…Management is the process of reaching organizational goals by working with and through people and other organizational resources" (Certo, 2000, p. 6). The management processes are planning, organizing, controlling and influencing, "also commonly referred to as motivating, leading, directing or actuating" (p. 7).
2. "The attainment of organizational goals in an effective and efficient manner through planning, organizing, leading and controlling organizational resources" (Daft & Marcic, 2004, p. 7).
3. "…Management is defined as the process of effectively and efficiently using an organization's resources to achieve objectives through the functions of planning, organizing, leading and controlling" (DuBrin & Ireland, 1993, p. 4)
4. "Management is a set of functions directed at the efficient and effective utilization of resources in the pursuit of organizational goals" (Griffin, 1997, p. 4). The basic management functions described by Griffin are planning and decision making, organizing, leading and controlling.
5. "The planning, organizing, leading, and controlling of resources to achieve

organizational goals effectively and efficiently" (Jones, George, & Hill, 2000, p. 5).

6. "…The process of getting things done, effectively and efficiently, through and with other people" (Robbins & Decenzo, 2004, p. 6). The management processes are planning, leading, organizing and controlling.
7. "Management is getting work done through others" (Williams, 2005, p. 4). Williams expands this definition by stating managers must consider efficiency and effectiveness. He further states that the management functions are planning, controlling, organizing and leading.

Lincoln and Guba (1985) suggest that sampling can stop when redundancy is reached. When considering basic management texts used in American colleges and universities, the above definitions have reached that state – they've become redundant. *Management is a process of planning, leading, organizing and controlling.*

AVIATION MANAGEMENT

Based on review of a wide variety of sources and the authors' combined fifty plus years of business experience in challenging management positions with three major airlines, and after significant reflection, the recommended definition is:

"Aviation management" is the study and practice of general business processes used to achieve targeted objectives in the aviation industry.

The term "process" is used explicitly in most of the above definitions and is implicit in the others. One impact of this is to separate management – the process – from other definitions of management, such as referring to the group of people who do the managing, or using the term as an adjective or adverb, "that's just another management ploy." Our focus is on how things get accomplished – the processes used -- in the organizational world.

Another consistency in the above definitions of *management* is that the four basic processes are planning, leading, organizing and controlling. (Aviation students sometimes find this easy to remember with the phrase "Planes land on concrete" – P, L, O, C.) Since these four specific functions are a given component of management, repeating them in the proposed definition seems unnecessary. The summary phrase "general business processes" encompasses those terms.

This proposed definition also allows adding, as fits the perspective and context of the individuals concerned, other functions. Some might argue that safety is a separate but mandatory component of aviation and is a basic part of all aviation management processes. The proposed definition allows but does not require that viewpoint.

The authors' industry experience shows that the degree a manager is considered "effective" and "efficient" relates to whether an individual does or doesn't maintain a position and the degree to which the individual is rewarded when in the position. But, "effective" and "efficient" are meaningless without some definition such as "decrease the cost per available seat mile (CASM) by 1.2 cents by December 31st." As Daft and Marcic (2005) state, goals must be "specific and measurable" (p. 153). Organizational objectives define expected levels of effectiveness and efficiency within the context of the specific company or governmental division or department. By working toward "targeted objectives" an individual or group is attempting to be both effective and efficient as specifically defined within the context the activity takes place.

The "aviation industry" is a purposefully broad term. It can and should encompass the FAA, NTSB, military aviation, airport authorities, general and business aviation, ground service organizations that provide maintenance and fueling, industry lobby groups, global distribution system (GDS) software companies, private and corporate aviation, airport operations, Doctors Without Borders, etc. Some organizations are so broad they must be viewed on a continuum. The division of General Electric that produces jet engines is one of 11 divisions. Others are commercial finance, consumer finance and the NBC Network (GE business directory, April 6, 2005). Part of General Electric belongs in "aviation management" and part doesn't.

Important aspects of investigating management are purposely omitted from this article. Peter Drucker is the guru who helped frame the current views of American management. His half-century of writings offer important philosophies that are best considered as part of the "study" of management. For example, he indicates that management is "the organ of the institution" that must perform three tasks: (1) establish the purpose and mission of the institution (2) make work productive and workers effective, and (3) manage social impacts and responsibilities (Drucker, 2001, p. 14). These and many other of his thoughts, and the writings of other respected management authors, provide an important richness to defining what management is and what managers (should) do. But, we believe that consideration of such aspects is an unnecessary layer for a basic working definition.

CONCLUSION

It's up to the reader to judge if, or to what degree, the logic offered above aids in answering the student's question, "What is *aviation management*"? From an educator's perspective the answer, based on the proposed definition, might be something like:

The field (or our program) of aviation management involves learning about how and why aviation managers accomplish important goals for their organization. This might mean putting out fires if you work for the National Forest Service, or how to reduce the number of injuries to mechanics if you are in the Air Force, or, if you work for Air West, how to increase your airline's revenues by successfully increasing fares on specific segments.

At this point, the reader has at least three options. The first is to argue that it is impossible to define the term, or any term. A definition or understanding of a term must be viewed on a continuum or semantic ladder, and where on the ladder the viewer looks results in providing meaning for the term. The viewer may consciously or unconsciously consider only the lower rungs where concepts are most tangible or may look toward the top rungs where concepts are most intangible. A "dining table" can be defined as a hard substance, made of oak, oak comes from a tree, trees consist of individual cells, cells from molecules, molecules from electrons, and electrons from "the great beyond," etc. Or, a table is a device on which to serve a meal, a meal is a cultural opportunity for sharing views by those who participate, and the thoughts generated may involve consideration of a higher power from "the great beyond." Yes, it's possible to take *aviation, management* or *aviation management* on an eclectic trip anywhere on the semantic ladder. But, for humans to jointly accomplish anything, they must come to some common understanding of terms that permits communication with one another. The authors believe that it is both possible and desirable to find a common understanding of *aviation management*.

A second option is to rebel at attempting to reach any type of consistent viewpoint among aviation educators and agree with Emerson that, "A foolish consistency is the hobgoblin of little minds..." (Bartlett, 2000). Some might even argue that "academic freedom" allows individual choice of what to believe and that attempts to force a consistent view on the community is unethical. An individual is certainly free to take that position. Research shows, however, that decisions made by groups are generally superior to those made by individuals and that by assisting in the process, an individual is likely to feel more valued as a professional (Andrews & Baird, 2000).

The third option is to aid the work toward and be willing to agree upon a basic definition of *aviation management* for use in the academic community. Based on the authors' experience in the business world, if the field of aviation management is to move forward, the participants must have some consistent view of what they are about. The alternative is students, parents, administrators and advisory board members sensing a disjointed group of individuals who don't have any clear agreement about what it is they're doing.

You get to pick your option.

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Developing a Web-based Learning Site for U.S. Army Aviation Students: Lessons Learned

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ABSTRACT

Research determined that there were no supplemental study materials provided via electronic delivery (i.e., CD-ROM, web-based training, computer-based training, web sites) for Initial Entry Rotary Wing (IERW) students in the Primary Division of the U.S. Army Flight School, Fort Rucker, Alabama. Informal surveys were conducted to gather information regarding implementation of electronic delivery. Survey results indicated a positive attitude and desire for electronic instructional media. Therefore, the main focus of this project was development of a web-based learning site that would directly support current instructional objectives of the Primary Division. This paper examines lessons learned during the developmental and implementation process.

INTRODUCTION

The primary purpose of the Initial Entry Rotary Wing program at Fort Rucker is to prepare new aviation students for assignments as rated aviators in tactical aviation units worldwide. In addition to their flight training, students receive ground training in aviation related studies which include but are not limited to navigation, aerodynamics, aeromedical, meteorology, and emergency procedures. Flight school is divided into several sections. Each of these sections has a specific focus and requires successful completion of a checkride and oral examination.

The Primary Division in the IERW program includes the first ten weeks of flight training. During these ten weeks, students are provided both flightline and classroom training. The classroom training is designed to supplement flightline training. However, due to classroom time constraints, students are often exposed to topics at the flightline that have yet to be covered in the classroom. In addition, it is not uncommon for classroom activities to be briefer than the expectations of the flightline instructors.

Although students receive written handouts, these handouts are designed as study guides for classroom examinations, which may lack the depth required to pass oral examinations at the flightline. Neither classroom nor flightline instruction includes the integration of instructional media with the exception of video. Video footage is limited and used sparingly. Instructional media such as Flash, Shockwave, or even simple animations are relatively non-existent.

Lack of planning for future improvements appears to be due to a lack of funding rather than a lack of interest. Funding has been provided for multimedia enhancement of leadership courses and replacement of existing correspondence courses. There is an ongoing interest in development of web-based and multimedia courses. The Army has recognized that these technologies have the potential to save money by reducing travel costs, allowances, and printing correspondence material (TRADOC, 2003b). However, at this time, only specified courses have been identified for enhancement or conversion. Since the IERW student is already on location for other training, little cost savings can be identified for converting or enhancing classroom courses.

During informal interviews, students professed an interest in digital multimedia tutorials, study guides, and learning games. Although there may not be a cost saving potential or a need to convert existing classroom courses, there are other reasons for developing web-based multimedia programs. Characteristics of today's student are continually changing and with every new class comes a more technology savvy group of individuals. Students today may benefit from development of web-based multimedia. Whereas students previously used libraries and reference manuals to conduct research, today's students are increasingly turning to web-based references and search engines for their research pursuits. Therefore, if students are seeking information online, it only seems prudent to begin to develop reliable and trustworthy web sites that students can access rather than to leave their research to chance.

REVIEW OF LITERATURE

The utilization of computers and the internet to enhance, support, or host training and education is not a new idea. In fact, Dr. Seymour Papert was pioneering an effort to revolutionize education with personal computers as early as the 1960's (MaMaMedia, 2000). Developing computer-based instruction (CBI) modules for learning can be placed on stand-alone computers or put on CD-ROM and mailed to individuals for use on any computer. So why should educators bother with the Web? Greenberg and Lakeland (1999) suggest that ease of development and access are two primary reasons for utilizing the web for instructional facilitation. In addition, the reach in terms of geography and time become boundless. Individuals seeking information on any number of topics are only as far away as the nearest computer with an internet connection.

Although the ability of the personal computer and the internet to deliver education and training is not at dispute, the quality and extent of its capabilities have long been disputed. The dispute seems equally divided between those who believe the Internet will revolutionize the educational industry and those who believe the capabilities of computers in the classroom have been oversold and underused (Cuban, 2001). In fact, many internet enthusiasts have come to believe that the internet will become a primary distribution system for education and training at a distance (Simonson, Smaldino, Albright, & Zvacek, 2000).

The use of computers and the internet to impact education is not limited to K-12 or Higher Education. Many working adults find it increasingly difficult to schedule supplemental education between their work and personal lives. In addition, many corporations are discovering cost savings by allowing a percentage of their employees to telecommute. Online courses allow students the opportunity to save the cost of travel and still fulfill their work obligations while completing studies at their own pace (Simonson et al., 2000). In addition to cost savings, students gain exposure to collaborative learning opportunities that may not be available on a traditional campus. Individuals, educators, and researchers have discovered new opportunities to collaborate, communicate, create accessible databases, and conduct research all from the comfort of their own homes.

While the apparent cost-benefit analysis may be appealing for many employers, it is wise to be cautious regarding the application and scope of technology. Improperly designed or implemented technological media can result in an expensive and inefficient endeavor (Shank & Sitze, 2004). Therefore, it is a good idea to approach distance-learning initiatives carefully. A careful examination of the reliability and stability of supporting platforms may save substantial frustrations and monetary investment in the long run.

METHOD

The instructional model used for the development of the Aviation Trainer web-based learning site was the Interservice Procedures for Instructional Systems Development (IPISD) (Branson, 1975). The Center for Educational Technology at Florida State University and the U.S. Army Combat Arms Training Board at Fort Benning, Georgia contracted the preparation and development of this model. This model serves as a developmental standard for the Army, Navy, Marines, and Air Force. The model consists of five phases. A single individual or a team can complete these five phases.

The main goal of this project was to develop a professional, user friendly and accessible web site for the students and instructors of the IERW Primary Division. However, one may ask why a model that is nearly 29 years old and developed before the wide use and dissemination of desktop computers would be used as a development model for a web-based learning site. The answer lies in the original purpose of the IPISD model. As stated previously, this model was developed as an "interservice" model. The main purpose of developing an interservice model is to streamline interchangeability, coordination, and training across military services. However, this did not limit each of the individual services from amending the model as appropriate for that individual service. After review and adoption, the U.S. Army Training and Doctrine Command (TRADOC) converted the model to an Army publication (TRADOC Publication 350-70).

Since the original conception of the IPISD model, the U.S. Army has updated TRADOC Publication (TP) 350-70 to reflect current technology and new research/theory. In addition, several supporting documents have been developed to provide detailed information in areas of interest.

Many of these publications are still in draft format and were not used due to their status. However, TP 350-70-2 was of significant applicability to this project. This publication provides guidance for producing interactive multimedia instruction. This document outlines a process to plan, design, develop, and validate multimedia courseware (TRADOC, 2003b). This pamphlet was used extensively in actual development of multimedia products incorporated into the Aviation Trainer web site. However, this paper will not concentrate on a detailed technical description of how each multimedia lesson was developed. Rather, this paper will focus on lessons learned while utilizing this methodology to develop a web-based learning site.

RESULTS

A multimedia web site was developed to support the Primary Division students of the IERW program at Fort Rucker, Alabama. Five instructors reviewed content and layout during the design and development stage. Several errors in content were identified and corrected during this evaluation phase. After development, a formative evaluation was conducted with IERW students, instructors, and managers. Informal interviews were conducted face-to-face and via e-mail. Participants provided feedback regarding site usability, layout, appearance, and future recommendations for content.

Instructors interviewed indicated that the web site provided easily accessible tutorials and study guide. Instructors particularly liked the ability to provide instant reference material for new students. Managers expressed a desire to share the web site with new students but also raised concerns regarding proprietary issues of some materials provided. Positive student comments included easy accessibility, no cost, current/updated information, and use of "plain language." Students expressed an interest in and enjoyment of educational games. Negative comments primarily surrounded the learning environment and included low bandwidth access (slow download of study guide), lack of access to a personal computer, waiting times for computers at the learning center, and family distractions. Other negative comments concerned font size, download information, and size/orientation of graphics. All negative comments were addressed during the formative evaluation. Changes involved removing questionable proprietary content, updating font size/type, converting graphic size/orientation, and providing download information for users. Bandwidth issues were addressed by reducing file sizes and providing alternate download options. Environmental factors outside the scope of this project were not addressed (i.e., learning center, family distractions). Overall, reaction to the web site was positive and enthusiastic. Students and instructors felt the site was useful as a study guide and reference for Primary Division flight training.

A site statistics program (LiveStats) was used to collect information regarding site traffic, content accessed, geographical locations accessing site, access times, number of hits, number of visits, and other useful tracking information. A "hit" is recorded each time a user accesses a page or graphic on your site. A "visit" is recorded each time your web site is accessed by a user. LiveStats provides "unique visitor" tracking which provides more reliable and detailed information about your site visits (DeepMetrix, 2003). These statistics are helpful in determining user characteristics and are provided at no charge by the hosting service. Knowledge of these user characteristics assisted the designer in making informed decisions regarding web site content and management. The traffic for the web site was much higher than anticipated for the first month online. Initial estimates for site visits and hits were low (200 to 300) based on the site's lack of advertising and total student population of approximately 300 at any given time. The interest generated by visitors other than students, instructors, and managers was unanticipated and accounted for a large amount of site traffic. The site was launched in March of 2004. During the month of March, LiveStats recorded a total of 1,250 visits which accounted for a total of 55,941 hits.

Based on initial site statistics and feedback received during and after the formative evaluation, the Aviation Trainer Web Site is providing digital multimedia content that both students and instructors find beneficial. Although it would be difficult to directly attribute use of the web site to student success on checkrides, several students who used the web site and successfully passed the end of phase checkride commented that the site was extremely useful as a checkride study guide. Sample data were not collected for post-checkride students regarding web site use and benefits due to lack of student access. Students who participated in the web site rollout voluntarily provided positive feedback after checkride. Future research is planned to capture post-checkride data via survey, interviews, or student scores on checkride.

DISCUSSION

The following topics outline the lessons learned during the design, development, and implementation of the Aviation Trainer web site. As mentioned previously, the main goal of this project was the development of a web-based learning site that would directly support current instructional objectives of the Primary Division. The lessons learned are categorized into three categories. Many of the lessons learned fell into more than one category. This is especially true in the case of building a professional and accessible web site. Since these two categories go hand-in-hand, the lessons learned for these two categories were summarized together.

Professional and Accessibility Lessons Learned

Using Templates

The web site was originally designed to be of assistance for a small number of students attending IERW. Minimal growth was anticipated, as was the volume of intended content. Therefore, the original web pages were developed without aid of templates. Since the number of web pages planned was minimal, it was felt that updating these pages would be a small task. The unanticipated usage and popularity of the site dictated that additional content and pages be added. The addition of content and web pages soon became demanding when updating navigational links on an individual web page. The use of templates would have avoided this problem altogether. Although current content pages were updated to templates, organization and structure did not support template usage and the structure quickly became unmanageable. This became most apparent during the formative evaluation when errors were discovered in content.

Underestimating site popularity and usage level can lead to increased workload, site down time, increased hosting fees, and frustrated users. A site redesign resolved this issue for the Aviation Trainer web site. Down time for this site was minimal since the redesign was completed off-line and then uploaded upon completion. However, these resources may not always be available to a site designer and would have been unnecessary if proper planning had been in place from the beginning. The redesign included templates with editable and non-editable regions. Site navigation and external links are embedded in non-editable regions. This now prevents inadvertent changes to site navigation and makes updating navigation on the entire site quick and painless. It is vital that a site be designed to accommodate unexpected changes in traffic and navigational links. Regardless of initial size of the site, leaving room for expansion is imperative.

Keeping a Journal

Flanders and Willis (1998) strongly recommend use of a development journal. These parameters include font sizes, types, color palette choices, navigation schematics, picture sizes, compression, resolution, tags, and other pertinent information one might forget over time.

Using Well Defined Folders

This site was originally expected to contain a small number of files. Therefore, definitive folders for items such as borders, pictures, resources, and individual tutorials were not created. This resulted in chaos when site content expanded. It became nearly impossible to track down a single file without well defined folder delineation. When the site was redesigned, great effort was made to create folders for each element that were both logical and easy to navigate.

Checking Site Statistics

As stated above, it is important for a webmaster to understand how site statistics can assist in site management and future planning decisions. Not all hosting services offer site statistics. Of those hosting services that offer this service, it may be limited at best. It is important to choose a hosting service that provides information you need. The Aviation Trainer web site utilizes FinestHost. This hosting service provides competitive hosting fees, discounts for resellers, and LiveStats site statistics. When choosing a hosting service that provides site statistics, designers should compare statistical packages. Statistical information that might be considered important is total number of hits per day/month, total number of visits, popular pages/documents, countries and states accessing the site, trends, and the Internet Service Provider (ISP) of frequent visitors. Examining site statistics can provide an overall picture of how the site is being used and who the audience includes. It is important to consult the statistics of a site to determine what, if any, changes need to be made to the site navigation and content.

The term "hits" is commonly used and remains highly acceptable to the general web development community. A "hit" is a measure of the number of times a page is accessed by a user. Unfortunately, hits are an inaccurate measure of web site statistics. The problem with measuring site hits is that every graphic on the page is included in the count (DeepMetrix, 2003). Since this site statistic can result in misleading information, web developers began searching for a better way to interpret site traffic that would be more meaningful for their industry. The next evolution in site statistics is "page views." Page views are number of times a web page is viewed. This solved the problem of recording multiple hits for one web page but page views still have their pitfalls. When proxies and caches become involved, page views can also become a misleading measure. One answer to this dilemma is measuring visits and sessions. This statistic can measure page views per visit, which may be an indication of customer interests. While it is significant to note page hits, views, and visits, it is more important to understand what documents or information visitors are viewing. This will provide insight into what new types of data should be incorporated into future additions or changes to web site content. It is important to look at site statistics as a whole rather than focusing on individual numbers in isolation.

For example, based on predictions, it was extremely surprising to discover that the total number of hits for March 2004 exceeded 55,000. To determine whether this number was deceptive, the number of visits for the month was compared. For the month of March, 1231 site visits were recorded. As stated above, it is important for a web developer to understand how to read their site statistics. For example, in the month of March a total number of 55,941 hits were reported. The next line in the report lists average number of hits during "a month" as 8,498. At a quick glance, the reader may assume that 55,941 divided by 31 (days in March) should equal 8,498.18. In fact, the key words are "a month." This phrase indicates the average number of hits across the months the site has been active. These data are important when examining a trend analysis on your site. This example reinforces the point that the reader of a site statistics report should be familiar with how the data is reported in order to reap the benefits of the information provided. It cannot be emphasized enough that site statistic reports are only as good as the reader is thorough.

Selected Media

Selection of media for web-based learning web sites is of critical importance. Although there are many instructional development programs available commercially, none of these programs offer a complete solution for all web site development features. Interestingly, eighteen separate programs were used to develop the site content for the Aviation Trainer web site. The programs selected for this project were based largely on programs available to the site designer at a low or no cost. Although it would have certainly been possible to limit the number of programs utilized, it is still important to recognize monetary investment required to undertake such a project. When selecting programs for web development, it is suggested that program managers determine design team expertise and develop a comparison checklist that lists program strengths, limitations, and cost. This will ensure that the team is provided with the best software for the most reasonable price. In addition, educators considering undertaking a web development project should also recognize their limitations regarding web development expertise. Although it is not impossible to develop a web-based learning site as an individual, the Aviation Trainer web site is an example of the limitations that an individual may encounter. Of particular consideration is the level of programming expertise available to the developer. Without at least a basic programming background, it will be difficult to develop sophisticated training modules. However, for those with limitations in this area, there are off-the-shelf programs that are available that will aid in circumventing the programming process. However, it is important to note that a large majority of the programs will also limit the applicability and flexibility of the learning modules.

User Friendly Lessons

Checking Browsers

When developing web pages, it is important to understand that web pages will be viewed differently depending upon the browser they are being displayed within. However, something that may catch a designer by surprise is inaccurate reporting regarding browser capabilities. This was encountered after using CourseBuilder to develop several tutorials. CourseBuilder is a free add-on tool for Dreamweaver. According to the CourseBuilder user guide, this software was supported by both Netscape and Internet Explorer in versions later than 3.0. This turned out to not be the case. Although Netscape will display the content, it does not support some of the interactions in the tutorials. Some of these interactions were critical to success of the tutorial since they were included in the evaluation and quiz portions of the tutorial. This may vary significantly based on browser and version. It could be difficult to find abnormalities like this one until the tutorial is loaded. After reviewing the site statistics to determine user browsers and versions, there was little if any effect on The Aviation Trainer web site. There were no user reports of inaccessibility due to browser incompatibility. However, this may not always be the case. It is a good idea to test these features prior to completing an entire tutorial. This will prevent wasted design and implementation time.

Connection Speeds

It is important to always consider connection speed of the users. In the case of this project, students living on post only had access to 56K modem connection. Students accessing the web site from the learning center were subject to the post server access speeds, which can vary greatly throughout the day. This significantly limits the ability to use large graphics, movies and audio files. Consideration should be given to the overall size for each web page. Large page file sizes result in long downloads on slow internet connections. Forcing the user to wait for longer than six to eight seconds for a page to download can lead to frustration. This frustration may cause the user to stop the page download and abort any intentions of viewing the site. On this site, every attempt was made to ensure that the page sizes were as small as possible without compromising page content. Where file size could not be reduced, alternate accessibility was provided (i.e., study guide).

CONCLUSION

There are many other considerations when building a web-based learning site than those listed above. However, this paper focused on some of the more costly and confusing aspects of web development as well as those that presented a significant obstacle during the development of the Aviation Trainer web site. Prior to undertaking a project of this size, managers should consider potential costs and unexpected costs of site development (i.e., hosting fees, revisions). Costs may vary widely based on personnel available, their expertise, and outsourcing costs. It is also important to recognize that the learning site may evolve over time based on student, instructor, and industry demands. The most significant consideration an educator can give to a web-based learning site is the ability to be flexible and adaptable over time.

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Integration of the SHEL Model with the Flight Operational Quality Assurance (FOQA) Program

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ABSTRACT

The SHEL Model has been used to explore relationships between liveware, environmental, hardware and software factors. This study attempts to integrate Flight Operational Quality Assurance (FOQA) program data with the SHEL model. Aircraft record data that can be used to monitor the human interface within the entire system, plus identify faults and potential failures within the system before a major accident or incident occurs. These data have existed for over four decades, and FOQA offers a way to both analyze and act upon them. The relationships between the SHEL model and FOQA data can help to ensure our nation's skies are the safest and most efficient in the world.

One of the challenges in early aviation was the integration of the human and machine interface to accomplish the goal of flight. Over the decades, and now more than a century since the Wright Brothers accomplished the goal, powered aircraft have evolved into machines that barely resemble the Wright Flyer; however, the human element has not changed. Scientists have gained an increased understanding of how humans interact with aircraft, but human beings are still the same as they were when Orville and Wilbur first piloted their flying machine. This study attempts to integrate Flight Operational Quality Assurance (FOQA) program data with the SHEL model.

Aircraft have undergone enormous technological advances in structures, avionics, and automation. Engineers have grappled with concepts such as what information the instruments should transmit, how the controls should be shaped, placed, and respond, and how to "pilot proof", to some extent, the operation of the aircraft systems. A problem, which has always existed in aviation, has been the interface of the human with the environment, procedures, and machine in order to operate in an efficient, timely, and most importantly safe manner. Since two out of every three accidents can be attributed to human error, it becomes apparent that the human portion of the loop requires the greatest concentration of effort to make aviation as safe as possible (Wiener & Nagel, 1988).

In 1972, Elwyn Edwards developed a method inspired by the well-known conceptual model, which he called SHEL (Marti, Lanzi & Pucci, 2001). This model details the relationships between the human liveware "L", the machine hardware "H", the software "S", which encompasses rules, regulations, techniques, and practices, and the environment "E" (Wiener & Nagel, 1988, p. 11). The model has been utilized to understand the various ergonomic implications associated with flight. For the purposes of this paper, the "SHEL" elements will be referred to as: Crew = "L", Aircraft = "H", Air Traffic Control (ATC), and Federal Aviation Regulations (FARs) = "S", and environmental factors to include wind and weather = "E". When the model is shown pictorially, it appears as shown in Figure 1.

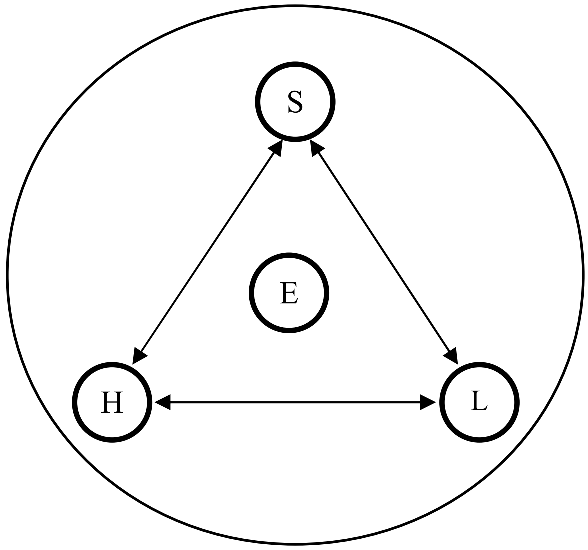

Figure 1. The SHEL Model. From *Human Factors In Aviation* edited by Earl L. Weiner and David C. Nagel, 1988, p. 15. Copyright 1988 by the Academic Press. Reprinted by permission.

The environment, while not directly connected to the “S”, ”H”, and ”L” nodes of the model, includes factors over which no one has control. These include physical, economic, political, and social factors (Wiener & Nagel, 1988). The connection of the nodes “S” “H” and “L” are known as interfaces. In the case of “L-H”, it is referred to as “Liveware to Hardware Interface”. In this paper it will be annotated as: “L-H” or “L-L” in the case of liveware to liveware,

The interactions within the SHEL diagram are a focus of Human Factors research. An example of “L-S” is when a crew of an aircraft has to obey rules, procedures and regulations. These rules can be the Federal Aviation Regulations (FARs), a company’s Standard Operating Procedures (SOPs), or just the laws governing the driving to and from work. An example of “L-H” is a cockpit crew operating the controls of an aircraft during a flight. When the pilot reaches for the controls of the airplane and manipulates them in a certain fashion, it’s an example of an “L-H” interaction. An example of “H-S” interaction is when an aircraft flies through or into an Air Traffic Control Facility’s (ATC) section of airspace. The crew (L) has to follow the rules governing the airspace, but the aircraft must also be capable of maneuvering in accordance with those rules. The engineer’s design and the aircraft’s capabilities are the key to this interaction. If an aircraft (H) cannot climb to meet the requirement (rules/procedures) of a climb segment on a departure from an airport (S), then there is a conflict between “H-S” that commands attention.

There is a system of data collection being used today that can be used with the “E” node of the SHEL diagram. The modified center of the SHEL diagram will be “E/F” rather than just “E”. The “F” in the proposed SHEL model stands for Flight Operational Quality Assurance, otherwise known as “FOQA”. The FAA regulations state, “FOQA is a voluntary program for the routine collection and analysis of digital flight data for the purpose of identifying adverse safety conditions, and where appropriate, proactively initiating corrective action before such conditions can lead to accidents” (Federal Register, 2002, p. 56771). FOQA’s beginning was really in 1958, when the Civil Aeronautics Board mandated that flight data recorders (FDRs) be required equipment on all U.S. registered airliners (GAO, 1997). Although FDRs have been in existence that long, FOQA is a fairly new process. United Airlines has the distinction of having the oldest FOQA program (Kolczynski, 1998). The FAA officially started incorporating FOQA data into its safety programs in 1995 according to the General Accounting Office (GAO, 1997). Figure 2 shows the revised SHEL diagram.

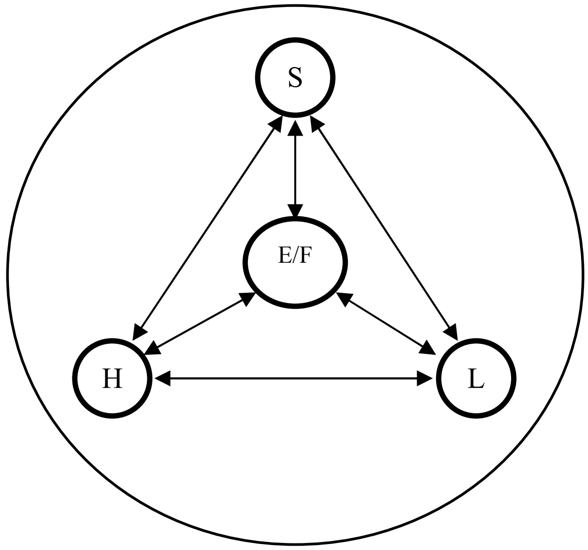

Figure 2. The SHEL Model. From *Human Factors In Aviation* edited by Earl L. Weiner and David C. Nagel, p. 15. Copyright 1988 by the Academic Press. Reprinted by permission. Modified by the author.

It is difficult to analyze any of the SHEL interactions without data. The FAA and FOQA are making it possible to analyze almost every aspect of commercial aviation, short of analyzing the brain waves of the pilots. Flight data recorders record an enormous amount of data. The performance of the "H" portion of the SHEL diagram is fairly straightforward. Direct analysis of the flight recorder data has been used for many years in accident investigations around the world. But in order to understand how FOQA assists with the "S" and "L" portions of the diagram, one must first understand FOQA.

FOQA is not a new stand-alone system. FOQA takes flight data and transforms them into information that can be used on a day-to-day basis, rather than for accident investigations as they have historically been used. In the past, the only time data were extracted from an FDR was when an aircraft crashed, or there was a major incident that required FDR data for an investigation. With the advent of miniature electronics and multi-channel FDR's, much more data can be obtained on a regular basis. The FOQA data are obtained by instrumenting the aircraft with numerous sensors in addition to those normally utilized, or by tying into the existing data buses within the aircraft. These sensors feed information into the FOQA recorder data banks for future analysis. Another common practice is to piggyback data from the aircraft's existing FDR. This process is much like hooking jumper cables from one car to another. These devices allow maintenance to download the FDR data easier than removing the FDR from its installed location. Another method is to install a device called a Quick Access Recorder (QAR) in the aircraft. This device is a stand-alone recorder that ties into the aircraft systems to record as many as 900 different parameters. Some QAR's use an optical disk that can store an average of 10 days of flight data before needing to be removed and replaced with a new disk (Cunningham, 1999). Data can also be recorded on magnetic tape devices, or by a process known as "…milking your existing FDR" (Flight Data Services LTD, 2003, p. 2).

Large amounts of data can be gathered very easily with such devices. In a 1997 report to the General Accounting Office pertaining to QAR's, the following was noted:

> Flight data recorders may not capture a sufficient number of parameters to be useful for FOQA purposes. Currently the FAA requires from 16 to 29 parameters to be recorded on flight data recorders in transport aircraft; a FOQA program, however, would likely capture many more parameters. Typically, the 200-500 parameters available on modern digital aircraft allow a more comprehensive set of

conditions to be monitored. Finally, flight data recorders hold about 25 hours of flight data, a relatively short time period. Instead, some U.S. airlines use a device called a quick access recorder (QAR) to record FOQA data to a removable optical disk or Personal Computer Memory Card International Association (PCMCIA) card. QARs record flight data that are output from the aircraft's digital flight data acquisition unit (DFDAU), the same device that feeds parameters to the flight data recorder. On average, QARs can hold from 100 to 200 hours of flight data. (GAO, 1997, p. 22).

There is an enormous amount of data that can be obtained. "On Boeing 737-500 series aircraft, an average of 7.2 Mb of data is obtained per day, that has 329 parameters, resulting in an average of 2.6 Gigabytes of tail number specific data per year" (Davis, 1999).

There are numerous issues regarding FOQA data. The first one is obviously retrieving it. Delta Airline's standard operating procedure (SOP) is to download their FOQA data through the use of maintenance technicians. Delta and the Airline Pilots Association (ALPA) management members meet approximately every seven to ten days to analyze the FOQA data. The team members determined that there are 83 parameters that they look for, ranging from "…excessive rotation rates, pitch rates that were too high or low on takeoff or landing, glide slope deviations during an Instrument Landing System Approach (ILS), excessive descent rates, engine events, and various maintenance events" (Cunningham, 1999, p. 32). This process involves numerous person-hours and a fair amount of coordination to make sure the data are captured for further analysis. One of the easiest ways to capture FQOA data is to do it automatically by transmitting the data each time the aircraft blocks in at the terminal or hangar (Flight Data Services LTD, 2003). With today's wireless network technology and robust computing capabilities, this seems like a reality that's not too distant in the future.

Another problem area is with the FOQA data itself. According to the FAA it is up to each individual airline to determine how they are going to capture, analyze, protect, and disseminate the data. Safety experts and the FAA agree that FOQA data need to be protected from open public distribution (14 CFR – CHAPTER I – PART 13.401, 2003). This allows the data to be used to help prevent future safety incidents, and to learn from the past. FAA regulations are in place to accomplish this. According to the FAA, if the FAA Administrator approves an operator's FOQA program, "the FOQA data will not be used for punitive measures against the operator or its employees, unless an incident or accident resulted from a criminal or deliberate act" (14 CFR – CHAPTER I – PART 13.401, 2003, (4e)). Safety experts and the FAA are in agreement that access to FOQA data needs to be restricted except for safety uses (14 CFR – CHAPTER I – PART 13.401, 2003).

When the data have been captured in a QAR, retrieved by maintenance, or directly transmitted to an airline's FOQA department, they are analyzed by airline personnel. In the case of Delta Airlines, the QAR disk is sent to Delta's Corporate Safety Office, where it is placed in a guarded location until their FOQA team can analyze the data. So what would qualify as a "FOQA Event", otherwise known as a "flagged event"? The Delta team members examine the data to see if any of the 83 specific events are identified on the QAR. An example of a flagged event would be excessive airspeed on final, glide slope deviation, or an incorrect configuration (Cunningham, 1999). These are much like "bit-balls" in certain aircraft. The indicators merely tell managers, maintenance, or the FOQA team that something has been exceeded.

The Delta FOQA team can select any event they deem necessary during a flight, in the interest of safety. All that's required is a change to the FOQA software, which would enable the capturing and processing of data, pertaining to the event, identified for analysis. The FOQA data are then de-identified or erased by a board member called the gatekeeper (Cunningham, 1999). This is the process that removes the identity of the aircraft's crew, so the data can remain anonymous. It is important that the data not be de-identified if a violation or accident occurs. The FOQA team and the airline's management must also have procedures in place to keep the identity of the crew, if they intend to use the data to identify additional training requirements (Cunningham, 1999).

The SHEL model and FOQA can be linked together to help an airline use FOQA to improve the "S"-"H"-"L" interactions to make the skies safer, and more efficient. One accident that might have been avoided if FOQA data had been used was on the evening of March 5, 2000 when a Southwest Airlines 737-300 went off the end of the runway at the Burbank (BUR), California airport. The crew of the mishap aircraft accepted a "slam dunk" approach, which is an approach that is begun very close to the airport, at an altitude that is higher than normal. If flown properly, airspeed can be managed and a safe stabilized approach can be accomplished. This did not happen on the night of this accident. The National Transportation Safety Board (NTSB):

> …conducted an airplane performance study in conjunction with this accident investigation. FDR and radar data indicate that the airplane began its final descent to BUR about three nm from the runway 8 threshold. Taking into account the airplane's altitude of 3,000 feet msl at the beginning of the descent and the 725-foot msl elevation of the touchdown zone (TDZ) on runway 8, geometry calculations indicate that the airplane would have had to have descended at an average flight path angle of about 7° to touch down in the runway 8 TDZ. Radar and FDR data show that the airplane descended at an average flight path angle of about 7° until flare, at an average vertical speed of 2,200 feet per minute (fpm), and at indicated airspeeds of between 182 and 200 knots. The airplane began to flare about 170 feet agl. and flared for about 9 seconds before touching down at 182 knots indicated airspeed on runway 8. Average ground speed during the flare was 195 knots, indicating that the airplane traveled about 3,000 feet during the flare. (NTSB, 2002, p. 12)

The long landing, on a short, wet runway, with a tailwind, and excessively high approach airspeed culminated with the aircraft departing the prepared surface. It is important to note that Runway 8 at Burbank is only 5,801 feet long (Bob Hope, n.d.). The aircraft came to rest next to a gas station off the airport property.

The high descent angle was the first "FOQA Flag" that should have been triggered during this accident. The NTSB report indicates that:

> A comparison of the recorded radar data of the accident airplane to 70 other airplanes that had landed at BUR on runway 8 between 1000 and 2200 on June 13 and 14, 2000, showed that of the 16 airplanes vectored from the north side of BUR to land on runway 8, 12 were vectored to intercept the final approach course between 9 and 15 nm west of the runway threshold. Flight 1455 was given vectors that resulted in interception of the final approach course about eight nm west of the runway threshold. The comparison also showed that the glide paths of most airplanes approaching runway 8 were between 3° and 4°. The accident airplane's glide path was 7°. (NTSB, 2002, p. 18)

The second "FOQA Flagged" event would have been the touch down speed in this accident, which according to Southwest Airlines procedures was "Target Speeds". Chapter 3, Section 6 of the procedures, states, in part: "Fly Vref [32] + 5 knots for tailwind landings". The CVR transcript indicates that, at 1804:42, the first officer informed the captain that the target airspeed would be 138 knots" (Aircraft Accident Brief, 2002, p. 14). The touchdown speed of this aircraft was 182 knots with the flaps extended to the 40-degree setting. On this particular version of the Boeing 737-300, the speed that is not to be exceeded with the flap 40-degree setting is 158 knots indicated airspeed (NTSB, 2002). The aircraft's speed for this approach was 44 knots above the target speed of 138 knots and resulted in a flap over-speed of 24 knots to both the flaps and the flap actuating assemblies.

It is important to note the actions of the first officer during this accident. During the approach the first officer:

> …also stated that when the captain called for flaps 40°, the airspeed was about 180 knots and went as high as 190 knots during the approach. The first officer indicated that he pointed to his airspeed indicator to

alert the captain of the flap limit speed of 158 knots at flaps 40°. (NTSB, 2002, p. 4)

The SHEL interactions to look at are the "H"-"S"-"L" interactions of the high descent rate, high airspeed, and lack of following procedures during this approach. Figure 3 is a diagram of an ILS with a 3-degree glide path. The dashed line superimposed on the approach shows a 7-degree glide slope, approximately that of the Southwest flight.

The fix "First" is approximately nine nautical miles from the end of RW17 in this example ILS. This can be used to represent the Southwest flight's final approach segment. Rather than being on the solid line at this notional fix, according to the accident report, the aircraft was on a 7-degree approach glide path, represented by the dashed line. Not only was the aircraft well above glide path, it was being flown with excessive airspeed at this point in the approach. During the Southwest approach, the desired 3 to 4-degree descent gradient was most definitely exceeded.

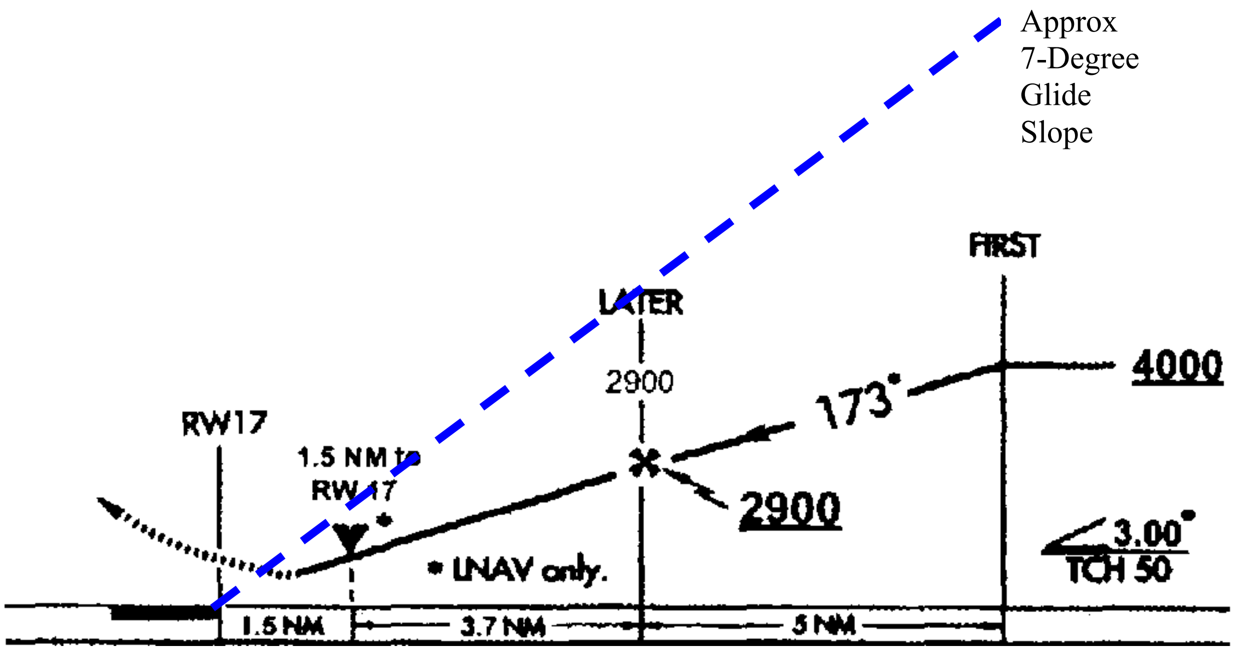

Figure 3. ILS Example. From *Airman's Information* p. 5-4-11. February 24, 2000 reprinted by permission.

FOQA allows an airline to set windows that will alert the airline if a parameter has been exceeded. One such parameter is stabilized approach criteria, defined at "a predetermined point and beyond the aircraft is "in the window". Different airlines have different parameters. They may include aircraft configuration, speed, minimum power settings, and vertical speed, to name a few. An example might be: "Outer Marker – Aircraft on the localizer and glide slope, gear down, flaps approach, speed less than 140 knots 500 feet above decision height or above touchdown if field in sight – Aircraft still on localizer (loc) and glide slope, gear down, flaps full, speed Vref + 15 or less. Note: This is the "window", should your speed vary by 15 knots or more or should you lose the loc or glide slope by one dot, execute a missed approach or go around " (Stabilized Approach n.d., p. 1). Figure 4 shows an airline's procedure for an ILS, which includes call outs, and parameters that should be met at certain points on the approach. There are also target airspeeds and altitudes associated with each of the windows in Figure 4.

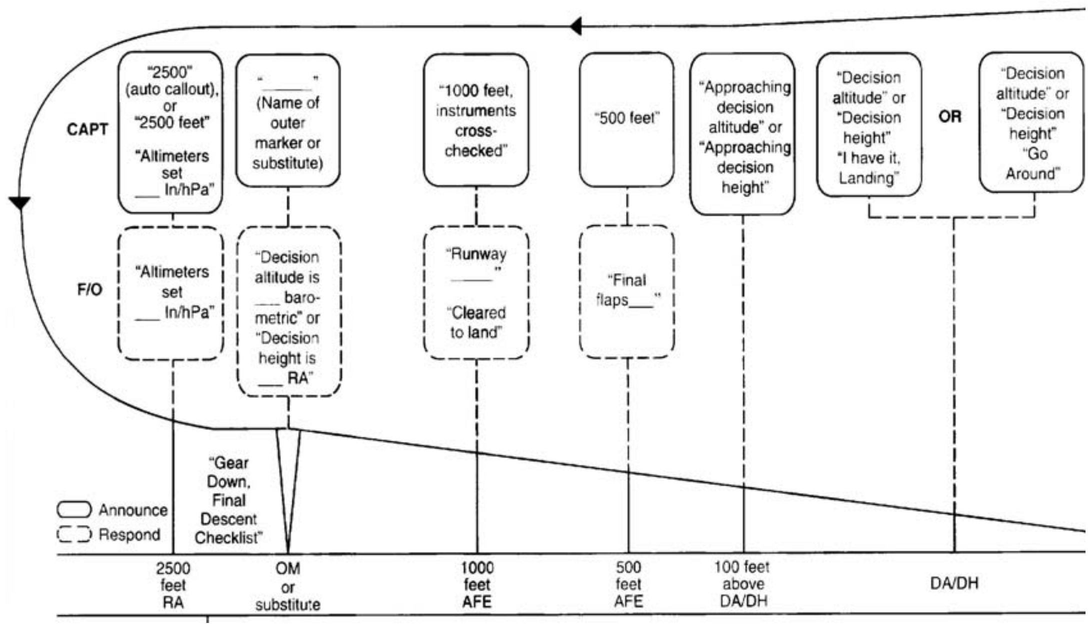

Figure 4. Approach example. From "Flight Operations Manual" February 24, 2000. Reprinted by permission.

By knowing the parameters associated with the approach, FOQA and the FOQA team can set parameters "windows" to look for certain events. Figure 4 shows that by 500 feet agl. the landing flaps are supposed to be in their final position. If the FOQA data shows movement of the flaps below 500 feet agl., as indicated by the radar altimeter, then a FOQA flag should alert the team. If the situation warrants, the crew could be called to figure out what happened. If there was a definite reason for the SOP deviation, one of three things can happen. If the flagged event was a momentary deviation that was situation dependant, the company might overlook the event. If the results of the flagged event are such that the rules need to be changed, then the FARs might require revision. And finally, if the SOPs are not allowing the aircraft or crew to perform correctly, then the SOPs need revised. If the team discovers that the incident warrants further crew training due to poor procedural knowledge, it's better than allowing a situation to develop such as Southwest's Burbank accident.

Take another example; suppose the aircraft was 20 knots fast at the same 500-foot agl. point as in the last example. If a company's SOPs are to be within 5 knots of the bugged target speed, this might indicate a major deviation. If the weather reports indicated nothing to counter the data, remedial training of the crew might be warranted. If the weather reports indicated that there were gusty winds and poor weather on that day at that arrival airport in the flagged event, then the FOQA flagged event might not warrant any further investigation. The analysis must allow for investigation before an event leads to false accusations that a crew performed poorly.

During the NTSB investigation of Southwest's accident at Burbank, they found that probable causes of the accident "…was the flight crew's excessive airspeed and flight path angle during the approach and landing and its failure to abort the approach when stabilized approach criteria were not met" (NTSB, 2002, p. 22). The flight crew was not solely responsible for this accident. The NTSB also faulted the Burbank approach controller. The NTSB stated that the "…controller positioned the airplane too fast, too high, and too close to the runway threshold to leave any safe options other than a go-around maneuver" (NTSB, 2002, p. 22).

Numerous "S" "H" "L" interactions were involved in this accident. "L"-"S" interactions were obviously involved with regard to both approach angle and airspeed. The approach angle of 7-degrees was double what is labeled as the accepted norm. The touchdown speed of 182 knots was 44 knots above the target approach speed, and exceeded the flap extension speed for the flap 40-degree setting by 24 knots (NTSB, 2002). Was this an isolated incident, or do incidents like this occur more frequently? Can FOQA and the SHEL model help avoid accidents like this in the future?

FOQA allows airlines to monitor and analyze data on a regular basis, rather than the infrequent schedule of a checkride. FOQA allows continuous monitoring and analysis of the "S"-"H"-"L" interactions that are happening every minute of every day, on every single flight. When a check airman is giving checkrides, crews are more likely to be on a best behavior to perform all duties in accordance with published regulations, company SOPs, and in accordance with the FARs. FOQA allows an airline to monitor and improve procedures when the check airman isn't present. According to Gary Davis, Deputy Division Manager, Air Transportation Division, Flight Standards Service "The vast majority of information gained by FOQA cannot be found in any other way. Periodic line checks conducted by check airmen cannot provide the same level of insight into daily operations as the continuous monitoring of FOQA data. Check rides are a "one look opportunity" (Davis, 1999, s-4). This is the big difference between FOQA data and a check airman. FOQA is there all the time, and through proper analysis and protection it can provide insight to numerous problem areas before they develop into major incidents, or even accidents. This continuous monitoring of SHEL interactions is where airlines are poised to gain the most from FOQA. It should be noted that at the present time, Southwest Airlines does not have an operational FOQA program.

The Southwest accident at Burbank might not have been the only incident of this type at the airport. The FAA cited the controllers as being causal in this accident. The question must be raised then, how many other aircrews were given short vectors to the "slam dunk" approach like this in the past, and just made it work? These "L"-"L" interactions could possibly have been identified by analyzing FOQA data. If FOQA events are indicating that only certain aircrew members are having more FOQA events than others, then aircrew training and or monitoring might be warranted. Additional training could remedy any deficiencies that a specific crew has. This would be an example of a "L" interaction being the focus of attention. This analysis must obviously be done before the FOQA data is de-identified by the FOQA team. The central node "E/F" on Figure 2 would indicate that the problem lies with the "L" node rather than the others, based on the captured data. This requires the FOQA analysis and filters to be highly refined and accurate. If numerous FOQA events are being flagged by an airline, the FOQA data analysis can allow an airline to pin point the problem areas. The FOQA team can analyze the data to identify whether the events are crew, aircraft, weather, or airport specific, rather than taking an educated guess.

If the data identify that a certain aircraft or aircraft fleet type is having issues, the "H" node in the SHEL model should be the focus of the data analysis, and the team must look at how the aircraft is being operated. Using Burbank as an example, if only a certain aircraft fleet type is having problems stabilizing approaches, and all other types of aircraft are within acceptable standards, then procedures must be modified to take this aircrafts limitations into account. This is an example of modifying or taking the "H"-"S" interactions into account. By changing the procedures, the way the aircraft is operated, or the rules that air traffic control uses for this aircraft type, the limitation can be accommodated to allow the aircraft to operate safety.

The NTSB cited the controllers at fault in the Burbank accident. If FOQA data from numerous fleets and airlines could have identified that all fleets, crews, and airlines were having difficulty with the arrival procedures into the airport the procedures the air traffic controllers were using could have been modified to make them safer. Ultimately, the crew in the Southwest accident was guilty of the most basic fact in flying an aircraft; if the approach does not look right, then "go-around." During the course of the approach, the crew failed to put together the pieces of the puzzle that should have led to an eventual go-around from the approach. The co-pilot made mention of the excessive speed, even pointed to the airspeed indicator, but failed in forcing the issue of executing a missed approach. One tactic might have been to state "Southwest 123 is executing a missed approach" over the radio. This might have finally clued the captain into the fact that he needed to execute a missed approach rather than prosecuting a flawed approach and landing. Ultimately, the crew must make the right decision within the SHEL model.

The "L"-"L" interactions are difficult to monitor other than through the cockpit voice recorder. Current regulations do not allow cameras in the cockpit. Crew Resource Management (CRM) classes and seminars are held to reenact incidents such as the Southwest accident. This is an excellent place to chair fly just such incidents. During CRM seminars, and even at home, a cockpit crewmember can think about scenarios and about what he or she will do during such an event.

Airlines can benefit in more that just the operations department. The maintenance department can reap enormous benefits from FOQA. Take for instance an event known as a flap overspeed. This event occurs when the aircraft exceeds the manufacturer's placarded speed for a specific flap setting, otherwise known as flap position. For instance, in Southwest's accident aircraft the maximum airspeed limit for a flap setting of 40-degrees was 158 knots indicated airspeed (NTSB, 2002). If this speed is exceeded, maintenance should inspect the aircraft for damage. If this speed is exceeded excessively, serious damage to the aircraft is possible. The problem arises when these incidents occur repeatedly, by just a few knots, or a one time excessive overspeed, such as the Southwest incident, without the incident being entered into the maintenance forms. Over time, if not inspected and repaired, occurrences like this one introduce fatigue and stress cracks throughout the aircraft structure.

An incident like this results in the greatest FOQA benefit for an airline's maintenance and safety department. At Delta, if management and the FOQA teams identify an incident, a mini-investigation subsequently occurs. If the event identified by FOQA was entered into the aircraft forms, and maintenance cleared the entry, or is in the process of working the issue, no further action is taken. If the event was not cleared by maintenance, or was not entered into the aircraft forms, the team makes the following maintenance entry in the logbook "discovered by FOQA" (Cunningham, 1999, p. 32). Using the flap overspeed scenario as an example, Delta's procedures dictate that if the overspeed exceeded the placarded limit by less than 15 knots, the aircraft can remain in scheduled service until the next scheduled 100-hour inspection. If the overspeed was 15 knots or greater, then the aircraft is grounded and removed from scheduled passenger revenue service until it can be inspected (Cunningham, 1999).

Without FOQA, the safety system relies completely on the integrity of aircraft crews to realize and admit to exceeding the limits of various aircraft systems whether intentionally or unintentionally. Overspeeds are very serious and can be caused by crews that truly didn't notice the overspeed, possibly due to task saturation, or lack of situational awareness. FOQA can help an airline's maintenance department perform only the necessary maintenance, and identify major maintenance required. This is an example of all the nodes of the SHEL model being affected by the "E/F" node. Causing the incident or performing the maintenance action to correct the problem affects the human "L" directly or indirectly. The aircraft "H" is involved because it was damaged or required maintenance. The rules and procedures "S" were an issue because they were not recognized, followed, or were not sufficient to prevent the incident from happening.

An example of an S"-"H"-"L" failure that FOQA might have been able to help identify was the 1982 accident of an Air Florida 737-200 on January 13, 1982. One of the accident's causes was the "flight crew's failure to use engine anti-ice during ground operations and takeoff, their decision to take off with snow/ice on the airfoil surfaces of the aircraft, and the captain's failure to reject the takeoff during the early stage when his attention was called to anomalous engine readings" (NTSB, 1982, p. ii). The NTSB found that the flight crew had not used engine anti-ice during ground operations. The buildup of snow and ice on the aircraft, and in particular on the engine pressure probes, were the major causes of this accident. The blocked pressure probes caused incorrect engine thrust readings. The artificially high pressure readings for a given throttle setting caused the crew to actually set a lower power setting and corresponding throttle position, resulting in insufficient thrust being produced to sustain flight. The low power setting and buildup of snow and ice on the aircraft prevented the aircraft from generating the lift required to sustain flight (NTSB, 1982).

Aircraft engines require anti-ice for certain operations in cold weather. FOQA and its data could have helped prevent the Air Florida accident. Anti-ice rules and procedures "S" have been changed since this accident (NTSB, 1982). Rules are now in place that governs how long an aircraft can sit on the ramp after being deiced. The times vary depending on what type of deicing fluid is used. "S", "H", and "L" interactions were all modified together by using the N1 (engine RPM) gauges in addition to the (EPR) exhaust pressure ratio gauges to set engine thrust levels. Procedures are now in place "S" so if one gauge fails or is reading incorrectly, the engine thrust can be set correctly using the other indication. This cross checking of engine instruments ensures that engine operation is what the crew expects. FOQA data might have shown that Air Florida was not turning on the engine anti-ice when temperatures were below a preset level. If this data could have come to light, training procedures could have been altered so the crew "L" actions could be changed prior to the accident, possibly avoiding the accident entirely. Wouldn't it have been great to listen to FOQA rather than allowing the environment to influence this accident?

In 1958, when the Civil Aeronautics Board mandated that all commercial airliners must have flight data recorders, FOQA was born. FOQA has been in its infancy since then. Technology changed rapidly during the 1970's with the introduction of the Traffic Collision Avoidance System (TCAS), the Ground Proximity Warning System (GPWS), and Cockpit Resource Management (CRM) programs. All of these programs were identified as problem areas, which impacted the national airspace system. Experts have noticed that FOQA has great potential and is "One of the yet un-exploited tools" (Brandt, 1999, p. 1). It has capabilities that can revolutionize how humans interact with their environment and the machines that they operate within that environment. One of the biggest challenges that face airlines, unions, and lawmakers is data protection. In order for FOQA data to be used to its fullest potential, it must be protected much like the NASA system that's in place to report pilot deviations and admissions. The difference between them is that NASA's system relies on pilots to self-disclose information. FOQA is monitoring all the time, everyday. All we have to do is look at the data and make the appropriate changes.

Today's airline environment is very competitive. No one can afford to operate inefficiently or in an unsafe manner. FOQA provides a tool that can revolutionize the safety system, the SHEL model, and the interaction of man, machine, and his environment. Even the Wright Flyer had FOQA on board; it just took Orville and Wilbur a lot of time to try to remember what happened on the short flights. They would have loved to have the tools available today to monitor and analyze flight operations.

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