UNIVERSITY AVIATION ASSOCIATION

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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The *Collegiate Aviation Review* is published annually by the University Aviation Association, and is distributed to the members of the Association. Papers published in this volume were selected from submissions that were subjected to a blind peer review process, and were presented at the 2003 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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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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FAA "Captured?"
Is the Federal Aviation Administration Subject to "Capture" by the Aviation Industry?

David B. Carmichael, Ph.D., Mary N. Kutz, Ed.D and Dovie M. Brown, M.S.
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ABSTRACT

Among the missions of the Federal Aviation Administration (FAA) are the following: regulating civil aviation to promote safety and fulfill the requirements of national defense; and encouraging and developing civil aeronautics, including new aviation technology (FAA 2002). The conflict between missions has led to questions regarding potential "capture" of the FAA by the industry that it regulates and a possible compromise of its critical aviation safety role. This article examines the concept of "capture" as related to both private industry and government agencies and further explores both sides of the issue pertaining to possible "capture" of the FAA

INTRODUCTION

According to an FAA website, among the FAA's major functions are the following: "Regulating civil aviation to promote safety and fulfill the requirements of national defense; and encouraging and developing civil aeronautics, including civil aviation technology" (www.faa.gov).

Over time many questions have been raised regarding a possible conflict between these two elements of the FAA mission. These questions surfaced during cases such as the May 11, 1996 fatal crash of a Valujet DC-9 that plunged into Florida's everglades as the result of a fire caused by hazardous cargo being transported contrary to regulations. This accident occurred even though multiple safety-related problems had previously been reported about Valujet operations. In support of the carrier, FAA initially opted to allow Valujet to continue operation. This is one of several examples where safety may have been compromised by industry influence.

The aviation industry has remarkable power in affecting the FAA. It can bring pressure to bear on the FAA through direct Congressional or White House intervention, as well as through congressional committee staff. In addition, the FAA is very sensitive to the "alphabet groups" such as the Air Transport Association (ATA), the Aircraft Owners and Pilots Association (AOPA), the National Business Aviation Association (NBAA), the International Air Transport Association (IATA), and the General Aviation Manufacturers Association (GAMA). These, and groups like them, can place enormous weight on the FAA to abrogate their safety mission or goals in favor of the industry.

Within government agencies, decision makers are frequently reluctant to publicly raise issues concerning specific goals due to the negative political consequences. By avoiding the issues, goals are more likely to be tentative or unclear and therefore subject to being determined by industry. Decision makers are less likely to be held accountable. This can result in the undermining of agency goals and subject the agency to capture by the very interests whose behavior the goals were established to regulate.

Many FAA critics cite FAA's dual mission as an irreconcilable conflict that compromises aviation safety in favor of promoting the industry. One of the strongest critics of the FAA is former Department of Transportation Inspector General Mary Schiavo. Ms. Schiavo asserts that much of the FAA's failure to act on safety matters can be blamed on its dual role, and often conflicting mandate to police the airlines for safety and to promote commercial aviation (Ignelzi, 1997).

Is she right or does FAA's dual role force a kind of balance between an agency that might be prone to over regulation without a parallel check and balance system with the industry it regulates? Other governmental agencies and even private industry organizations with significant fiduciary or safety related responsibility have shown that they are also vulnerable to pressure to ease regulatory or audit affect. The Food and Drug Administration, the Securities and Exchange Commission, the Occupational Safety and Health Administration and a number of private commercial industries such as big five audit firms are also subject to compromise for a variety of reasons including professional relationships, the lure of consulting revenue, or conflicting missions.

Although private industry and other government agencies share similarities and differences with FAA, all are subject to influence that requires maintaining a kind of balance. At what point do they go too far and cross the line? Has FAA lost that balance and become subject to "capture" by the industry it regulates?

"CAPTURE" DEFINED

The concept of "Capture" is based on the Stiglerian model of the demand for regulation rather than studying the behavior of legislators and others on the supply side of regulation. "Together with the work of Peltzman (1976), Stigler is credited with the development of the *capture theory of regulation* in which an interest group 'captures' the regulatory agency and bends regulation to its own interests" (www.humboldt.edu).

In another study of regulatory agencies, Marver Bernstein described a series of phases that constitute the life cycle of an agency. At first a new agency is full of enthusiasm for protecting the public interest; but as it matures the enthusiasm gives way to more realism about its role; until finally it either becomes a protector of the status quo or a captive of the interests it purports to serve.

Conversely, private interests may be amply powerful so as to influence the regulatory agency to serve primarily the interests of those subject to the regulation—"in other words, the regulated group captures the regulators" (Kroszner, p.26).

Robert Monks and Nell Minow (1991) make the case that corporations actually thrive under regulatory control. In their book *Power and Accountability*, Monks and Minow assert "The ultimate commercial accomplishment is to achieve regulation under law that is purported to be comprehensive and preempting and is administered by an agency that is in fact captive to the industry" (p. 131).

"CAPTURE" IN GOVERNMENTAL AGENCIES

The very nature of governmental organizations in the United States encourages the participation of business in the affairs of government. Political contributions, congressional action, White House action, and the actions of industry-led lobbying groups manifest this influence. Absent abuse, the process gives voice to citizens who might otherwise not be heard.

H.R. Mahood, in *Interest Groups In American National Politics, An Overview* (2000) describes the freedom to organize and act on behalf of the interests of groups of citizens as an enduring feature of our open, democratic system of government. He states: "Almost 1000 advisory committees exist within the various agencies today, giving their respective members or clientele groups a unique degree of access and/or voice in agency deliberations. These settings allow for hundreds of semiofficial associations to bring together congressional personnel, agency bureaucrats, possibly White House personnel, and group spokespersons. These formalized relationships, then, allow for the sharing and formalization of policy concerns" (p. 101).

He illustrates this with the Farm Bureau, which is an organization concerned with the Department of Agriculture's farm policy, as are members of Congress on the agriculture committees. The same could be said of most federal, state, and local agencies including the FAA.

The very process that allows industry to influence Federal agencies such as the FAA and discourage them from being too aggressive in the industry-policing function may actually subject the agency to public scrutiny for being too lax and ultimately result in a kind of "capture" of the agency. When something does go wrong, FAA is often criticized for "being in bed" with the aviation industry.

The FAA is not the only Federal organization subject to such criticism. Most, if not all, share the same potential for capture by the industry they regulate. The Nuclear Regulatory Commission (NRC) has been accused of an "unholy alliance" with the utility industry. In a 1996 newspaper article, a number of common bonds are listed that link the regulators with the regulated. The article detailed efforts that Shirley A. Jackson, chairwoman of the NRC, was making toward creating a more objective regulatory environment in the nuclear power industry (Remez & McIntire, 1996).

Another example of the conflicting environment that regulatory agencies face is detailed in a recent article about the Occupational Safety and Health Administration (OSHA). The article poses the following question: "Is it OSHA the regulator and enforcer, the agency that adopts complex new standards and cracks down on violations? Or is it OSHA the educator and partner of industry, the one that warns of hazards and helps employers avoid them?" (Korman, Kohn, Illia, Winston & Gunn, 2001)

A third example deals with the Food and Drug Administration (FDA). In a 1996 article, FDA was described as extending numerous olive branches to the industry it regulates. This included local grass roots meetings to hear industry complaints, allowing fuller scrutiny of its policies and behavior, seeking industry input on the way it trains its field investigators, working with the scientific community to speed the approval of new products, and other efforts to create harmony with the industry (Dickinson, 1996).

In another article, the conflict that Federal agencies face is described by Treasury Secretary Lawrence Summers in describing the conundrum faced by the Internal Revenue Service (IRS).

In a January (2000) speech to corporate accounting and tax officials Secretary Summers strongly argued against those who "have framed debates on IRS priorities around a trade-off between enforcement and customer service." Summers answered those critics by saying: To have effective tax administration, there must be both compliance and high-quality customer service (Barlas, 2000).

Secretary Summers' speech not only describes the mission versus service tightrope that IRS walks, but that most or all other regulatory agencies must walk.

"CAPTURE" IN PRIVATE INDUSTRY

Similar to governmental organizations like the FAA, NRC, OSHA, FDA, and IRS, the audit industry is charged with the objective oversight of the financial health of its clients. This objectivity is called audit independence. Audit independence includes the notions of being unbiased, fair and impartial, and being intellectually honest (Carmichael, 1999).

Also similar to governmental organizations, auditors walk a tightrope between objective financial analysis and providing lucrative services to clients. Because clients are impressed with the integrity, objectivity and quality of the services provided by their CPA's, they also want them to provide many non-audit functions. Their tightrope consists of the ethical dilemma of serving the expanding needs of their clients against the requirements of auditor independence (Colson, 2001).

However, as recent events have shown, auditors have apparently been "captured" by clients with the temptation of profits from other services. The largest and most distinguished audit firms have been besmirched by apparent compromise of auditor independence. In 2000, nearly half of the partners at Pricewaterhousecoopers (PwC) —a total of 1,301— reported at least one violation of the law, with the average being five. In the wake of this disclosure, PwC established a fund of $2.5 million to create an internal education program in settlement of charges levied by the SEC (Barlas, 2000).

In another case involving a Big 5 accounting firm, Deloitte and Touche's impartiality was challenged by the Minnesota attorney general's office in the fact that Allina Health System paid the accounting firm $17 million in consulting fees in 1999. While both firms stood by its audit, the appearance is clear that a compromise of audit objectivity is possible or probable (Galloro, 2001).

One of the most recent and most publicized cases of compromise of audit independence is Arthur Andersen's relationship with Enron. In this case, Andersen not only performed corporate audits that found the now bankrupt corporation solvent, but helped to create some of the controversial off-the-books partnerships that obscured Enron's true financial status (Berger, 2002).

Although the audit industry has been receiving most of the attention in recent months, there are a number of other industries similarly subject to "capture."

"CAPTURE" OF THE FEDERAL AVIATION ADMINISTRATION

While FAA and other Federal regulatory agencies do not have the financial motivations to compromise their mission standards, they are often pressured by negative press coverage, lobbying groups, the Congress, and the White House to be kinder and gentler to those whom they regulate. In addition, the politically appointed heads of those agencies often come from the industries that they regulate. The political pressures and the industry relationships push those agencies in the direction of the interests of the regulated firms. As a result, the differently motivated, but similar capture of agencies by the industries they regulate result in a dynamic similar to the Enron/Andersen relationship.

The *Public Citizen, Congress Watch* (2002) published a report entitled "Delay, Dilute and Discard: How the Airline Industry and FAA Have Stymied Aviation Security Recommendations." In that report they cite a number of reasons why the FAA should not have been allowed to manage aviation security. Their rationale included the following statistics: The top nine airlines in 2000 and their trade association, the Air Transport Association (ATA), employed 210 lobbyists, including 108 lobbyists with "revolving door" connections. (They worked in Congress or another branch of the federal government prior to being hired by the airlines.) Of these lobbyists, 10 were former members of Congress. Two held cabinet positions as secretary of the U.S. Department of Transportation (DOT), which oversees the FAA. Another three held senior positions at the FAA. Fifteen lobbyists employed by the airlines in 2000 have worked in the White House…The coziness between the industry and FAA is manifest in the fact that three FAA administrators, the top post in the agency, have come from the industry (www.citizen.org/congress/regulations, p. 2).

The Center for Public Integrity recently conducted a study of FAA and its role as a regulator of the airline industry in which they described an "incestuous" relationship between the two. They also note that industry rather than FAA or Congress sets airline safety standards.

The National Transportation Safety Board (NTSB) in general, and Mary Schiavo in particular, has frequently chided FAA for failure to take timely action on their recommendations pertaining to such issues as: "bogus" parts installed on aircraft, implementation of new seating arrangements for enhancement of survival and the practice of allowing airlines to pay the cost of training FAA Flight Inspectors which might affect enforcement actions.

In a special report by the Association of the Bar of the City of New York Aeronautics Committee in March 2002, the FAA was again taken to task on its relationship with Valujet. The airline began service in October 1993. Between 1993 and 1996, the FAA investigated the airline 21 different times. Investigators found Valujet flying with mandatory equipment broken. In addition, FAA cited Valujet pilots for making routinely bad cockpit decisions. By March of 1996, the airline's internal reports showed a number of problems including eight engine shutdowns during flights, and twenty-eight problems with landing gear. At the same time, the FAA was holding Valujet up as a "poster child" for deregulation, citing its lower fares and rapid growth. The New York Bar suggested that FAA was caught up in its mandate to promote as well as regulate the airline industry (Aviation Today, 2002).

A comprehensive newspaper article from the Seattle Times in 1995, primarily about the certification process on the Boeing 777, captures the critique of the FAA and raises an important question. The article suggests there is a wary consensus that the FAA stands aside while the industry charges ahead. The article raises the question whether FAA is standing so far away that it can no longer tell when something goes wrong and the safety of airplanes is compromised. The article concludes with some questions about why aviation safety is relatively very good. Is FAA lucky or good? (McDermott, 1995) We suggest that the FAA is very good at what it does, in spite of its legion of critics.

FAA CAPTURE: THE REST OF THE STORY

While there is significant risk in a process as complex as the regulatory aspect of federal government, a system of checks and balances has evolved which certainly does not leave the opposite viewpoint voiceless. Even though industry and the alphabet groups reign in on federal agencies and their regulatory powers, there are similar checks and balances from an entire web of special interest groups whose expressed purpose is to "government watch" and/or promote their specific brand of dissent pertaining to corporate activities as well as opposing special interest groups. Many of those groups have the full cooperation of the media and their own special interest groups lobbying Congress as well, such that a case could be made that we have not only achieved a protective balance against the corporate capture of our regulatory agencies, but perhaps have on occasion swung the pendulum too far in failing to give credit to an agency with an outstanding safety record.

Keith Hill, Consultant, FAA Designated Engineering Representative for Level A software, Seattle, Washington, offered his comments on aspects of Mary Schiavo's book *Flying Blind, Flying Safe*. While acknowledging that there is room for improvement in the FAA, he pointed out a number of factual errors in Mary Schiavo's book and refutes the notion that the FAA is accountable for all failures related to air travel or that more government regulations and/or more rigorous inspects are a panacea for whatever ails the industry. He argues that the tough position FAA must maintain in making decisions that affect safety while keeping in mind the impact to the industry does not compare to NTSB which has no restrictions and can make recommendations and take the FAA to task without regard for cost or other installation implications and when the preponderance of the evidence is that the incremental benefit is far smaller than the cost. He also cites examples of unbalanced reporting filled with misinformation from *Computer Weekly* regarding such issues as …the Boeing decision to use common Ada source code compiled to three different microprocessors for the Primary Flight Computer software. The original plan was to use source code in three different languages. It is generally recognized that there are advantages and disadvantages for each of these two design approaches. After extended study and much discussion, Boeing concluded that the single language approach was the better choice. Interestingly, by making the decision when they did, short term costs to Boeing actually increased. The Computer Weekly quoted 'experts' who stated that Boeing "defied the principles" relating to dissimilar redundance and that wording has carried over into *Flying Blind, Flying Safe.*

He further stated that Designated Engineering Representatives are involved in all certification-related meetings and he has never seen evidence that FAA gave way on significant issues. In fact, he described them as rather acrimonious and far from being cozy between FAA and Boeing.

A careful look at the FAA record throughout its history, of course, clearly reveals one of the safest records of any transportation mode to date. An examination of air carrier accidents alone, which is the most highly visible and frequently most criticized, reveals interesting data. The agency most critical of the FAA publishes on their web site *Table 2. Accidents and Accident Rates by NTSB Classification, 1982 through 2000, for U.S. Air Carriers Operating under 14 CFR 121* (www.ntsb.gov). In that table they classify accidents of carriers in four categories by "major," "serious," "injury" and "damage." "Major" is defined as an accident in which any of three conditions is met: (a) a part 121 aircraft was destroyed, or (b) there were multiple fatalities, or (c) there was one fatality and a Part

121 aircraft was substantially damaged. "Serious" was classified as an accident, in which there was one fatality without substantial damage to a Part 121 aircraft, or there was one serious injury and a Part 121 aircraft was substantially damaged. The "injury" and "damage" categories involved no fatalities. In 1982 there were three major accidents and four serious accidents with 7.040 million aircraft hours flown. Each year since 1982 the number of hours flown increased, with the exception of 1991 (when there was a slight drop from the previous year), yet the highest number of major accidents that occurred in any given year was eight in 1985 and 1989, respectively. In 2000 there were three major accidents and three serious accidents (one less serious accident than in 1982) while the number of aircraft hours flown more than doubled to 18,040. The year 1998 saw the safest year with zero "major" accidents and three serious accidents. Granted, one fatality is one too many, but transportation by any other means involves risk of fatality also and the aviation industry's record is clearly well above the others. Logic would seem to indicate that if the Agency has truly been a captive of the industry it regulates, that record would have imploded upon itself long ago rather than continue to indicate a drop in the number of major and serious accidents per hours flown. Something must be working. Yet its critics persist in assigning terms like "tombstone" to the agency, implying that it only takes action after a fatal crash, and every year its critics predict that next year is the year airplanes will fall from the sky in record numbers.

CONCLUSIONS AND RECOMMENDATIONS

Noll and Owen (as cited in Mahood, 2000) argue that while "capture theories have enjoyed currency among some journalists and scholars, more recent studies raise doubts about their validity" (2000, p.23). Chubb (as cited in Mahood, 2000) states the capture theories may be too simplistic since public agencies all differ significantly in structure, congressional mandate and oversight, public support and other characteristics. The clientele of those agencies also vary in size, organizational structure, career personnel and culture that affect their willingness to be influenced by outside forces. Agencies undergo cycles of activism and quiescence. All of these factors create a much more complex picture than that postulated by the capture theory. Mahood postulates that capture theories "simply do not provide sufficient data and appreciation of interest group – agency interactions over time" (p. 23).

The definition of "capture" in itself is unclear in that it implies a level of control of the regulatory process by an industry such as aviation that would indicate a drop rather than an improvement in safety in spite of doubling the amount of miles flown. Still another fallacy in the definition of "capture" is the concept that interest groups 'capture' the regulatory agency and bend regulations to their own interests. Is that not a part of the original checks and balances built into the Federal Aviation Administration's dual assignment by Congress to allow industry to protect an overzealous bureaucracy from regulating an industry out of business by providing input into the regulatory process and bending regulations to protect their own interest?

Since change is the name of the game in organizations and today's winners may be tomorrow's losers, especially in highly volatile ones like the FAA, a longitudinal study over an extended period of time could provide valuable insight into whether or not the agency's regulatory responsibilities have truly been "captured" by the industry it regulates or whether perhaps the checks and balances are keeping the system in better balance than we suspect. Perhaps the FAA's conflicting safety and industry mandate as assigned by Congress is the problem or perhaps it is not. Perhaps it is functioning better than current media reports lead the public to believe and we are just moving through one of those pluralistic periods where the voices of activism are commanding more attention than the Agency, and the system of checks and balances is working as it should to counter the power of a large and powerful industry. Either way, the seriousness of the issue mandates further and more objective consideration than the constant parade of charges against an agency and an industry with a proud history.

One of the most important analysis tools in business is the breakeven point where revenue is just enough to cover expenses. Using the breakeven point analogy, perhaps an exploration should be conducted of the system in place regarding what point and at what level the FAA can absorb new responsibilities and stay above the acceptable "breakeven point" in terms of carrying out its conflicting responsibilities. For example, how long can FAA continue to absorb new responsibilities such as the recent addition of new law enforcement responsibilities before it crosses that line or breakeven point and really does lose the ability to maintain the balance between safety and security and industry needs, thus jeopardizing safety such that the aviation safety record topples? Has Congress already crossed that line not only with the FAA but with other agencies such as the Immigration and Naturalization Service that made headlines recently for extending a student visa to one of the terrorists six months after that terrorist flew an airplane into the World Trade Center? Is the "capture" related to bad congressional decision-making in their efforts to "capture" votes from a segment of society rather than an Agency's attempt to work within its mission and the resources assigned by a congress bending to interest groups?

The aviation industry is a volatile industry with a proud history of technological development that blazed the trail for this country's technological development throughout most of the last century. It has been founded and nurtured through cyclical times yet managed to maintain the highest standards throughout much of its history; its volatility is well established; and its high visibility subjects it to constant public scrutiny, as well it should be. Regardless of current media opinion, it deserves an objective look at current charges that challenge that history.

REFERENCES

Association of the Bar of the City of New York Aeronautics Committee (2002). Aviation Today Special Reports, Report on aviation safety, March 1, 2002, PBI Media.

Barlas, S. (2000). Auditor independence rules. *Strategic Finance, 81* (9), 25-26.

Bernstein, M. (1955). *Regulating business by independent commission*. Princeton, NJ: Princeton University Press.

Carmichael, D. R. (1999). In search of concepts of auditor independence. *The CPA Journal, 69* (5), 38-43.

Chubb, J.E. (1983). *Interest groups and the bureaucracy: the politics of energy*. Stanford, CA: Stanford University Press.

Colson, R. H. (2001). Scope of practice: Independence and MDP. *The CPA Journal, 71* (2), 80.

Galloro, V. (2001,). Auditing the auditors. *Modern Healthcare, 31* (22), 36-38.

Ignelzi, R. J. (1997, April 6). Coming in: and indictment of FAA from a watchdog who should know. *San Diego Union-Tribune,* Books, p.5.

In the unlikely event: the politics of airline safety. (1998). Washington, D.C.: The Center for Public Integrity.

Korman, R., Kohn, T. I, Winston, S., Gunn, E. (2001). Will the real OSHA stand up? *Engineering News Record, 247 (*1), 30-34.

Kroszner, R. S. (2000). The Economics and Politics of Financial Modernization. *FRBNY Economic Policy Review,* October 2000.

Mahood, H.R. (2000). *Interest groups in American national politics.* Upper Saddle River, NJ: Prentice Hall.

McDermott, T. (1995). Is the FAA up to the job? A question of safety: Do airplane makers dominate regulators. *Seattle Times*, June 4, 1995.

Monks, R. & Minow, N. (1991). *Power and Accountability.* New York: Harper Collins.

Noll, R.G. & Owen, B.M. (1983). *The political economy of deregulation: interest groups in the regulatory process.* Washington, D.C.: American Enterprise Institute.

Remez, M., McIntire, M. (1996, December 2). Critics say NRC and utilities have an unholy alliance. *Hartford Courant*, p. A1.

http://www.faa.gov.apa/history/overview.htm http://www.humboldt.edu/~envecon/econ_423/lectoutlines/ch7.htm. Hackett, Professor Steven. *Lecture outlines. Environmental and natural resources economics: theory, policy, and the sustainable society,* 2nd Edition.

http://www.ntsb.gov. *Accidents and accident rates by NTSB classification, 1982 through 2000, for U.S. air carriers operating under 14 CFR 121.*

http://www.wws.princeton.edu. U.S. Congress, Office of Technology Assessment, *Critical Connections: Communication for the Future, OTA-CIT.407, 1990.*

Upset Recovery Training In Collegiate Flight Programs

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ABSTRACT

Loss of control in flight has been a factor in a number of aircraft accidents in both commercial and general aviation. Although the frequency with which these accidents occur is small, the results are often fatal in nature. Both the aviation industry and regulating bodies have seen the trends in accident statistics and support the inclusion of training for pilots in the skills necessary to handle these occurrences. Upset recovery training provides the skills necessary to recognize and recover from critical flight situations that can occur.

INTRODUCTION

As professional aviation educators our job is multi-layered. We are required to assist students in the development of skills to the level mandated by the Federal Aviation Administration (FAA) pilot certification. We are also required to expose the students to any possible situation that may occur during their careers as professional pilots, regardless of how remote the possibility. Finally, our job as educators is to prepare our graduates so that they are marketable in the aviation industry.

It is a fine line between what the FAA requires for an applicant to pass a practical test and preparing that applicant for events that may occur in the foreseeable future. Upset recovery training fits within this fine line. The FAA requires unusual attitudes to be completed on many of the practical tests for pilot certification, but upset recovery training is not required for initial or recurrent certification for any pilot certificate.

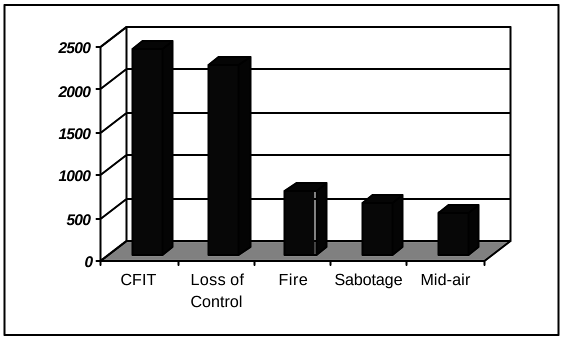
An aircraft upset, as an industry standard, is defined as pitch attitudes greater than 25º nose up, 10º nose down, bank angles greater than 45º, or within the above parameters, but flying at airspeeds inappropriate for the conditions. (Boeing, 1998) While these numbers are routinely obtained and in some cases exceeded in general aviation, the fact that we are training the professional aviators of the future makes it imperative that they are fully aware of this industry standard. For the purposes of this paper, aircraft upsets are defined as pitch attitudes greater than 30º nose up or down, or bank angles greater than 60º. The difference in the aircraft upset standard for this paper as compared to the industry standard is due to the difference in utility, normal and transport category aircraft.

The purpose of this paper will be to determine the extent to which collegiate aviation programs are offering or mandating upset recovery training in their curriculum. Further analysis will be used to determine the scope of this training and the stage at which it is completed.

PAST ACCIDENTS

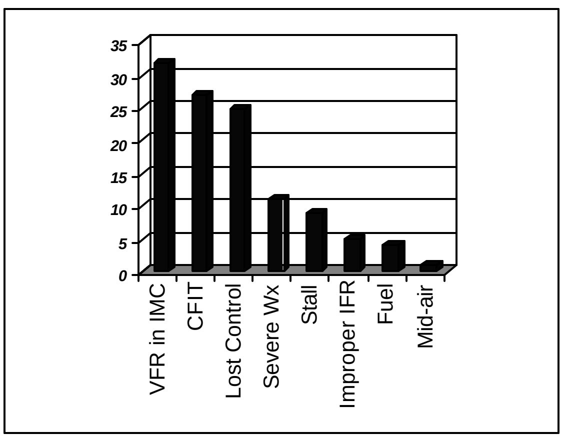
The prevention of aircraft upsets does not receive the same amount of attention from the FAA that other causes of accidents receive because they are not often the root cause and are not as clearly defined. Regardless of this fact, when an aircraft upset occurs, resulting in an accident, the conclusion is often catastrophic. From 1987 to 1996 there were 37 in-flight loss of control accidents in transport aircraft, which resulted in over 2200 fatalities. (Airplane Safety Engineering, 1997) This put loss of control accidents as the second highest cause of airline fatalities worldwide from 1987 to 1996 (Figure 1).

Figure 1



General aviation did not fare much better with respect to loss of control accidents. In 2000, loss of control accidents were the third leading cause with 25, preceded by visual flight (VFR) into instrument meteorological conditions (IMC) with 32, and controlled flight into terrain (CFIT) with 27 (Figure 2). (AOPA, 2001)

Figure 2



These numbers are significant and attention needs to be brought to these issues.

There are numerous examples from the National Transportation Safety Board and the Flight Safety Foundation of aviation accidents with aircraft upset as a root cause. In each instance there are varying circumstances surrounding the events leading up to the accident and varying levels of training received by each crewmember. For those accidents involving the omission of upset recovery training it is possible that the accidents might have been prevented if the crew had experienced upset recovery scenarios during initial or recurrent training.

There are also some accidents that occurred regardless of the fact that the crew had received upset recovery training within recent certification flights. It is important to note that even the best efforts of instructors and safety personnel to equip aviation professionals for all possible situations sometimes fail to meet the task at hand. Pilots are still involved in accidents stemming from skills that should have been acquired during private pilot flight training. In the case of upset recovery training, it is better to equip the aviation professional with all available tools for success and then have them fail, rather than send them forward and hope that they can recover on their own. The following are several accident scenarios to highlight the NTSB findings and how the accidents might have been prevented.

February 15, 1992, a DC-8 freighter on approach in instrument meteorological conditions to the Toledo Express Airport entered a steep bank and pitched nose down, resulting in the aircraft crashing 26 seconds later, killing the crew and one passenger. (Flight Safety Foundation, 1993)

A U.S. National Transportation Safety Board (NTSB) investigation report concluded that the probable cause of the accident was the "failure of the flight crew to properly recognize or recover in a timely manner from [an] unusual aircraft attitude. The NTSB said the unusual attitude could have resulted from a spatial disorientation experienced by the captain [who took control of the aircraft during climbout from the second missed approach], caused by either physiological factors or a failed attitude director indicator. About five seconds after the captain took control, shortly after the first officer acknowledged the turn to 300 degrees; the Flight Data Recorder (FDR) showed that the turn rate increased dramatically. Simulations, the NTSB said, showed that the bank angle then steepened to about 25 degrees when the captain said the words "what's the matter?", and a flight-path study indicated that eight seconds after exceeding 30-degrees bank angle, the airplane was passing through about 60-degrees left bank at a 14-degree descent angle, the report said. The first officer assumed control and began leveling the wings and raising the nose of the airplane, but the impact with the ground occurred before the unusual attitude recovery was complete.

This combination of steady, sustained turning, acceleration-to-deceleration changeover, and abrupt ascent to descent transition, at night with no visible horizon or outside references, is especially conducive to spatial disorientation.

The NTSB also concluded that the first officer's response to the captain's release of control was immediate and correct in execution, but a more aggressive control input may also have averted disaster. "Airline pilots are not periodically trained to recover from unusual attitudes as are military pilots or civilian acrobatic pilots," the NTSB said. "The presumption is that an airline pilot should avoid an unusual attitude and will never have a need to recover from one."

This accident is a textbook case of the flight crew not having the necessary training to deal with the situation at hand. In this accident the flight crew properly recognized they were in an upset situation, but due to a lack of experience they were not aware of how much control deflection should or could be applied to recover to straight and level flight. The NTSB summed it up when they stated that the accident underscored the need for further improvement in unusual attitude recovery and CRM training.

Obviously the crew was highly qualified to operate the aircraft and they had sufficient training in normal and abnormal operations but they inadvertently let the airplane get into an upset situation. That, in and of itself, is not the main point of this accident, but the main focus is the failure to properly respond to the upset situation.

November 11, 1998, a Saab 340 entering a holding pattern in instrument meteorological conditions at 15,000 feet over Eildon Weir, Australia had the autopilot disconnect, airplane roll left and descend 2300 feet before the flight crew regained control. (Flight Safety Foundation, 2001)

Upon entering the hold the airspeed deteriorated due to an accumulation of ice until the airspeed reached 136 knots. At this point the airplane stalled and rapidly rolled left to a bank angle of 127º and pitched 36º nose down. The first officer initially started the recovery, but the captain took control of the aircraft and recovered it to normal flight. During their Saab 340 transition training, both pilots received flight training in an airplane to recognize and recover from stalls, and to recover from unusual airplane attitudes. At the time of recurrent training the company's simulator-training program included stall recognition-and-recovery training but not unusual-attitude-recovery training. Nevertheless, training captains were allowed to use time remaining at the completion of scheduled simulator training sessions to conduct exercises requested by pilots. The captain of the incident airplane had practiced unusual-attitude recovery in the simulator; both pilots had practiced stall recovery in the simulator. The airplane operating manual (AOM) and the aircraft flight manual (AFM) did not contain information on recovering from unusual attitudes.

Despite the fact that the simulator training program and the operating manuals did not address upset recovery training, the captain took it upon himself to gain exposure to these flight situations. The experience he gained from these maneuvers may have allowed him to remain focused during the event and return the airplane to straight and level flight. During the transition training the first officer did not practice unusual attitude recovery; whether he would have been able to recover the airplane given enough time is uncertain. Had the captain not pursued upset recovery training on his own initiative the flight might have turned out very differently.

There are cases in which the flight crew makes the correct situational assessment and the necessary control inputs to recover despite never having experienced upset recovery training. Such was the case in the following accident report. April 29, 1993, an Embraer EMB-120 RT Brasilia entered an unusual attitude while climbing to Flight Level (FL) 220 in which one flight attendant and twelve passengers received minor injuries. (Lawton, 1994)

The crew was climbing to an assigned cruising altitude of FL 220 when the airplane stalled and went out of control. The airplane lost 12,000 feet of altitude before the flight crew regained control. Within 7 seconds of the stick shaker onset, the airplane developed a high rate of descent that reached in excess of 17,000

[FPM (5,182 meters per minute)] during which the roll oscillations continued. Roll oscillations as high as 90 degrees in each direction and pitch attitudes as low as 67° airplane nose down were recorded during the descent. Coincident with the roll oscillations, the airspeed reached about 210 KIAS, and the airplane, while remaining near a stall condition, developed a positive load factor between 2 and 3 Gs. The airplane finally recovered from the out-of-control descent when control forces were relaxed and the landing gear was lowered.

Whether the recovery from this accident was due to luck, experience, or a little bit of both, the NTSB nevertheless concluded that "this accident illustrates the need to emphasize to pilots the aerodynamic fundamentals of a stall-induced loss of control and the need to move the control column to reduce the angle of attack to recover from such a loss of control." The NTSB's recommendation clearly shows that upset recovery is a concern that must be addressed.

INDUSTRY SUPPORT

There is widespread support for upset recovery training throughout industry and government, and numerous companies and agencies made statements supporting efforts in upset recovery training with extreme unusual attitudes. Starting in June of 1996, a task force of 35 industry organizations participated in a series of five meetings and two review cycles in a collaborative effort to produce the Airplane Recovery Training Aid (Boeing, 1998). This training aid set the standard for recovery from aircraft upsets upon which numerous organizations have based their training program. In a statement on the Boeing website, Airbus and Boeing encourage all operators to endorse and include airplane upset recovery training (Boeing, 1998). Aircraft manufacturers have worked with operators to try and improve the safety record of aircraft such that the aviation industry and companies involved within that industry have a proven track record when it comes to aircraft accidents. Realizing that upset recovery training can reduce accidents, USAIG, the insurance company, has approved the aircraft maneuvers training (AMT) course at Texas Air Aces as one of the follow-up recurrency programs its clients may take for credit toward better rates (Marsh, 1999). Another training program, offered by Chandler Air Service in Chandler, AZ, trains FBI pilots in their 10 hour upset recovery training program (Marsh, 1999).

Pilot organizations, including the National Business Aviation Association (NBAA) and the Air Line Pilots Association (ALPA), have voiced their concern with regard to training pilots in upset recovery. ALPA believes that the stall training mandated by the FAA does not adequately equip an airman to successfully recover from an event with an aerodynamically stalled or "performance degraded wing" (Air Line Pilots Association, 1998). ALPA goes on to state that the FAA should require training in recognition and recovery from ice-induced roll upsets or other aerodynamically degraded conditions (Air Line Pilots Association, 1998). Pilots, along with ALPA, state that upset recovery training is a necessity for the safe operation of an aircraft and it would be prudent for the FAA to revisit the requirements of pilot training. The NBAA Safety Committee voices its agreement in the NBAA Management Guide with the statement that turbulence/upset training is one of the best practices, one that will provide the highest margin of return for the investment in safety training (Sands, 1999).

Some consensus exists that there is a definite need for upset recovery training for aviation professionals; what remains is to determine who should provide the training. The purpose of this paper is not to determine where this responsibility lies, but to determine what is being done in collegiate flight programs.

METHOD

The authors developed a telephone survey (Purdue University, 2003) to assess the current status of upset recovery training in college flight training programs. The survey was designed to determine the current and proposed methods of upset recovery training in each flight program and to use the results to foster dialogue between institutions to determine the most effective method of upset recovery training. The phone survey was conducted during the spring of 2003. Four-year collegiate schools with flight programs were contacted and asked to complete the survey. Some two-year collegiate institutions also conduct upset recovery training, but to keep the sample size reasonable and to assure a high response rate, the 42 four-year collegiate schools listed in the University Aviation Association's Collegiate Aviation Guide (1999) were contacted. The authors were able to obtain survey information from 30 schools, which is a response rate of 71%.

SURVEY RESULTS

The first question asked if the flight program is providing upset recovery flight training defined by pitch attitudes in excess of 30º nose high or nose low or bank angles in excess of 60º. Of the schools that were contacted, 9 (30%) stated that they did have a program in place to provide this flight training and 21 (70%) stated that they did not have a program for upset recovery training. Of the schools that stated that they did not have a program two of them stated that they were looking into the possibility of starting a flight program for upset recovery training in the near future.

Of the schools that did have a program in place for upset recovery training several more questions were asked to determine the extent and the requirement of the students for the training. The next question asked whether the training was mandated for all flight students, of which 4 (44%) stated that it was a requirement. Of those schools that did not mandate the training, time requirements and student cost were stated as the major reasons.

The type of aircraft used in each of the programs was determined to be widespread. Aircraft such as Super Decathalons, Aerobatic Bonanzas, Citabrias, Cessna 150 Aerobats, DeHavilland Chipmunks, Extra 300s, Cap 10s, and Great Lakes bi-wing aircraft were used. Several of the aircraft listed were being used because that was the aircraft that the school owned or could readily acquire when the decision was made to develop an upset recovery or aerobatic program. Of the schools that were able to select their aircraft, cost and availability of the aircraft as well as the ease of operation were quoted as the reasons for the selection.

The selection requirement for instructors that complete the upset recovery training was also determined. In every program, the selection process started with determining which instructors would be interested in teaching in such a program. Flying an airplane in these types of attitudes on a weekly, if not daily, basis is not for every instructor, so finding those that have a natural interest is the first step. After determining those that are interested, a hierarchy of qualifications such as seniority, past training, experience, and overall piloting skill were assessed to make the final determination.

An attempt to determine the deficiencies in the upset recovery programs was made by asking what was disliked about the program or, if possible, what would be changed. The answers to this question were widespread and included items such as making the training mandatory (for those for which it was not mandatory), making the training more in-depth or more extensive, focusing more on upset recovery rather than aerobatic training, the fact that the training can be overwhelming to some students, and scheduling each student in the program when the weather does not always cooperate. Each of these concerns is valid and in the ideal world each of these problems could be easily overcome, but when any type of training is completed there will always be room for improvement. As long as an organization is willing to attempt this type of training, the benefits will far outweigh the obstacles that are encountered.

After the variety of answers to how the programs can be improved, an attempt was made to determine what the benefits were to completing upset recovery training. In each program, student confidence and experience was determined to be the largest benefit from this type of training. At the start of this type of training, several students are understandably nervous or have a high degree of anxiety as to what lies ahead. After the completion of the training most students have more confidence in their normal flying skills and abilities as well as an understanding of what an airplane's capabilities are, based upon their experience in the upset program.

Finally, a Likert Scale of 1-5, with 5 being the highest score, was used to determine the perceived effectiveness of the upset recovery training. Based upon the fact that the programs did what each school was striving towards, scores averaged 4.6. Several comments were made that the training that was being provided was an introduction to the concepts and ideas of upset recovery training, and in order to obtain a level of proficiency in advanced maneuvers and recoveries, more training would be necessary.

All of the schools were asked further questions about the types and levels of flight training that are provided in areas that approach upset recovery training. All of the schools surveyed accomplish unusual attitude training as required by the FARs for pilot certification, but this survey made a distinction between unusual attitudes and upset situations. Primarily the amount of pitch and bank separates an unusual attitude and an upset situation. The argument could be made that upset situations are essentially extreme unusual attitudes.

All of the schools complete spin training in an airplane for the certified flight instructor certificate as required by the FARs, but 5 of the schools that complete upset recovery training and 3 of the schools that do not complete upset recovery training deliver spin training as part of the commercial flight training. This type of training is a logical middle ground for those programs that want to do more than unusual attitudes, but cannot support a full upset recovery-training program. Furthermore, spin training is especially applicable to general aviation due to the higher probability of spins occurring in general aviation aircraft.

A question about formal classroom training was asked of every school that participated in the survey and the results were wide ranging. All of the schools that complete upset recovery training have a portion of the training in a classroom where accident statistics, various scenarios, and recovery techniques are discussed. One school offers a class for credit, which documents the history and theory behind upset recovery training while providing some instruction using commercially available computer flight simulators. The majority of the schools included this training in some other class. Some schools discussed upset scenarios while diagnosing accident data for human factors and accident investigation classes.

The final question asked of every school participating in the survey attempted to determine how important (Likert Scale 1 [not important] – 5 [very important]) upset recovery training was for preparing students for the aviation industry. For those schools providing upset recovery training the answer, not surprisingly, was a strong 5 in all cases with a couple of qualifiers stating only if the training is done properly. For those schools not providing upset recovery training the answers ranged from 3 to 5 with the average being 4.25.

All of the questions and answers that were discussed in the previous section are displayed in Appendix A.

DISCUSSION

Upset recovery training is one area of aviation safety and accident prevention that does not receive a great deal of dedicated focus. Controlled flight into terrain (CFIT) and visual flight (VFR) into instrument meteorological conditions (IMC) have and continue to be at the center of the FAA's attention when it comes to accident prevention, but upset recovery training sometimes falls by the wayside. The fact that CFIT and VFR into IMC have more concrete cause and effect relationships and are more easily addressed has made these problems frequent subjects of accident prevention efforts. Given the number of variables involved in upset scenarios and the airplane and instructor requirements, this type of training presents some large obstacles.

The importance of upset recovery training in preparing students for the aviation industry is obvious when looking at the numbers for both schools that do and do not provide upset training. The decision to include or exclude an upset recovery program must nonetheless be based upon cost effectiveness. Every school must make resource allocation decisions based on the need to provide the best education possible for the students. If given the choice, the majority of the schools surveyed would provide upset recovery training but factors including equipment and instructor availability and money may dictate the decision.

It is important to note that all of the schools providing upset recovery training in an airplane realize the importance of providing classroom training on the subject as well. Training in an airplane without the accompanying classroom portion lends itself more towards aerobatic rather than upset training. Where aerobatic training focuses primarily on the manipulation of flight controls to produce a specific flight path in structured patterns, upset recovery training focuses on recovery techniques from upset situations without predetermined flight patterns. In addition to those schools that provide training in an airplane, some of the schools that cannot, at this time, support a flight portion have dedicated portions of classroom lectures to the subject of upset scenarios or recovery techniques. Obviously, training in a classroom, followed by instruction in an airplane is the ideal situation, but some training, whether in a classroom or in an airplane, is better than no training at all.

CONCLUSION

Some consensus exists that upset recovery training is an important piece of the total instructional package. Among four-year schools engaged in flight training, a small but significant percentage include some elements of upset recovery training. Among those that do not, the costs involved as well as the equipment and instructional requirements present difficult obstacles for development of a program of this type. In view of the costs of flight training, these are difficult problems to overcome, regardless of the importance attached to such efforts.

Given the safety mantra repeated in the airline industry these days, however, one should expect that upset training will garner increased attention in the future. As with any new initiative, decisions must be made regarding content, effective training methods, and instructor qualifications. Few agreed upon standards exist for such training, and instructor qualifications are not well defined. Furthermore, as the FAA has little to say with respect to the subject of upset recovery, training departments and programs are reluctant to venture forth without support and agreement on the issues involved.

An open dialogue on the subject of upset recovery training, including the specific content, teaching methodology, and instructor qualifications, should begin immediately. Given that such training is considered important for the preparation of professional pilots, input from airline training personnel and those involved with safety should be part of the development process.

It is critical to the success of this initiative that relevant information on the subject of upset recovery be shared among flight training programs. Research and study in this area continues at the present, funded in part by the FAA. The findings and recommendations of these efforts will be important for both the development of collegiate upset recovery programs and aviation safety, in general.

Appendix A

Questions		Answers
Is your program providing upset recovery training defined by pitch attitudes in excess of 30 degrees nose high or nose low or bank angles in excess of 60 degrees		Yes - 9 (30%) No - 21 (70%)
Only Answered by programs providing upset recovery training (9 schools)	Does your program mandate such training for all flight students?	Yes - 4 (44%) No - 5 (56%)
	If not, which students are required to receive this training, or is it strictly optional?	The 5 schools stated it was optional to help keep student costs to a minimum
	What airplane(s) are used for this training?	Extra 300, Aerobat, Super Decathlon, DeHavilland Chipmunk, Aerobatic Bonanzas, Citabrias, Cap 10s, Great Lakes Bi-wing
	What criteria led to the selection of this airplane?	Cost and Availability were main factors
	What specific training is required to qualify instructors for this duty?	Multi-layered based upon; natural interest, seniority, past training, experience, piloting skill
	What do you dislike about the current method of Upset Recovery Training?	Making training mandatory, more in-depth training, more student friendly,
	What are the overall benefits to upset recovery training?	Increased student confidence and experience
	What is the perceived effectiveness (scale of 1-5) of your Upset Recovery/Unusual Attitude Training?	Average of 4.6
Do you complete spin training as part of the commercial certificate?		5 of the schools that do and 3 that do not provide upset recovery training complete spin training during the commercial certificate
How much formal classroom instruction is mandated on the subject of upset training?		All schools surveyed provide some level of upset recovery training. The levels provided ranged from discussing this training in conjunction with accident investigation exercises to a class for credit covering upset recovery training entirely
How important (scale of 1-5) is Upset Recovery Training for preparing students for the aviation industry?		9 schools providing upset recovery training - 5 average
		21 schools not providing upset recovery training - 4.2 average

REFERENCES

Aircraft Owners and Pilot Association - Air Safety Foundation (2002). 2001 Nall Report: General Aviation Accident Trends and Factors. *Retrieved January 15, 2003, from* www.aopa.org/asf/publications/01nall.pdf.

Air Line Pilots Association. (1998, June). Submission of the Air Line Pilots Association to the National Transportation Safety Board Regarding the Accident Involving Comair Flight 3272 at Monroe, MI on January 9, 1997*(.7967 CMR 3272). Herndon, VA: Serber, M. L.*

Airplane Safety Engineering. (1997, June). Statistical Summary of Commercial Jet Airplane Accidents, Worldwide Operations. 1959-1996. *Seattle, Washington: Boeing Commercial Airplane Group*

The Boeing Company. (1998). Aerodynamic Principles of Large-Airplane Upsets. *Retrieved January 15, 2003, from* http://www.boeing.com/commercial/aeromagazine/aero_03/textonly/fo01txt.html

The Boeing Company. (1998). Airplane Recovery Training Aid *(MC 20-97). Seattle, Washington: Boeing Commercial Airplane Group.*

Flight Safety Foundation Editorial Staff. (1993, March). Spatial Disorientation Linked to Fatal DC-8 Freighter Crash. Flight Safety Foundation Accident Prevention. *Volume 50, Number 3.*

Flight Safety Foundation Editorial Staff. (2001, October). Icing, Inadequate Airspeed Trigger Loss of Control of Saab 340. Flight Safety Foundation Accident Prevention. *Volume 58, Number 10.*

Lawton, R. (1994, November). Airframe Icing and Captain's Improper Use of Autoflight System Result in Stall and Loss of Control of Commuter Airplane. Flight Safety Foundation Accident Prevention. *Volume 51, Number 11*

Marsh, A. K. (1999, August). In-Flight Emergencies: Upset Recovery, Making the Most of a Bad Attitude. AOPA Pilot. http://www.aopa.org/pilot/features/inflight9908.html.

Sands, J. (1999). Training Best Practices: What Are You Doing?. NBAA Digest. *Volume 12, Number 6/7, Operations Notes.*

Reassessing Inclusion Of Environmental Justice In The EIS Process: A GIS-Based Study Of Lambert-St. Louis International Airport

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ABSTRACT

Populations identified as poor or minority under federal guidelines are protected against discriminatory actions which may result from a myriad of activities, including transportation system capacity enhancements: those infrastructure construction projects intended to improve or expand routes and facilities. The outcomes of environmental justice investigations, and, consequently, the conclusions based on the results of such studies, are critically dependent upon the analytical strategy to be applied in deriving statistical outcomes and the spatial resolution of the research design as dictated by the researcher's choice of reference unit and the selection of a particular areal analysis methodology. This paper investigates the potentially confounding effects of certain research strategies, as applied to an analysis of a large midwestern airport and examines the implications of the outcomes for capacity enhancements within the context of the air transportation system.

INTRODUCTION

On February 11, 1994, President Clinton signed Executive Order EO12898, "Environmental Justice in Minority Populations," to ensure, as its title implies, equity and justice for "protected populations"—those groups identified under federal guidelines as being indigent or minority. Definitions of environmental justice (EJ) vary considerably, often depending on the political goals or aspirations of the individual(s) or entity providing the semantic context (Liu, 2001). The United States Environmental Protection Agency (USEPA) Office of Environmental Justice (1999) defines EJ as:

The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations and policies. Fair treatment means that no group of people, including racial, ethnic or socioeconomic groups, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies.(p. 6) The United States Department of Transportation, Federal Aviation Administration (USDOT, FAA) (2000) defines environmental justice in the following way:

Environmental justice is the fair treatment and meaningful involvement of people of all races, cultures, and incomes, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Ensuring "fair treatment" of all people does not mean that risks should be merely shifted from one population to another; rather, the goal of environmental justice is for Federal decision-makers to identify impacts that are disproportionately high and adverse, and identify alternatives that will avoid or mitigate these impacts. (p. 2)

As a result of EO12898, Federal agencies, administrations, departments, and bureaus have become deeply involved in monitoring potential environmental impacts on populations defined by regulatory criteria as being predominately minority or poor in composition and consequently protected under the broad aegis of the Federal Government. Ensuring environmental justice is a priority for the Environmental Protection Agency (EPA) (Liu, 2001). Both the Federal Aviation Administration (FAA) (FAA, 2000; USDOT, FAA Southern Region, 2000), and its parent organization, the United States Department of Transportation (DOT) (Forkenbrock & Schweitzer, 1999; Steinberg, 2000), among other agencies and offices within the Federal Government, have implemented environmental equity (EE) policies, procedures and guidelines and assigned staff to police discrimination cases and resolve environmental justice disputes (Forkenbrock & Schweitzer, 1999). As a consequence, noise pollution, among other impacts, must be evaluated within the context of environmental justice criteria and considered in performing an environmental assessment (EA) or included as a component of any airport environmental impact statement (EIS).

Noise is the paramount environmental concern at airports (Ott, 2001). Airport environmental equity issues related to noise arise where increasing numbers of flight operations or capacity enhancements (e.g., runway constructions or extensions) result in elevated levels of sound energy (actual or anticipated) which are perceived to disproportionately affect "protected" populations—those identified as predominantly indigent or minority in composition when compared to a larger reference group. Historically, noise related environmental impacts have represented a significant impediment to the realization of airport capacity enhancements.

In a period approaching 30 years, only 4 new major airports have been built in the United States: Dallas/Fort Worth, Southwest Regional, Denver International and Austin Bergstrom (McNerney, 1995). "Only six new runways were built during the 1990s, when airline departures increased by more than 25% to 8.6 million a year" (Alonso-Zaldivar, 2001, p. 1). "'Only concrete investments are going to truly make the system more efficient and responsive to . . . demands,' said John Carr, president of the National Air Traffic Controllers Association. 'By concrete, I mean back the trucks up and start pouring us some more runways—please'" (Salant, 2001, p. 2).

However, it's not just a matter of backing cement trucks to the forms and "pouring some runways." It is generally accepted that it takes 10 to 15 years from conception to completion of a runway at nearly any major airport (Alonoso-Zaldivar, 2001; Torriero & Zajac, 2001). The greatest portion of this time is spent in executing and assuring compliance with " . . . 28 federal laws, 12 executive orders, hundreds of lesser federal regulations and dozens of local rules and ordinances . . . " (Torriero & Zajac, 2001, p. 1). An FAA study found that approval of just the environmental impact statement for runway construction in a metropolitan area required an average of 4.5 years. (This came as a complete surprise to the agency who had " . . . been telling customers it normally . . . [took] 2 to 2 ½ years") (USDOT, FAA Southern Region 1999, p. 1). The inclusion of environmental justice evaluations as part of the EIS process has the potential to increase both costs and construction time for any airport capacity enhancement. Therefore, it is extremely important that, with respect to environmental justice issues, the environmental impact statement assessment is based upon unflawed, empirically derived criteria. The authors will subsequently demonstrate that, in the particular of elevated noise levels in areas surrounding an airport, this is not necessarily the case.

SOME PRELIMINARIES REGARDING ENVIRONMENTAL EQUITY

Depending on one's point of view, the concept of environmental equity or environmental justice may be either sublime or anathematical; noble or odious; ameliorative or pernicious—if you are the Reverend Jessie Jackson or Professor Robert Bullard, environmental justice is the Holy Grail; if an airport manager, a Procrustean bed. The marriage of the two terms, environment and justice, is certain to strike an empathetic chord with the majority of Americans who will recognize these as two positive concepts, desirable, even essential. Critics counter that the rationale in linking these two words, each with an inherently positive association, is that such a joining will engender a sort of synergy wherein the dyad carries greater force than that provided by the connotative sum of the individual words. Thus, defacto acceptance is ensured wherever the phrase may be used (Perhac, 2000). To better understand this ambivalent dichotomy, capable of producing intense emotions in stakeholders at all levels, an accounting of the events leading to the current state of environmental justice (and associated regulations) may be edifying.

But first permit the brief justification of a convention to be observed throughout the remainder of this paper. While the concept of environmental equity has been proffered and brandished under several labels (Liu, 2001; Pellow, 2000; Ringquist & Clark, 1999) (e.g., environmental racism, environmental injustice, environmental inequity, environmental discrimination, ecojustice), the best known among these is environmental justice. Identifying and associating this concept through a variety of terms, which are given to nuances in meanings and definitions of broader or narrower scopes, produces significant problems in the literature (Pellow, 2000; Ringquist & Clark, 1999). "Different terms reflect different political imperatives and symbolize various icons for mobilizing mass support for public policy objectives . . . [E]nvironmental equity is relatively technical and unprovocative . . . Environmental racism is 'provocative and evocative—an excellent media tool' for mobilizing the attention of people of color" (Liu, 2001, p.13). Environmental justice became the term of choice during the Clinton presidency (Liu, 2001.)

"*Environmental justice* is one of the most loaded expressions in the political lexicon" (Steinberg, 2000, p. 82). It carries the connotation of an entitlement, of a group or individual wronged, of a debt owed. However, as we shall see, the literature does not necessarily support this assertion. Implicit in the term, environmental justice, is the perpetration of a harmful act upon which justice must be visited to reconcile the wrongdoing. It is a captious phrase. The terms environmental injustice, environmental discrimination, environmental inequity and environmental racism are equally objectionable on similar grounds, connotatively implying guilt without due process. On the other hand, the phrase, environmental equity, implies fairness, and given the current Zeitgeist, wherein hypersensitivity to the suggestive nature of connotative implications abound, we, the authors, believe this latter is the best choice from among the alternatives. Therefore, with the exception of phrases quoted from other sources, environmental equity will be the preferred term throughout the remainder of this paper.

ONE SIDE OF THE COIN: AN OVERVIEW OF ENVIRONMENTAL EQUITY

The crux of the environmental equity (EE) argument is " . . . that poorer people in general, and people of color in particular, face risks—from their proximity to hazardous facilities and waste sites—that are disproportionate to their numbers in the population" (Williams, 1999, p. 313). Many authors place the origins of the EE movement in the early to mid 1980s (Williams, 1999; Worsham, 2000); others establish these a decade or more earlier (Weinberg, 1998). "Theorizing about environmental justice can be traced to work done in the 1970s. Even though it is rarely acknowledged, there was an influential group of political economists who documented important systematic features of global capitalism that distributed environmental externalities disproportionately to marginalized communities ([see] Schnaiberg, 1975; Anderson, 1976; Stretton, 1976; [and] . . . Buttell, 1987 for general review)" (Weinberg, 1998, p. 605).

The reason that the 1980s are generally cited as the period of EE nascency is because that's when things really began to pop, environmental-justice-wise. In 1982, residents of Warren, a predominantly African-American county in North Carolina, protested the siting of a proximate polychlorinated biphenyl (PCB) landfill (Worsham, 2000). Five hundred people were arrested during the 1960s–civil–rights–style protests which attracted national attention and U.S. General Accounting Office (GAO) scrutiny (Bullard, 2000). Too, it was during this time that three major studies, often considered the very foundation of empirical EE literature (Bullard, 2000), reported correlative data to support the contention that communities with concentrations of poor and/or minority populations bore disproportionately higher numbers of locally undesirable land uses (LULU's) (e.g., chemical polluters, toxic waste sites, landfills). These studies were the GAO report on the proposed Warren, North Carolina PCB landfill, *Siting Hazardous Waste Landfills and Their Correlation with Racial and Economic Status of Surrounding Communities*, Professor Robert Bullard's study, *Solid Waste Sites and the Houston Black Community*, both published in 1983, and a 1987 research project commissioned by the United Church of Christ (UCC), *Toxic Waste and Race in the United States* (ibid.). These studies cleaved a chink in the floodgates holding back a reservoir of evidence purporting to substantiate environmental injustices, and soon research reporting correlations between race and/or poverty and environmental inequities began to pour through the breach–at first just a trickle, but soon a torrent. The literature would become voluminous (Williams, 1999). And, the public began to take notice. Worsham (2000) wrote:

The GAO and UCC findings received significant publicity and . . . [i]n response to growing pressure from academics and government officials, President Bush's Environmental Protection Agency (EPA) Administrator William K. Reilly eventually established the "Environmental Equity" working group in 1990 to study environmental justice issues. WPA's 1992 *Environmental Equity Report* confirmed earlier studies, finding that members of minority populations have disproportionately greater observed and potential exposure to environmental pollutants, and this disproportionality could not be explained by income alone. [A] comparison between poor, African-American, and Hispanic percentages shows that these minority groups are more concentrated in [substandard air quality regions] than the poor population in general. (p. 635)

Proponents of environmental equity (e.g., Bullard, Jackson, the Congressional Black Caucus, the United Church of Christ Commission for Racial Justice) leveraged the notoriety of the North Carolina demonstrations, supporting academic literature and the high-profile reports published in the late 1980's to pressure those with political influence and the stamina to listen. As a result, the Federal Government swung ponderously into action. In 1990, the EPA created an internal environmental equity workgroup " . . . to examine evidence regarding the inequitable distribution of environmental risk. The results of the workgroup's research convinced the EPA to create a new Office of Environmental Equity (now the Office of Environmental Justice)" (Ringquist & Clark, 1999, p. 81). In June, 1992, the EPA released a report on environmental equity in which the agency stated " . . . evidence indicates that racial minority and low-income populations are disproportionately exposed to lead, selected air pollutants, hazardous waste facilities, contaminated fish tissue, and . . . [further that this exposure results in] . . . higher than average potential . . . risks . . . [suggesting that these populations are] . . . more likely to actually experience harm due to these exposures" (USEPA, 1992, p. 1-2). In that same year, the United States Environmental Protection Agency established the EPA Office of Environmental Justice (OEJ).

According to Cooper (2001) still more force was applied, as pressures mounted:. . . to bring together the announced commitments to civil rights and to the environment that Clinton and Gore had echoed throughout the [1992] campaign. In hearings in March and April 1993, longtime civil rights advocate Don Edwards (D-CA) took the lead in demanding that the EPA had an obligation under Title VI of the Civil Rights Act to move against recipients of federal funds who were engaged in environmental racism . . . That demand received vigorous support from the U.S. Commission on Civil Rights. In September, the Louisiana Advisory Committee (1993) published its hard-hitting report titled *The Battle for Environmental Justice in Louisiana* . . . The report called on the [Civil Rights] commission to demand action. Chairman Arthur Fletcher obliged, writing to the EPA administrator and calling for the use of civil rights statutes and regulations to attack the problem. (p. 130)

Less than 6 months later, on February 11, 1994, President William Jefferson Clinton, signed what appeared to be a garden-variety (or should that be a Rose Garden-variety?; or as some would have it, sub rosa garden-variety?) presidential document, Executive Order (EO) 12898, to ensure "Environmental Justice in Minority Populations" (Clinton, 1994). Bob Bullard states, without compunction, that president Clinton authored this document "[i]n response to growing public concern and mounting scientific evidence . . . " (Bullard, 2000, p. 561). As we shall see in the next section, there are those who would disagree with Professor Bullard.

Although many consider Executive Order 12898 to be the single most significant pronouncement for the political advancement of environmental justice (Bryant, 1995; Millan, 1998), the truth is that this document really did not do much (Cooper, 2001). In fact, in the final paragraph of that executive order, 6-609, Clinton states that in signing EO 12898, he intends only to improve the internal management of the executive branch (Clinton, 1994). A little later that same day, however, the president signed a second document, a somewhat less innocuous presidential memorandum on the same subject. This latter, minimally publicized and so less scrutinized, put the teeth in the preceding executive order. These two documents and their interpretation by the EPA provided the foundation and impetus (Bryant, 1995; Cooper, 2001; Liu, 2001; Whitehead & Merritt, 1999) for a federal environmental justice juggernaut (Lester, Allen & Hill, 2001). To some observers, the presidential promulgation of environmental equity was part of " . . . a pattern of using presidential memoranda [and executive orders] to create and implement significant and often controversial policies throughout the [Clinton] administration" (Cooper, 2001, p. 127). Given the contentious nature of the environmental equity debate in both public forum and academic literature, it does not seem the least inappropriate that what many perceive as the seminal event (Millan, 1998) in the Federal Government's official campaign for environmental equity should begin in controversy.

Clinton, in the remainder of his second term as president, remained noticeably silent on environmental equity issues, " . . . and there has been no [further] executive leadership in this policy area" (Ringquist & Clark, 1999, p. 80). As for federal agencies, administrations, departments and bureaus, well that's another matter. Environmental equity issues are currently very high on the EPA's list of priorities (Liu, 2001). The EPA Office of Civil Rights participates in the National Environmental Justice Advisory Council, an agency that exists to help local communities pursue remedies for environmental discrimination, and each EPA regional office now has an environmental justice coordinator to oversee efforts at improving environmental equity (Cooper, 2001).

The environmental equity movement picked up momentum throughout the decades of the 1980's and '90's to become a juggernaut. "[T]he growth of the environmental justice movement in the United States surprised even seasoned policymakers by its speed and the magnitude of its impact on national policy" (Lester, Allen, & Hill., 2001, p. 1). However, even the silver lining of environmental equity is not without its dark cloud.

THE OTHER SIDE OF THE COIN: AN ALTERNATIVE VIEW OF ENVIRONMENTAL EQUITY ISSUES

In 1994, the same year that William Jefferson Clinton signed EO 12898, Vicki Been published *Locally Undesirable Land Uses in Minority Neighborhoods: Disproportionate Siting or Market Dynamics?* in the Yale Law Review, an article which refuted the validity of the claims made in the earlier environmental equity studies. Specifically, Been took exception with the causal relationships and strength of the correlations previously described (Been, 1994). Since this article was published, a debate has raged in the literature, which shows no sign of abating. According to Williams, "first wave" studies, of which the earliest were Professor Bullard's article and the GAO report, uncovered widespread inequities, but the body of later, "second wave" literature, starting with Been's piece, does not corroborate the findings of the first (Williams, 1999).

Among the "second wave" of researchers were those who agreed with Been that social dynamics may largely explain the appearance that poor and minority populations bear a disproportionate burden of environmental risks (Perhac, 2000; Sadd, Pastor, Boer, & Snyder, 1999). "There is reason to believe . . . that disproportionality is not always, or even often, the result of environmental racism. Socioeconomic analyses, for instance, have revealed that in many cases minorities and the poor voluntarily move into higher-exposure neighborhoods, where property may be less expensive or jobs more plentiful . . ." (Perhac, 2000, p. 91). Because some "researchers widely rely on . . . statistical data to identify areas of disproportional risk, without seeking out the underlying cause . . . " (ibid, p. 92), the results of their research findings do not reflect the true nature of the phenomenon they are reporting. The tendency in these instances has been to report a positive correlation for the existence of environmental inequity when, in fact, no injustice was perpetrated since the studied population chose with free volition to live in the high-risk area.

Others refer to this phenomenon (the movement into higher-risk neighborhoods of poor and minority populations under the influence of lower home ownership costs or higher paying jobs) as "minority move-in" (Sadd, Pastor, Boer, & Snyder, 1999). The "second wave" authors have cogently argued that, to some greater or lesser extent (the exact impact is yet to be determined), "minority move-in" explains the bias observed in the statistical correlation between the frequency of disadvantaged and minority individuals in proximity to hazardous sites and LULU’s (Been, 1994; Perhac, 2000; Sadd et al., 1999). The "snapshot" approach to research practiced by the "first wave" of environmental equity researchers " . . . does not elucidate whether . . . [hazardous] facilities were located in minority areas or whether minorities moved in after the proximity to potential hazards shifted property values and neighborhood desirability" (Sadd et al., 1999, p. 119).

Other authors cite variations in spatial resolution (the size of the units selected as researchable areas) as an ongoing problem producing mixed results in the literature (Ringquist & Clark, 1999; Steinberg, 2000; Worsham, 2000). For example, according to Williams (1999):

> Among the various analyses of environmental injustice, we find different operationalizations of community. The several operational definitions conflict with one another, yielding divergent research conclusions. Earlier studies uncovered the national scope of environmental injustice for communities of color
>
> Recent studies, however, have used different operational definitions, and have reached contrary conclusions about the scope of inequity. Some of the latter studies have not found evidence to support the claim that communities of color face disparate environmental inequities on a national scale. (p. 314)

Further, Williams cites a 1995 study wherein Glickman and Hersh purposely controlled the spatial resolution of the study area (Pittsburgh) to produce conflicting results with respect to environmental equity (1999). It appears that, just as setting the alpha level in a statistical study will affect statistical significance and reported outcomes, determining to what extent, if any, environmental inequities exist is greatly influenced by the research design, particularly the spatial resolution chosen for study. (This phenomenon is sometimes referred to as geographic scale effect or just scale effect.) The choice of using political jurisdiction, community, neighborhood, zip code or census tract as the unit of analysis must be carefully evaluated before beginning any environmental equity research, as outcome and validity hang in the balance. Williams concludes his 1999 article by pointing out that the injudicious use of spatial resolution has inflamed the environmental equity debate.

SOME RELEVANT COMMENTS FOR PERSPECTIVE

The above cited uncertainties and controversies notwithstanding, several points are apposite to this discourse: 1) Environmental equity issues are a reality to be dealt with in the foreseeable future (Millan, 1998; Steingberg, 2000; Worsham, 2000). 2) With or without strong scientific evidence supporting claims of environmental racism or injustice, the Federal Government and Federal Courts will shape and control the evolution of the meaning and impacts of environmental equity (Whitehead & Merritt, 1999; Worsham, 2000). 3) It is not unlikely that we will observe " . . . an explosion of regulatory and judicial activity in site permitting and renewals" (Whitehead & Merritt, 1999, p. 33). 4) Due to the significance and volatility of this issue, both immediate and potential, stakeholders, regardless of affiliation or motivation, must receive the highest quality information obtainable (Worsham, 2000).

Increasingly, those who research environmental equity issues are beginning to question the extent, or even the existence, of disproportionality in the spatial distribution of hazardous facilities or locally undesirable land uses (LULU's) proximate to minority and poor populations. In dispute are: 1) the causes of these inequities (e.g. if these are the result of socio-economic dynamics, then the resident population freely chose to live in the affected area and hence factors other than discrimination are responsible); 2) the extent of such inequities, where they may exist; 3) the degree to which any discriminatory injustice may have been done. Many authors (previously cited) believe that much of the existing environmental justice literature (and, therefore, the beliefs and policies engendered by corresponding research) are based on imprecise or flawed methodologies. In the following analysis, the authors of this paper examine how the use of various research strategies can influence environmental justice analyses to the extent of confounding research outcomes, or worse, provide a means for manipulation of the experiment to foreordain the resultant findings.

MODELING NOISE IMPACTS IN AREAS SURROUNDING LAMBERT-ST. LOUIS INTERNATIONAL AIRPORT

GENERATING THE NOISE CONTOURS

The use of geographic information systems (GIS) has emerged as an applied research strategy applicable to the analysis of the spatial aspects inherent in environmental justice studies (Liu, 2001; Perhac, 2000; Sadd et al., 1999) as well as transportation issues (Chakraborty, Schweitzer, & Forkenbrock, 1999; Forkenbrock & Schweitzer, 1999). As an applied research tool, GIS is particularly suited to exploring the impacts of airport noise on protected populations. In an analysis similar to that recommended by the FAA for EIS studies and, therefore, used in previous EE researches examining transportation engendered externalities (Chakraborty, Schweitzer, & Forkenbrock, 1999; Most, Sengupta & Burgener, 2002), the authors of this paper relied substantially on the spatial capabilities of GIS, using Environmental Systems Research Institute's (ESRI's) ArcView 3.2 and ArcGIS 8.0 (as well as the Integrated Noise Model (INM), version 3.0c) to evaluate the dynamics of the population demographic, race, over a period interimistic to the census years, 1990 and 2000. In performing the analysis, the authors generated a series of noise contours for 1990 and 2000 based on data obtained from the FAA (USDOT, FAA 1990; USDOT, FAA 2000) and Bureau of Transportation Statistics (BTS) (USDOT, BTS, 2002). The INM, developed under the auspices of the Federal Aviation Administration, was used to evaluate aircraft noise impacts on neighborhoods around Lambert-St. Louis International Airport. Runway usage, specific aircraft and powerplant types, flight operations and flight path information, obtained from the most recent Lambert Environmental Impact Statement (USDOT, FAA, 1997), were analyzed and coded for input into the INM. Integrated Noise Model defaults produced the most conservative surrogate flight profiles. The INM generated noise contours in 5 decibel (dB) increments using an "A-weighted" measure, which is derived by electronic filtering or mathematical transformation of actual measured decibels to approximate sensitivity of the human ear to various levels and frequencies of sound. Further adjustment of the noise levels experienced by the affected population is achieved by the use of Day-night Average Sound Level (DNL), which more heavily weights night operations.

The Federal Interagency Committee on Noise (FICON) suggests a 60 dB DNL as the baseline for airport noise contours for two reasons: (1) "The ability to determine the contribution of different noise sources is . . . diminished at lower noise levels. At lower DNL values, the existing non-aircraft noise may mask the aircraft noise. In the airport environs, the non-aircraft noise may begin to dominate aircraft noise at levels below DNL 60 dB" (FICON, 1992, p. 3-5). (2) "[B]ecause public health and welfare effects below DNL 60 dB have not been well established, the FICON decided not to recommend evaluation of aviation noise impacts below DNL 60 dB" (USDOT, FAA, 2000, p. 43809).

Using the INM, the authors initially generated contours in increments of 5 dBA for the census years 1990 and 2000, producing eight areas having modeled exposures of 60-65dB, 65-70dB, 70-75dB, and 75-80 dB levels of A-weighted, DNL noise. Because the 75 dB contour generally fell along, or just outside the airport boundary it was retained, and three areas of analysis (falling within the boundaries of the 60-65dB, 65-70dB, and 70-75dB contours) were generated for each census year. In this way, two sets of three contours were created, producing a total of six areas of interest. These decadal contour pairs (e.g., the 65-70dB contours for 1990 and 2000 represent one decadal contour pair) were next combined into composites to delineate the boundaries of those areas assumed to be consistently exposed to the corresponding levels of noise over the 10 year period under consideration. We thus produced three composite contours of 60-65dB, 65-70dB, and 70-75dB (See Figure 1, Appendix A). Each was smaller than either pair from which it was generated, as these composites represented only those areas likely to have received the corresponding level of noise during the decade spanning the period between 1990 and 2000. For reasons discussed below, the 65-70 dB area was subsequently discarded, leaving two areas of analysis: those within the composite 60-65dB and 70-75dB contours.

The authors output the INM contours in a CAD ".dxf" format, saving these for subsequent input into the GIS software. Using ArcView, each ".dxf" contour pair was converted to a shapefile and re-projected to UTM NAD 83/Zone 15. We next created, with ArcINFO/ArcGIS 8.0, coverage polygons having topology attributes. (This enhancing operation was necessary to provide the ability to later "clip" census blockgroups with the composite contours.) Census blockgroups in ArcInfo ".e00 file" format were obtained from Missouri Spatial Data Information Service and Census Bureau databases (MSDIS/US Census Bureau 2001) for St. Louis County, St. Louis City, and St. Charles County and converted to shapefiles. Using ArcView, the authors merged the blockgroup shapefiles, clipping these with the enhanced contour polygons (See Figure 2, Appendix A). To explore the potentially confounding influences of various analytical techniques, two reference population aggregations and four spatial scale strategies were employed in analyses, which produced the demographic totals from which descriptive statistics were computed.

DETERMINING THE REFERENCE POPULATION

Our analysis next required a frame of reference, a comparison population against which to judge the impacts of modeled outcomes on protected groups. In reality, no clear guidance is available, and the selection of the reference population is often arbitrary. Consider the advice offered by the FAA and the Council on Environmental Quality (CEQ)—the agency designated to ensure compliance with the National Environmental Protection Act (NEPA) and the president's chief environmental advisory group. Once the minority population has been defined, " . . . care should be taken to determine if the percentage of minority population within the affected area is 'meaningfully greater' than the minority population's percentage in the general population or other 'appropriate unit of geographic analysis'" (FAA 2000, p. 6). The CEQ sets the criteria for this determination at 50% minority population or a minority population percentage present in the affected area "meaningfully greater" than the minority population percentage present in the general population or other appropriate unit of geographic analysis. Unfortunately, the definitions of "meaningfully greater" and "appropriate unit of geographic analysis" are nowhere given. Finally, CEQ guidance stipulates that "[i]f environmental justice concerns exist, the potential impacts to this population from the proposed action must be assessed" (ibid.). As previously mentioned, this lack of guiding specificity in determining the reference population has been cited by several authors as being responsible for conflicting and confounded research outcomes existing in EE literature.

In this analysis, the reference group could be selected in one of two ways. Because the original noise contours lie across parts of three large census units (St. Louis County, St.

Charles County and the metropolitan area of St. Louis, Missouri), the individuals residing in these areas might be aggregated to produce a reference population. A second approach would be based on the fact that intact blockgroups are located in either St. Louis County or the city of St. Louis (the census unit west of the Mississippi River). Table 1 in Appendix B summarizes these two approaches, wherein subtotal values are associated with the latter option (the sum of St. Louis city and county values) and grand total numbers are derived from the former (the aggregated population figures from all three census areas).

CONFOUNDING EFFECTS OF RESEARCH STRATEGIES

IDENTIFYING THE UNITS OF ANALYSIS

High-resolution spatial data are desirable, but often not available, and selection of a particular geographic unit (e.g., census blocks over blockgroups, or tracts in lieu of zip codes) may be necessitated by the availability of data or the type of study being conducted. For example, in some types of studies (e.g., longitudinal analysis of data from a period spanning several decades) the use of coarser data may be attractive because areas having greater spatial extent are more stable with respect to time. Such exigencies notwithstanding, the spatial resolution of the area must be chosen with care to prevent negating research outcome validity. In this study, various census areas were considered and subsequently rejected. Zip codes and census tracts were too large, since more than one contour cut across the same area. When aggregated in this way, the data became too coarse for analysis. On the other hand, not all relevant data necessary to complete the analysis were available at the block level. Consequently, the authors selected blockgroups as the census units upon which this particular analysis would be based.

THE ANALYSES

"Within analysis," "adjacency analysis," "cross-area transformation" and "areal interpolation" represent four methods available to environmental equity researchers for use in determining the area impacted by an externality (in this case, the noise associated with operations at Lambert-St. Louis). Each strategy is simple and straightforward, providing an uncomplicated way to characterize the area of analysis. "Within analysis" allows the use of only those geographic units contained entirely within delineating boundaries. In the context of our analysis, only those blockgroups surrounding the airport and completely within the composite noise contours were considered for the within analysis. The use of such discrete geographic units is a simple method ensuring that the entire population of that area has been equally exposed to a given externality. One danger in such an approach is that the characteristics of such a small, isolated sample may not be representative of the greater population purported to experience the undesirable impacts. Another problem in the use of a "within analysis" strategy is the exclusion of those geographic units not wholly bounded by the area of study. For example, in our analysis the use of blockgroups necessitated discarding the composite 65-70 dBA contour, because no blockgroup fell completely within its boundaries. The within analysis was performed for a total of six blockgroups: two fell between the 70-75dB composite boundaries and four were inside the those of the 60-65 dB contour (Fig. 2). The results are provided in Appendix B, Table 2

In an attempt to overcome what is known as "border effect," environmental equity researchers may employ the strategy of "adjacency analysis" (Liu, 2000). When a study is too narrowly constrained to the boundaries of the geographic unit(s) containing or adjoining the source of the externality while other areas actually experiencing environmental impact(s) are not considered, border effect produces results that do not accurately characterize the attributes under investigation. The confounding effects of areal units too narrowly defined on research outcomes may be the result of an inadequate understanding of the phenomenon under investigation or, the more egregious circumstance, a desire for expediency.

Using ArcView, the authors identified all blockgroups contained partially or completely within the 60-65dB and 70-75dB composite contours. The blockgroups thus identified became the basis for performing the "adjacency analysis", which yielded a total of 141 blockgroups. Of these, 101 were intersected or contained by the 60-65dB contours and 40 were within or contiguous to those associated with the 70-75dB levels. Aggregated "adjacency analysis" blockgroup values for the composite contours were calculated; the results are summarized in Table 3, Appendix B. Where the researcher suspects that "within or adjacency analysis" may produce unrealistic results or confound research outcomes, spatial interpolation techniques (discussed below) may be appropriate alternatives.

Spatial interpolation techniques may be employed to overcome the limitations of partial geographic areas, such as those created by certain GIS operations (e.g., buffering and clipping). Because truncated blockgroups represent only a fraction of the entire geographic unit of analysis, researchers may ascribe characteristics to the impacted region through the process of spatial interpolation, a form of mathematical transformation. Two interpolation methodologies applicable to environmental equity studies are areal interpolation and cross-area transformation. The mathematical formula for areal interpolation is frequently given as (Chakraborty & Armstrong, 1996; Liu, 2000; Margai, 2001):

$$P = \sum_{i=0}^{n} P_i + \sum_{j=0}^{m} \left[P_j \left(\frac{A_{je}}{A_j} \right) \right]$$

Where:

P = total population inferred through the interpolation process.

n = number of geographic units (e.g., blockgroups or census tracts) contained entirely within the delimiting boundary.

P_i = population of the intact geographic unit, n.

m = those partial geographic units (as might be truncated by a GIS operation).

P_j = population corresponding to the partial geographic unit, m.

A_{je} = the partial area of the truncated geographic unit.

A_j = the total area of the truncated geographic unit.

The above formula allocates population numbers to all areas created by a GIS clip, intersection or buffer operation by assigning values to each geographic unit based on the proportion of the areal region created by the GIS truncation as compared to the total area of the complete feature. (As example: If a blockgroup is clipped so that 25% of its area remains inside the perimeter of the GIS-generated polygon and the total population of the original unit was 8,000, 50% of which met the criteria of being minority under federal guidelines, then it is assumed that 1,000 protected persons would reside within the area created by the clipping operation.) To derive the total population of the area of analysis, the inferred values for all partial areas created by GIS operations are summed and added to those of the units falling completely within the boundaries of the clipped or intersected extent. Applying this strategy to the 60-65dB and 70-75dB contour areas produced the values given in Appendix B, Table 4.

Researchers may use cross-area transformation to ascribe unknown demographic characteristics to an area of analysis. This form of interpolation may be defined as a technique capable of generating attribute data based on one type of zone (the source zone) and subsequently assigning the inferred values to another (the target zone). It is a hybrid methodology, related to both areal interpolation and "within analysis." Because values are assigned following certain GIS operations to incomplete geographies based on the percentage of extant areas, cross-area transformation is akin to areal interpolation. It is related to "within analysis" in the sense that the area to be analyzed is generated based on the same intact geographic units completely contained within the boundaries of the delineating feature—these are the source zones. A percentage of the source zone population is assigned to the partial geographies according to the percentage of target zone remaining in the area of analysis subsequent to a GIS operation such as clipping, intersecting or buffering. The justification for such assignment is the assumption that any geographic unit completely contained within the area of analysis will accurately (or at least adequately) represent the demographics of the population residing within the larger area. The mathematical formula for cross-area transformation may be given as (Most et al., 2002):

$$P = \sum_{i=0}^{n} P_i + \sum_{j=0}^{m} \left[P_{ix} \left(\frac{A_{je}}{A_j} \right) \right]$$

where the symbols and variables are the same as those of the areal interpolation formula, with the exception that $P_{i\ x}$ represents the source zone from which target zone values are inferred.

For this analysis, the authors identified blockgroups completely contained within the composite INM contours as the source zones. These blockgroups are the base features from which population characteristics for the target zones—the extant portions of the blockgroups truncated by the GIS clipping operation—may be developed by multiplying the demographic values of an appropriate source zone by the proportion of each partial blockgroup intersected by the 60-65dB and 70-75dB contours. Summing source and target zone values generated the results presented below in Table 5, Appendix B.

RESULTS OF THE ANALYSES

Given the values in Table 1, the proportion of the population identified as belonging to protected groups (i.e., minority or non-white) remained essentially constant in the combined St. Louis City/County reference area during the ten year period under consideration: In 1990, individuals identified under census guidelines as being protected against environmental injustices accounted for 33.16% of the total population; in 2000 this value was 33.33%. When conflating these figures with those of St. Charles County, the numbers change somewhat, with 22.42% of the population being protected in 1990 as compared to 27.06% in 2000. This 4.64% increase in the proportion of protected populations in the aggregated census area is attributable to the increase in minority populations (from 15.83% to 23.17%) in St. Charles County.

When using the values obtained from the “within analysis” (Table 2), 97.51% of those living within the 60-65dB contour in 1990 belonged to protected populations; this percentage had increased to 98.17% by 2000. Such an increase, consistent with much of the research cited in environmental justice literature, would be expected if airport noise reduced property values to act as attractor inducing minorities and lower income families to populate the area. Further, the finding of such a large percentage of the population belonging to groups considered “protected” would certainly be considered aberrant and fit the strictest interpretation of the CEQ’s criteria of “meaningfully greater” in comparison to either reference population.

However, the population values for the 70-75dB contour are not expected: only 20.26% of the 1990 population was considered protected; in 2000, this figure was 29.41%. These values are approximately equal to, or less than, those of the general population, depending on which reference population is used (Table 1). In fact, the argument could be made when using the St. Louis City/County values for comparison, that those belonging to the unprotected, non-minority population are bearing a disproportionate share of the impact of environmental inequity. The fact that a significantly lower percentage of the protected population resides in the area of more highly elevated levels of noise makes the results of the “within analysis” all the more surprising.

The cross-area transformation (Table 5) also produced mixed results. This is not unexpected, considering the unit upon which the interpolation equation calculates target zone values is taken from the within analysis set. For groups considered protected and residing within the 60-65dB contour, the cross-area transformation equation assigned a value of 95.53% and 98.77% to the 1990 and 2000 target zones, respectively. For the 70-75dB contour, the values were 52.68% (1990) and 62.01% (2000). The expected increase in the percentages of minorities in the noise contour target zones over the ten-year period is again evident, as is the seemingly contradictory finding of fewer protected individuals in the higher noise areas. When compared to the totals obtained in the areal interpolation, those of the cross-area transformation were much lower, reflecting the influence of the arbitrarily selected source zone. In comparison to the general population, the higher percentages in both the 60-65dB and 70-75dB areas would likely be considered excessive under the CEQ guideline of "meaningfully greater."

In comparison to the results of the "within analysis" and the cross-area transformation, those obtained using areal interpolation differed markedly, at least in terms of percentages. In the 60-65dB contour, the non-protected population declined from 59.15% in 1990 to 48.91% in 2000, while protected populations increased from 40.85% to 51.09%. The protected population totals in the area defined by the 70-75dB composite were again lower in the higher noise area, although the percentage increased from 34.21% to 48.25%.

With respect to changes in the minority population over time, the adjacency analysis (Table 3) produced more consistent outcomes, varying by no more that 0.3% from one census year to the other. These results differ considerably from those obtained with previous methodologies. The 1990 values for protected populations were 31.68% and 31.65% for the 60-65dB and 70-75dB contours, respectively; given in the same relative order, those for the year 2000 were 43.62% and 43.39%. The relative stability in population figures across areas having significantly different levels of noise is contradictory to the expectation that the more significant externality apparent in the 70-75dB contour would reduce property values, inducing poorer and minority populations to occupy the area in higher densities.

Note that the values for the 60-65dB contour for both the "adjacency analysis" and areal interpolation (Table 4) are considerably less than those obtained using the "within analysis" and cross-area transformation. Notice too, that whether the lower values in the 70-75dB target zones of the "adjacency and within analyses" are statistically significant could well depend on the type of statistic used, the alpha level of the statistical test, and whether one elected to use the St. Louis City/County or conflated St. Charles/St. Louis reference population as the independent or predictor variable. The commonality among all the analyses is the increase in the percentage of minorities in all populations. However, because this trend is also apparent in the reference population, the question then becomes whether the rate of increase is greater in areas exposed to higher levels of noise than in those where the level falls below 60dB. Most relevant to this discourse are the disparate results produced by the various analytical methodologies.

CONCLUDING COMMENTS

It is clear from comparison of the foregoing analyses that, to obtain valid results, extreme care must be exercised not only in the selection of the tools and strategies of the research design, but also in the interpretation of the outcomes. This is crucial where the use of powerful computers, sophisticated GIS software, and elegant statistical analyses lend an aura of authority and authenticity to the most flawed of investigations. The outcomes of environmental justice investigations, and, consequently, the conclusions based on the results of such studies, are critically dependent upon the analytical strategy to be applied in deriving statistical outcomes and the spatial resolution of the research design as dictated by the researcher's choice of reference unit. With this in mind, consider that the selection of both research methodology and unit of analysis is subjective and ". . . often dictated by expediency, determined by how existing data bases are aggregated and which level of aggregation provides the most data at the smallest geographic scale" (Zimmerman, 1993, p. 652, quoted in Liu, 2000, p. 138). The arbitrary, perhaps cavalier, selection of areal reference units and research strategies imbue environmental justice research with a certain vulnerability.

For example, recall how one outcome obtained using the "within analysis," would tend to support the argument that those belonging to the population not protected under the aegis of federal regulations are bearing a disproportionate share of the noise externality attributable to Lambert-St Louis International Airport. This conclusion is dependent upon choice of reference population used for comparison to those groups considered protected. Recall, too, how completely arbitrary is the selection of the cross-area transformation reference unit, ($P_{i\,x}$), upon which the assignment of target zone population demographics rests. By selecting one or another reference unit having uncharacteristic, perhaps even "outlier" attributes, an investigator may foreordain the outcome of the interpolation. Carelessness in selecting $P_{i\,x}$ values may cause the researcher to inadvertently choose an inappropriate reference unit, thus confounding the findings. Worse, an unscrupulous investigator (e.g., one having "an axe to grind") can easily manipulate data through the a priori selection of a biased estimator. The verity of research analyses that focus on population demographics in the context of environmental equity is completely dependent on the careful and judicious selection of research tools and strategies. Perhaps more so than in other research endeavors, where attempting to assess the impacts of environmental externalities on a given population, the application of logic and reason to the selection of appropriate methodologies and the analysis of outcomes is essential in reaching valid conclusions.

That environmental equity researches are vulnerable to confounding biases is of what significance to those involved in aviation, or, for that matter, any other segment of the transportation industry? Largely due to implementation of EO12898, as outlined in the introduction to this paper, agencies, administrations and bureaus at all levels of the government mandate environmental justice analyses as part of the Environmental Assessment and Environmental Impact Statement processes. The requirement for such analyses slows efforts to lengthen runways, build new airports and expand existing ones. Where the outcomes of such analyses are challenged in court, the litigation/adjudication processes have the potential to significantly slow transportation capacity enhancements. Court battles over the EIS process are also expensive, consuming tax dollars and increasing the cost of infrastructure construction—costs that are ultimately transferred to the consumers of transportation services. Where based on biased research outcomes, such legal challenges have no validity. Even where the goal is noble, as in the championing of indigent or minority populations, the use of flawed data and confounded research outcomes to support opposition to capacity enhancements is an abrogation of the responsibility to provide an accurate accounting of the facts. Even here, the ends do not justify the means.

REFERENCES

Alonso-Zaldivar, R. (2001, February 3). U.S. backs new jet runways to ease delays. *Los Angeles Times.* Retrieved February 3, 2001 from latimes.com http://www.latimes.com/print/asection/20010201/t000009526.html.

Been, Vicki. (1994). Locally undesirable land uses in minority neighborhoods: disproportionate siting or market dynamics? *Yale Law Journal* 103, 1383-1422.

Bryant, B. (1995). *Environmental justice: issues, policies and solutions*. Washington, DC: Island Press.

Bullard, R. D. & Johnson, G.S. (2000, Fall) Environmental justice: grass roots activism and its impact on public policy decision making. *Journal of Social Issues*, *56*(3), 555-578.

Chakraborty, J., Schweitzer, L. A. & Forkenbrock, D. J. (1999). Using GIS to assess the environmental justice consequences of transportation system changes. *Transactions in GIS 3*(3), 239-258.

Clinton, W. J. (1994, May). Federal actions to address environmental justice in minority populations and low-income populations. Reprint of executive order no. 12898 (February 11, 1994). *Environment 36*(4), 16-19.

Cooper, P. J. (2001, March). The law: presidential memoranda and executive orders: of patchwork quilts, trump cards, and shell games. *Presidential Studies Quarterly*, *31*(1), 126-141.

Federal Interagency Committee on Noise (FICON). (1992, August) *Federal agency review of selected airport noise analysis issues volume 1.* Policy Report. Washington, DC.

Forkenbrock, D. J. & Schweitzer L. A. (1999, Winter). Environmental justice in transportation planning. *Journal of the American Planning Association*, *65*(1), 96-111.

Lester, J. P., Allen D. W. & Hill, K. M. (2001). *Environmental injustice in the united states: myths and realities*. Boulder, Colorado: Westview Press.

Liu, F. (2001) *Environmental justice analysis*. Boca Raton, Florida: Lewis Publishers.

Margai, F. L. (2001, August). Health risks and environmental inequity: a geographical analysis of accidental releases of hazardous materials. *Professional Geographer*, *53*(3), 422-434.

McNerney, M. T. (1995). *The use of geographical information systems for airport engineering and management.* Aviation Research Center Report Number ARC-700. Austin: University of Texas Center for Transportation Research.

Millan, S. (1998, Summer) And environmental justice for all. *Journal of Environmental Law and Practice*, *6*(1), 58-63.

Most, M. T., Sengupta, R. & Burgener, M. A. (2002). *Spatial scale and population assignment choices in environmental justice analyses*. Manuscript submitted for publication.

Ott, J. (2001, February 12). Runway advocates seek to ease regulatory bind. *Aviation Week and Space Technology*, *15*4(7), 32-34.

Pellow, D. N. (2000, January). Environmental inequality formation: toward a theory of environmental justice. *The American Behavioral Scientist, 43*(4), 581-601.

Perhac, R. (2000, Fall). Environmental quagmire. *Forum for applied Research and Public Policy*, *15*(3), 90-94.

Ringquist, E. J. & Clark, D.H. (1999, Spring) Local risks, states' rights, and federal mandates: remedying environmental inequities in the u.s. federal system. *Publius*, *29*(2), 73-93.

Sadd, J. L., Pastor M. Jr., Boer, J. T. & Snyder L.D. (1999, May). 'Every breath you take . . . ': the demographics of toxic air releases in southern California. *Economic Development Quarterly 13*(2), 107-123.

Salant, J. D. (2001, April 26). Airlines schedule too many flights. *The Washington Post.* Retrieved April 27 from washingtonpost.com, wysiwyg:/8/http://washingtompost.com/wp-dyn/articles/A3804-2001Apr26.html.

Steinberg, M. W. (2000, Fall). Making sense of environmental justice. *Forum for Applied Research and Public Policy*, *15*(3), 82-89.

Torriero, E. A. & Zajac A. (2001, June 11) Runways face built-in delays. *Chicago Tribune.* Retrieved June 12, 2001, from chicagotribune.com, wysiwyg:/4/http://chicago tribune.com...ion/ariticle/0,2669,SAV-0106110161,FF.html.

United States Census Bureau. (2001, June 27). Summary file 1, standard extract, census 2000. *American Fact Finder.* Retrieved February 16, 2002, from http://factfinder.census.gov/ servlet/ProductBrowserServlet?id=101769&product=Census%202000%20Summary%20File%201__ Missouri%20%28FTP%20Version%29&_lang=en.

United States Department of Transportation (USDOT). (1997, April 15). Department of Transportation (DOT) Order to address environmental justice in minority populations and low-income populations. *Federal Register* 62(72), 18377-18381.

United States Department of Transportation , Bureau of Transportation Statistics (USDOT, BTS), (2000) Airline on-time statistics: detailed statistics. *Airline Information.* Retrieved March 22, 2002 from http://www.bts.gov/ntda/oai/DetailedStatistics/.

United States Department of Transportation, Federal Aviation Administration. (1990). Table 7–aircraft departures scheduled and aircraft departures performed, by community, by air carrier, and by aircraft type 12 months ended December 31, 1990. *Airport Activity Statistics of Certificated Route Air Carriers*. Washington, D.C.: U.S. Government Printing Office.

United States Department of Transportation, Federal Aviation Administration (USDOT, FAA). (1997). *Lambert-st. louis international airport final environmental impact statement*. Kansas City, Missouri: Midwest Region.

United States Department of Transportation, Federal Aviation Administration. (2000, July 14). Aviation noise abatement policy 2000. *Federal Register 65*(136), 43802-43824.

United States Department of Transportation, Federal Aviation Administration (USDOT, FAA). (2001). Table 7–aircraft departures scheduled and aircraft departures performed, by community, by air carrier, and by aircraft type 12 months ended December 31, 2000. *Airport Activity Statistics of Certificated Route Air Carriers*. Washington, D.C.: U.S. Government Printing Office.

United States Department of Transportation, Federal Aviation Administration (USDOT, FAA) Southern Region. (1999, November). Environmental impact statements. *Airportopics.* Retrieved June 10, 2001 from http://www.faa.gov/aso/aso600/airportopics/9911/index.htm.

United States Department of Transportation, Federal Aviation Administration (USDOT, FAA) Southern Region. (2000, April). *DOT flagship initiatives.* Retrieved June 21, 2001 from the FAA Southern Region Airport Division, Environmental Newsline, http://www.faa.gov/ aso/aso600/envnews/0004/dotflagship.htm, accessed June 21, 2001.

United States Department of Transportation, Federal Aviation Administration (USDOT, FAA). (2000, August 15). *Environmental justice q&a*. Retrieved July 10, 2001 from Interim Policy Guidance, http://www.aee.faa.gov/ aee_200/ejq&a.pdf.

United States Environmental Protection Agency (USEPA). (1992, June). *Environmental equity: reducing risks for all communities volume 1.* EPA Policy Planning and Evaluation Report No. PM-221. EPA230-R-92-008. Washington, DC.

United States Environmental Protection Agency (USEPA). (1999, June). *Final guidance for consideration of environmental justice in clean air act 309 reviews.* Retrieved June 10, 2001 from http://es.epa.gov/oeca/ofa/ej_nepa.html.

Weinberg, A. S. (1998, September). The environmental justice debate: new agendas for a third generation of research. *Society and Natural Resources*, *11*(6), 605-614.

Whitehead, R., Jr. & Merritt, R. (1999, August). Managing environmental justice risks. *The CPA Journal*, *69*(8), 30-33.

Williams, R. W. (1999). The contested terrain of environmental justice research: community as unit of analysis. *Social Science Journal*, *36*(2), 313-328.

Worsham, J. B. L. (2000). Disparate impact lawsuits under title VI, section 602: can a legal tool build environmental justice? *Boston College Environmental Affairs Law Review*, 27(4), 631-706. Zimmerman, R. (1993). Social equity and environmental risk. *Risk Analysis*, 13(6), 649-666. Quoted in Liu, F. (2000). *Environmental justice analysis.* Boca Raton, Florida: Lewis Publishers.

Appendix A

Figures

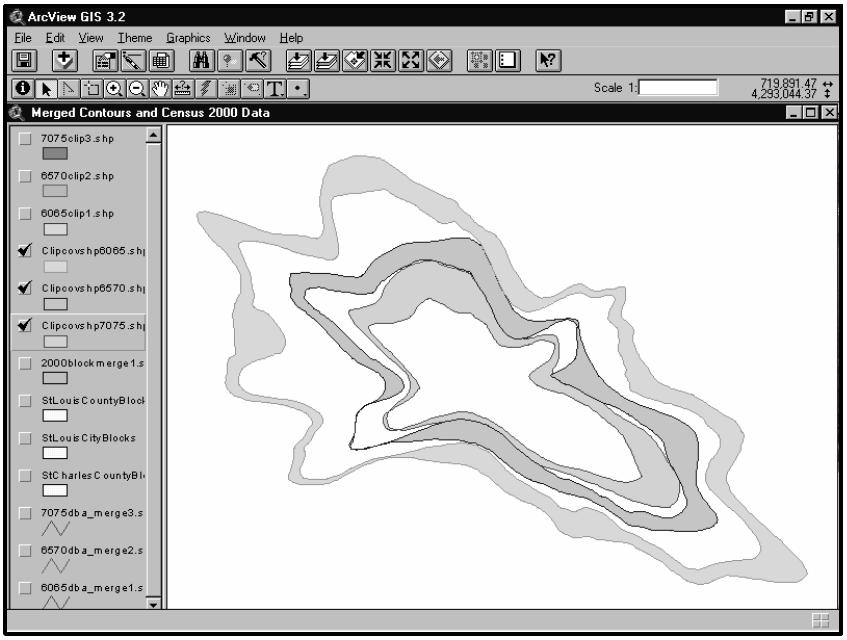

Figure 1 Composite INM noise contours for the period between 1990 and 2000.

Figure 2 Contour composites geographically referenced to census blockgroups.

Appendix B

Descriptive Statistics in Tabular Format

Demographic Units and Column Totals	1990 Total Population	1990 Non-protected	1990 Protected	2000 Total Population	2000 Non-Protected	2000 Protected
St. Louis City	212,675	205,209	7,466	283,883	268,756	15,127
St. Louis County	396,673	202,078	194,595	348,189	152,666	195,523
Subtotals	609,348	407,287	202,061	632,072	421,422	210,650
Percentages		66.84%	33.16%		66.67%	33.33%
St. Charles County	993,433	836,165	157,268	1,016,315	780,830	235,485
Grand Total (3 Units)	1,602,781	1,243,452	359,329	1,648,387	1,202,252	446,135
Percentages		77.58%	22.42%		72.94%	27.06%

Table 1. Reference population values (after Most et al., 2002).

60-65dB Contour Blockgroup Census ID Number	1990 Total Population	1990 Non-Protected	1990 Protected Population	2000 Total Population	2000 Non-Protected	2000 Protected Population
1072.00-3	552	27	525	529	6	523
1074.00-4	1176	14	1162	756	10	746
1074.00-5	872	28	844	598	17	581
1074.00-6	854	17	837	577	12	565
Totals	3454	86	3368	2460	45	2415
Percentages		2.49%	97.51%		1.83%	98.17%
70-75dB Contour Blockgroup Census ID Number	1990 Total Population	1990 Non-Protected	1990 Protected Population	2000 Total Population	2000 Non-Protected	2000 Protected Population
2114.01-3	2876	2685	191	2784	2311	473
2137.00-1	797	244	553	674	130	544
Totals	3673	2929	744	3458	2441	1017
Percentages		79.74%	20.26%		70.59%	29.41%

Table 2. Within analysis results (after Most et al., 2002).

60-65dB Contour (101 Blockgroups)	1990 Total Population	1990 Non-Protected	1990 Protected	2000 Total Population	2000 Non-Protected	2000 Protected
Totals	130,535	89,175	41,360	121,398	68,444	52,954
Percentages		68.32%	31.68%		56.38%	43.62%
70-75dB Contour (40 Blockgroups)	1990 Total Population	1990 Non-Protected	1990 Protected	2000 Total Population	2000 Non-Protected	20004 Protected
Totals	61,975	42,360	19,615	53,797	30,452	23,345
Percentages		68.35%	31.65%		56.61%	43.39%

Table 3. Adjacency analysis results (after Most et al., 2002).

60-65dB Contour (101 Blockgroups)	1990 Total Population	1990 Non-Protected	1990 Protected	2000 Total Population	2000 Non-Protected	2000 Protected
Totals	39,869	23,582	16,286	36,596	17,899	18,697
Percentages		59.15%	40.85%		48.91%	51.09%
70-75dB Contour (40 Blockgroups)	1990 Total Population	1990 Non-Protected	1990 Protected	2000 Total Population	2000 Non-Protected	2000 Protected
Totals	16,946	11,149	5,798	15,059	7,792	7,266
Percentages		65.79%	34.21%		51.75%	48.25%

Table 4. Areal interpolation results (after Most et al., 2002).

60-65dB Contour (101 Blockgroups)	1990 Total Population	1990 Non-Protected	1990 Protected	2000 Total Population	2000 Non-Protected	2000 Protected
Totals	19,661	879	18,782	17,992	221	17,770
Percentages		4.47%	95.53%		1.23%	98.77%
70-75dB Contour 40 Blockgroups	1990 Total Population	1990 Non-Protected	1990 Protected	2000 Total Population	2000 Non-Protected	2000 Protected
Totals	10,799	5,111	5,688	9,484	3,603	5,881
Percentages		47.32%	52.68%		37.99%	62.01%

Table 5. Cross-area transformation results (after Most et al., 2002).

Aviation Employment in the US: A Review of Data Sources

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ABSTRACT

The aviation industry—particularly the airline and aviation/aerospace manufacturing segments—has received significant negative attention due to financial and employment losses that it has suffered since the terrorist attacks of September 11, 2001. For example, nearly 150,000 jobs have been reported cut at the airlines and aviation/aerospace manufacturers combined. However, there is little said about the overall aviation industry backdrop for these cuts: How large is US aviation industry employment after these publicly announced cuts? The problem addressed by this research was one of finding sources to determine the overall size and scope of aviation industry employment in the US. A literature review was used that examined government documents, scholarly journals, aviation industry journals and information provided by aviation industry associations. In addition, the results of a telephone survey of the top 100 airline-served airports in the US were utilized. The literature review found that US aviation industry employment as of 2002 ranged from 1,870,400 to 2,169,845 depending on the data sources used to arrive at the total. It was also concluded that there are data details not available from the US Department of Labor employment statistics on the aviation industry that are important to determining a conclusive aviation industry employment estimate.

INTRODUCTION

Considering the negative economic and employment impacts of the post-9/11 era, the Iraq War and Severe Acute Respiratory Syndrome (SARS), the US aviation industry has been reeling. There were reports not long after the 9/11 attacks that US domestic airlines had furloughed or terminated over 150,000 employees and companies already in economic distress were failing, or filing for protection under Chapter 11 of the US Bankruptcy Code (Moylan, 2002). Since the Iraq War started, even more layoffs have been reported (Air Transportation Association of America, 2003b). The problem that arises when these reports appear is that it is difficult to put them into in aviation industry-wide context. That is, when a layoff of 150,000 people happens, yes, it is an important impact. However, how important, or, how large is it considering the entire industry, or just considering the airline segment of the aviation industry? This leads to the question: Where does one obtain aviation industry employment data? What sources are there for the industry as a whole, and by key industry segment, and how do they compare to one another?

The purposes of this paper will be to: (1) provide an assessment of the various aviation industry employment sources, (2) present employment information for the key aviation industry segments: Aviation/Aerospace, Airlines, General Aviation, Government and "other" and (3) present a literature review of aviation industry employment sources, with a goal to find the total aviation industry employment number for calendar year 2002.

Definitions

For the purposes of this paper, the following definitions were used:

1. Aviation/Aerospace Manufacturing included the subcategories of Military/Defense (aircraft, missiles, electronics), Civil (airline and general aviation; fixed wing and rotorcraft), and Space. These categories are all included in various definitions of the aviation/aerospace manufacturing segment provided by the Aerospace Industries Association of America or AIAA (Napier, 2002).
2. Airlines will include majors, nationals, large regionals and medium regionals, as defined

by the US Department of Transportation (Wells, 1999).

3. General Aviation will include companies and entities involved in "…all flying except that conducted by the military or the airlines" (General Aviation Manufacturers Association, 2003). Examples include general aviation fixed based operators, fueling companies, charter companies, corporate flight departments, fractional ownership companies, pipeline inspection companies using aircraft, flight training companies (and individuals who provide flight instruction), flying clubs, privately owned airports, agricultural operators and the like. General aviation manufacturing will be included under aviation/aerospace manufacturing.
4. Government will include non-military federal, state and local government entities that are involved in aviation. This category would include airports owned and operated at any level of government, state aviation agencies, and also would include the Federal Aviation Administration, the Transportation Security Administration of USDOT, and aviation components of agencies like the Immigration and Naturalization Service, Customs, Forestry, etc.
5. Other would include those entities not covered in prior categories such as the aviation aspects of travel agencies, university and college aviation programs, and other special entities.

METHODOLOGY

This study is, in part, a replication of an earlier study done by NewMyer, Kaps and Sharp that reported on 1995 aviation industry employment levels. This study was published in the *Journal of Aviation/Aerospace Education and Research* in Spring 1997 and reported an overall US aviation industry employment of 2,185,644. World events affecting the aviation industry, the availability of new aviation employment data sources, and the advent of increased access to employment data from on-line sources prompted the current study. A literature review was employed in this study, with one exception. The one exception is that an unpublished survey of employment at the top 100 airline-served airports in the US (conducted by the authors of this article) was utilized. While the details of this survey will be the subject of another future publication, the results were used in this article to help establish an employment number for local government owned airports. Included in the review of literature were articles published in such scholarly journals as *Journal of Aviation/Aerospace Education and Research* as well as information obtained from aviation industry publications such as *Aviation Week and Space Technology*. Information was also obtained from various government agencies related to aviation such as the Federal Aviation Administration, the Bureau of Transportation Statistics of the US Department of Transportation, Customs and the Transportation Security Administration. In addition, information about aviation employment was obtained from aviation industry associations such as the Aerospace Industries Association of America, Airport Council International-North America, Air Transport Association of America, National Air Transportation Association and National Association of State Aviation Officials. Finally, aviation employment information was utilized from the United States Department of Labor.

OVERALL AVIATION INDUSTRY DATA SOURCES

The NewMyer, Kaps and Sharp Study (1997)

This study reported the following US civilian aviation employment data for the year 1995:

Aviation/Aerospace Manufacturing	778,000
Airlines	640,453
General Aviation	339,891
Government	85,389
Miscellaneous (other)	341,911
TOTAL	**2,185,644**

Source: NewMyer, D. A., Kaps, R. W., and Sharp, S. E., Aviation Industry Employment Data Estimates Revisited, JAAER, Spring 1997, pp 7-18.

This study used US Department of Labor, Bureau of Labor Statistics data sparingly, and did not use airline employment data from the Bureau of Transportation Statistics, US Department of Transportation at all. It also used a study from 1979 as a key basis for the estimate of general aviation employment. With that study 24 years old at the time of the present study, it had to be totally replaced with another, more recent source. Finally, government employment figures were based on a combination of surveys (one of employment at the top 50 airports), government data and estimates. A much tighter, more focused estimate of US aviation employment is now possible.

US DEPARTMENT OF LABOR DATA

One of the most authoritative sources of information on employment in the US is the United States Department of Labor (USDOL). The USDOL classifies industries using the Standard Industrial Classification (SIC). SIC Group 45 is "Transportation by Air." This group includes "establishments engaged in furnishing domestic and foreign transportation by air and also those operating airports and flying fields and furnishing terminal services" (Office of Management and Budget, 1987). The Department of Labor states that there are 1,251,430 people employed in the Transportation by Air group, or SIC code 45, as of March 1, 2003 (US Department of Labor (2003). When collecting the data from the Department of Labor, there are two numbers: seasonally adjusted and non-seasonally adjusted. The difference between these two statistics is that seasonal adjustment uses a technique to account for holidays, weather, economic factors and other influences on the work force. The seasonal adjustment numbers are reported here.

The SIC then narrows the "transportation by air" group down further into sub-groups, for example, Major group 45 (Transportation by Air), Industry group Number 1, Industry number 2. This combines to 4512, which is "Air Transportation, Scheduled" (Table 1), a sub-group of SIC Group 45. The 4512 Industry group includes all companies that furnish air transportation over regular routes and on regular schedules. This industry classification includes scheduled air cargo carriers and scheduled air passenger carriers. A total of 508,700 are employed in this group as of April 4, 2003 (USDOL).

Industry classification 4513 is "Air courier services." The definition that the SIC of an air courier is "…anyone who furnishes air delivery of letters, parcels and packages generally under 100 pounds" (OMB). Other couriers that engage in providing pick-up and delivery, "drop-off points", or distribution centers are all classified under this industry code. Companies that fit into this code include: air courier services, private letter, package and parcel delivery through the air. The United States Postal Service is located under Industry 4311, while other delivery services are classified in Industry 4215, and yet other delivery services are classified in Industry 4731 (OMB). The data can be included in many of the classifications. Therefore, aviation industry employment data can be accounted for in many industrial classifications, which does not always give the researcher a clear picture of exact employment totals in the aviation industry within the USDOL data.

Industry classification 4522 (see Table 1) is reserved for "Air transportation, nonscheduled." This group consists primarily of airplane sightseeing services, air taxi services and helicopter passenger services to and from local airports, air cargo carriers, air taxi services, air ambulance services, flying charter services, helicopter services and others (OMB, 1987).

The airports, flying fields and airport terminal services fall under SIC 4581 (see Table 1). These are defined as "primarily engaged in operating and maintaining airports and flying fields" (OMB, 1987). This industry also includes air traffic control operations except government air traffic control (ATC) employees. Total employment for the 4581 group is 141,800 as of April 4, 2003 (USDOL, 2003). Federal Aviation Administration Air Traffic Control (ATC) employees are located in classification 9621 (Public Administration) and the data cannot be retrieved due to the fact that this grouping includes far more than just air traffic controllers. Aviation clubs are located in group 7997, which employs 341,000 people overall. However, again, there is no detail for the reader to discover what the aviation-related component of this group would be. (USDOL, 2003).

Aviation/aerospace manufacturing data can be found in SIC Group 37 (see Table 2). This group is referred to the transportation equipment group. Some of the important aviation-related manufacturers found in this group produce aircraft (military and civil), rotorcraft, space vehicles, and missiles. Also, 3721 is the SIC code for aircraft and its parts. This group includes all establishments that manufacture or assemble complete aircraft. Moreover, this group also includes any organization that owns their own aircraft while conducting research and development. Some examples of items classified in 3721 are: aircraft, blimps, gliders, helicopters, airships and various other "aircraft". Repairing and rebuilding aircraft on a factory basis are also included in the definition of 3721. The total employment for this group is 491,900 as of April 4, 2003 (USDOL).

Table 1

US Department of Labor Employment Data for
Industry Group 45: "Transportation by Air"

(All Employees, Thousands)

Year	Total (45)	Air Transportation (451)	Air Transportation Scheduled (452)	Airports, Flying Fields (458)
2000	1,279.9	1,085.2	582.5	146.5
2001	1,266.0	1,070.3	581.2	145.4
2002	1,161.4	970.9	508.7	141.8

SOURCE: US Department of Labor, Bureau of Labor Statistics, 2003

Table 2
US Department of Labor Data for
Industry Group 37: Aviation/Aerospace Manufacturing

(All Employees, Thousands)

Year	Total (372)	Aircraft (3721)	Aircraft Engines & Engine Parts (3724)	Aircraft Parts & Equipment nec.* (3728)	Total (376)	Guided Missiles & Space Vehicles (3761)
2000	464.1	233.9	100.6	129.6	86.3	59.2
2001	460.6	232.6	98.9	129.1	83.7	57.6
2002	410.2	205.5	92.4	112.3	81.7	56.0

SOURCE: US Department of Labor, Bureau of labor Statistics, 2003
* Not elsewhere classified

Group 3724 (see Table 2) classification includes aircraft engines and parts. Aircraft parts and auxiliary equipment not elsewhere classified is in Group 3728. This group employs 92,400 as of February 12, 2003. Space vehicles are classified as 3761, and employ 56,000 as of February 12, 2003. Finally, research and development on aircraft not owned by the manufacturer is classified in the Services industry 8731 which shows an employment level of 263,400. Again, the aviation detail is lost in the total and can not be retrieved.

The Aviation/Aerospace Manufacturing industry as reported in USDOL statistics, spreads the data across many groups and sub-groups and totals. Overall, the USDOL aviation/aerospace employment total is 689,000 (USDOL, February 12, 2003).

The major group 96 is where one can find the administration of economic programs. Specifically, 9621 includes the regulation and administration of transportation programs. Moreover, this section includes government air traffic control operations as well as government aircraft inspections. However, 4581 is the code that is used to classify private air traffic control operations. Therefore, given the information previously provided about government ATC employees being contained in Group 9621, two completely different classification groups count the same job, just in different sectors (public and private) (OMB,1987).

Airport Council International – North America Study

Airports Council International –North America (ACI-NA) reported in a study of the economic impact of US airports that U.S. scheduled passenger enplanements were estimated to be 683 million for 2001 and expect to be over a billion by 2013 (ACI-NA, 2002, p.1). The employment growth rate during that time is expected to be nearly 33% in ten years. (ACI-NA, 2002, p.1). That is an average annual growth rate of 4%. ACI-NA also states that there are, "1.9 million jobs on airports in the U.S., and 4.8 million are created in local communities, for a total of 6.7 million airport related jobs" (ACI-NA, 2002, p.1).

AVIATION INDUSTRY DATA SOURCES BY INDUSTRY SEGMENT

Aviation Industry Association Employment Data by Industry Segment

Aerospace Industries Association of America (AIA), which represents the nation's aerospace manufacturers, published a "white paper" on January 23, 2003 that stated, "Since September 11, 2001, aerospace employment has fallen approximately 93,000—to the lowest level since before 1953" (AIA). On March 4, 2003, AIA issued a press release entitled "Aerospace Employment Hits 50-Year Low" in which it stated, "U. S. aerospace employment has reached its lowest level since 1953-dropping to 689,000 at the end of 2002."

Air Transport Association of America, the association that represents larger airlines operating in North America, made this statement in their 2002 Annual Report: "One of the unfortunate outcomes of the terrorist attacks is that most airlines had to reduce their workforces. Airlines initially announced layoffs and furloughs of roughly 100,000 employees" (ATA). The report noted that the total drop in employment from year-end 2000 to 2001 employees in full time equivalent numbers was only from 679,967 to 670,730. However, these numbers included employment for associate members of ATA from other nations. The 2001 ATA employment figure for US airlines who were members of ATA was reported as 624,197 (ATA).

The National Air Transportation Association (NATA) is a Washington, D. C.-based aviation association that represents the aviation services segment of aviation. Aviation services employment is a key part of general aviation. Nearly 2,000 businesses owning, operating and servicing aircraft are a part of NATA. The members of this organization represent a key component that links the industry, airlines, general aviation and the military. "There are approximately 5,000 aviation service business locations nationwide" (NATA, p.1).

Aviation businesses are the foundation that supports the air transportation industry. Most of these businesses are fixed-base operators (FBO's), who provide ground services to the aircraft owners and operators. There can be many services provided by the FBO, much of which is determined by location, competition, experience and airport requirements.

According to the NATA, the general aviation industry employs approximately 638,000. In addition, the general aviation industry's economic activity is $64.5 billion (NATA, p.13). NATA does not give any indication of how they arrived at this figure nor do they indicate its composition (manufacturing, FBO's, corporate flight departments, flight training companies, and other such categories are not included).

The National Association of State Aviation Officials (NASAO) conducted an extensive study in October 2001 to collect the employment figures for state aviation commissions and departments that administer and oversee aviation activities in the 50 states. The total number of employees reported by NASAO at such state agencies, as of 2001 was 7,792 state employees for the 50 states excluding Puerto Rico and Guam (NASAO, 2001, p.i). When re-examining the numbers it was revealed that states such as Hawaii and Maryland had higher employment numbers in proportion to most other states, and in disproportion to their relative size and share of US aviation activity. Further examination of the NASAO data showed that certain states counted employees at state-operated airports and employees flying state-operated aircraft, and sometimes (but not always) included those employment figures as a separate number. By verifying these airport and aircraft-related employment figures, and then adding them to the total where needed, the total statewide employment figures reached a new total of 9,993 (Figure 1). This reflects an addition of 2,201 additional employees added to the total aviation employment at state aviation agencies, due to adding additional operational employees (NASAO, 2001).

Airline Employment Information from the Bureau of Transportation Statistics

The Bureau of Transportation Statistics (BTS) of the US Department of Transportation collects employment statistics for certificated air carriers on an annual basis. Their year-end 2002 report of the major (i.e., $1.0 billion or more in gross annual revenues) airlines shows a total of 489,662 full time employees, 96,228 part time employees and a total of 585,890 employees. In addition, BTS reported that there were 54,470 full and part time employees at national airlines (i.e., those with $100 million to $1.0 billion in gross annual revenues). Also, large regional airlines (i.e., $10 million to $100 million in gross annual revenues) were reported to have 3,285 full and part time employees while medium regionals (i.e., below $10 million in gross annual revenues) had 1,152 total full and part time employees. The airline industry-wide total employment level at the end of 2002 was report to be 642,797.

Agency-reported Aviation Employment at the Federal Level

Many agencies in the Federal Government are active in the aviation industry. First and foremost is the Department of Transportation. This Department includes the Federal Aviation Administration (FAA). The current count of FAA employees is 50,157 as of February 2003 (E. Nelson, personal communication, February 21, 2003). The US Department of Transportation's total number of employees is 68,290 (US Department of Transportation, 2003). Included in this number are 36,580 Coast Guard personnel who perform what are essentially military duties. Without the Coast Guard figures, the total employment at USDOT is 31,710 (USDOT). Of this number, it is estimated that an additional 1,000 employees are in the aviation field. This is due to the fact that USDOT still regulates the economics of air transport. The actual number was not found. Yet another reason to have standard, detailed, modal-reporting procedures for Federal Agencies is so the data can be retrieved. The largest number of employees related to the aviation industry employed by the Federal government is within the Transportation Security Administration (TSA). The TSA employs around 58,000, including administration as well as baggage screening and checking (Transportation Security

Administration , n.d). Therefore, these three federal agencies alone employ approximately 109,157.

In addition to the data reported for the three federal agencies so far, there are several other federal agencies with a role in aviation. For example, the State Department has an Office of Aviation Negotiations that employs twenty people (J. Byerly, personal communication, March 25, 2003). This office works hand in hand with the Department of Transportation and FAA in negotiating treaties and other international agreements. The Department of Agriculture has 159 aerial firefighters (G. Wilson, personal communication, March 25, 2003). These firefighters are actually placed in the Fire and Aviation Management division within the USDA. The Department of Interior houses the Bureau of Indian Affairs, which employs eleven aviation workers (J. Stires, personal communication, March 26, 2003). The INS Border Patrol has no data that can be retrieved. The Office of Air and Marine Interdiction currently has over 400 pilots in the program (L. Sabawa, personal communication, March 25, 2003). This office is under the Customs and Department of Justice. Finally, there is NASA that houses the Division of Aeronautics. NASA employs 18,190. Overall, there are 127,967 employees in the federal government that are directly involved in the aviation/aerospace industry (see table 3)

AIRPORT SURVEY DATA

A survey conducted by researchers at Southern Illinois University Carbondale extracted the direct and indirect employment of the nation's top 100 busiest commercial (airline served) airports in the US. This survey was conducted during the period of January through March 2003. This telephonic survey resulted in a 100% response rate. A total of 37,088 employees were found by the survey to be directly employed with the airport operators of these top 100 airports. The study also showed that there are 689,316 employees that are indirectly employed at the airports surveyed. This figure reflects employees at airlines, terminal concessionaires, automobile parking companies, rental car companies, etc. This second figure shows the economic impact of what an airport can bring to a city. However, the first figure is important since airport-specific employment data are hard to acquire and are essentially unavailable in the literature. Therefore, note that there are no other airport-specific data sources to use to report airport agency employment, other than those already reported via this survey and via the NASAO data.

Table 3

Agency-Reported Employment at the Federal Level

Agency	Employment Number
Transportation Security Administration	58,000
Federal Aviation Administration, Dept.	50,187
of Transportation (est. for aviation economicRegulation)	1,000
USDA (Aerial Firefighters)	159
Bureau of Indian Affiars	11
State Department (Office of Aviation Negotiations)	20
Customs (Pilots)	400
NASA	18,190
Total	127,967

SOURCE: Government Websites, Telephone Interview, and E-mails.

The "Other" Category of Aviation Employment

In the NewMyer, Kaps and Sharp study (1997), this category was counted as having the following employees:

Travel Agencies	300,000
Consultants (including construction)	10,000
Industry Associations	500
Aviation Educators	600
Related Industries	2,500
Air Cargo/Air Freight Forwarders	28,311
TOTAL	**341,911**

Current travel agency employment figures are available from USDOL, and they indicate the following:

Table 4
US Department of Labor Data for
Industry Group 4724, Travel Agencies

(All Employees, Thousands)

Year	Total (472)	Travel Agencies (4724)
2000	219.5	170.3
2001	208.5	160.5
2002	183.3	138.5

SOURCE: US Department of Labor, Bureau of Labor Statistics 2003

It is clear that travel agency employment has dropped significantly since the highs reached in the mid-1990's. With the impact of Internet sales of airline tickets, and the reduction of commissions paid to travel agencies by airlines, the role of travel agencies in booking airline travel has dropped significantly in the last eight years. On top of that, the estimate of aviation industry-related impact within the 1995 data was likely overstated. Therefore, the estimate of aviation industry employment impact from travel agencies today is estimated at 20,000 employees. In addition, 5,000 more employees should be added to this category to account for any other categories of aviation employment that were not accounted for elsewhere.

ANALYSIS OF DATA SOURCES

There are several problems with the current classification of aviation industry data as provided by the USDOL. First, aviation employment data are scattered over different industry groups of statistics. For example, aviation employment data can be found in the following SIC groups: 372, 376, 45, (including 4581, etc) 7977, 8731 (see Table 5), 9621 and other classifications. A second problem is that data detail is not always available. For example, group 7977 is where you would find employment for flying clubs and flying fields maintained by aviation clubs. Unfortunately, there is not a detailed breakdown within this group so the detailed data is not available by mode. Therefore the actual employment data that is reported to the public by the DOL for the aviation industry is sometimes incomplete. Third is the question of where the "general aviation" segment of the US Civil Aviation system falls within the USDOL classification system. The answer seems to be that it falls into many of the groupings previously mentioned, but with not enough detail in the reports to determine if a particular aspect of general aviation is included or not. Examples would be flight departments maintained by non-aviation companies and businesses. Another would be off-airport flight simulation companies. Another is aviation parts supply companies. Another is employment for the 50 state departments or commissions devoted to aviation. There are aviation industry-based employment statistics for some of these categories but it is difficult to verify such data within the USDOL data. So, in reality no one knows the employment data of the general aviation industry segment using USDOL data, due to the fact that general aviation is not used as a USDOL grouping or category, or sub-category, when collecting USDOL employment data. In addition, there are fractional ownership companies such as Netjets (Executive Jet Aviation). This company already owns and operates over 500 aircraft and employs over 1,800 pilots (John Lieber, Personal Communication, April 26, 2003). The fractional ownership concept is very new and, as with other categories of general aviation, it is not clear where these data are located within the

USDOL groups. Another similar category of general aviation is the category of corporate flight departments. This category of aviation has been a key alternative mode of air transportation during the post-9/11 era. As corporate employees find it more difficult to take airline trips, they have turned to corporate aviation. Again, it is not clear where this category of aviation employment falls within USDOL data. Finally, government-related aviation employment is not accessible in the USDOL data. It generally appears that these data are buried in the 'public administration' grouping of data. Also, it is not totally clear what the sub-grouping 'Airports and Flying Fields' includes…..is this an attempt to include 'general aviation' or is it a category strictly allocated to airport-related employees (managers, operations personnel, grounds maintenance, terminal maintenance, etc). The SIC classification is not clear on this point.

Another issue was identified when examining employment at state aviation organizations as collected by NASAO. At first, it was not clear that the total number of employees could realistically be determined for each state. And, in some cases, it looked like some states have overstated employee counts. For example, Maryland has 474 state aviation employees. However, separately, they also reported that 471 employees were assigned to operate either aircraft or airports. Using this knowledge you can see that there are only 3 full time state aviation agency employees who run the agency itself while the rest operate airports

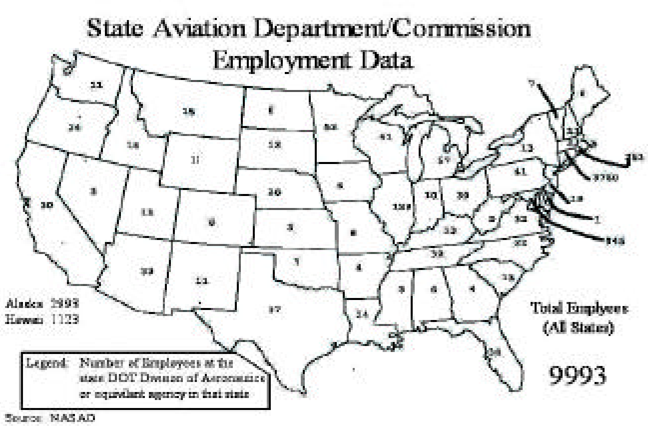

Figure 1

throughout the state. Some states did not have numbers that were quite this extreme. For example, Idaho owns four aircraft while one is leased, but they have two employees assigned to operate these aircraft (NASAO).

Determining the correct number of employees even by the state aviation agency can get confusing. For example, Hawaii and Maryland alone have a discrepancy of over 1,500 employees combined, depending on how the reader and state interpret and report the data, respectively. This is why there needs to be a uniform way of reporting such data, so the government and the aviation industry can get a clear account of how many employees are in the aviation industry as a whole.

CONCLUSIONS

The purpose of this paper was to: (1) provide an assessment of the various aviation industry employment sources, (2) present employment information for the key aviation industry segments: Aviation/Aerospace, Airlines, General Aviation, Government and "other" and (3) present a literature review of aviation industry employment sources, with a goal to find the total aviation industry employment number for calendar year 2002. The following conclusions were reached regarding each item above.

An assessment of various aviation employment sources.

As already noted, there are two 'soft' employment figures listed in the previous pages, one for general aviation and one for the "other" category. However, it is interesting that the BTS airline number plus the NATA number adds up to 1,280,797, which is only 119,397 off of the USDOL number (1,161,400) for 'Transportation by Air'. This difference can be accounted for by the fact that the USDOL number is more recent (2003) than either the BTS or NATA numbers which are from 2002 and 2000, respectively. In fact, if one used the 2000 USDOL number for 'Transportation by Air' the numbers are very close: 1,279,900 for USDOL and 1,280,797 for the BTS/NATA combination, or only 897 employees apart.

The advantage of using the federal, state and local government numbers in the 'combination' estimate is that these numbers are from verified sources and, in both the federal and local cases, are understated. In addition, there is no duplication or overlap among these independent sources of data. In the case of the federal numbers, there were some federal agencies for whom an employment number was not available. With regard to local government employees in aviation, the only 'hard' numbers are for the top 100 busiest airline-served airports. Since there are 19,306 landing facilities in the US, of which 5,315 are public use, and since there are another 535 certificated airports (in addition to the 100 surveyed) in the US (certificated to receive passenger airline service with aircraft over 30 passengers) (Federal Aviation Administration, 2002), it is clear that there are likely many more employees employed by local governments at airports. Therefore, it appears that some parts of this second US aviation employment number might be under-estimated.

Overall, the various sources discovered in this literature review provide a range of US aviation industry employment of between 1,870,400 and 2,169,845. The average of these two numbers is 2,020,123 employees. Note that the highest number of employees found in this current study is close to the number reported by NewMyer, Kaps and Sharp in 1997, which was 2,185,644. The current number has been reached with somewhat higher levels of confidence, with the exceptions noted. Also, the number of employees counted as 'miscellaneous' in the 1997 study was quite high (341,911) compared to the number used in the current study (25,000).

Aviation Industry Employment by Segment and Total Aviation Employment Number for 2002.

Arriving at a total US aviation industry employment number for the year 2002, using the information presented in this paper, will require one of two things:

1. The exclusive use of US Department of Labor data, or,
2. The use of some combination of numbers from the US Department of Labor and other sources.

First, using only USDOL data, there are two key industry numbers to report and they are for 'Transportation by Air' and for 'Aviation/Aerospace Manufacturing.' The latest numbers available in those two categories total to the following aviation industry employment number:

Transportation by Air	1,161,400
Aviation/Aerospace Manufacturing	689,000
Total	**1,870,400**

If a combination of data sources is used to arrive at a total aviation industry employment number, this is the number that is reached:

Aviation/Aerospace Manufacturing (USDOL)	689,000
Airlines (BTS Figures)	642,797
General Aviation (NATA)	638,000
Federal Government (Contacts)	127,967
State Government (NASAO)	9,993
Local Government (Survey)	37,088
Other (Estimated From Travel Agencies Agencies, College Aviation Programs	25,000
Total US Aviation Employment	**2,169,845**

While it is clear that *any* of the newly-estimated numbers are likely still a bit high and do not reflect the latest downside impacts of SARS and the Iraq war, it is also clear that there are on the order of 2.0 million people employed directly in some facet of the US aviation industry. This important number must be kept in mind as we as a nation consider any number of policy decisions that might positively or negatively affect the aviation industry. The aviation industry, considered as a whole, is a significant US employer, is a key net exporter of manufactured goods, transports millions of people annually, and provides access to over 19,000 airport locations nationally. And, when the US economy starts to rebound, the US aviation industry will help lead the way back to prosperity with excellent employees providing excellent products to the world.

Reference List

Aerospace Industries Association (2003, March 4), *Aerospace employment hits 50-year low.* Retrieved April 30, 2003 from http://www.aia-aerospace.org/

Aerospace Industries Association (2003, January 23), *Develop a national plan for revitalization of the aerospace workforce.* Retrieved April 30, 2003 from http://www.aia-aerospace.org/

Airports Council International – North America (2002), *The economic impact of U.S. airports 2002.* Retrieved January 22, 2003, from http://www.aci-na.org.

Air Transport Association of America, Inc. (2003a, March) *Airlines in crisis: The perfect economic storm.* Washington, D. C., Air Transport Association

Air Transport Association of America, Inc (2003b) *Airlines Seeing War Impacts.* Retrieved on April 22, 2003 from http://www.airlines.org/

Air Transport Association of America, Inc. (2002), *2002 Annual report.* Washington, D. C.: Air Transport Association

Bureau of Transportation Statistics, US Department of Transportation (2003) *National Transportation Statistics 2002, Table 1-3: Number of U.S. Airports*. Retrieved April 30, 2003 from http://www.bts.gov/

Bureau of Transportation Statistics, US Department of Transportation (2001) *Number of employees-Certificated carriers 2001.* Retrieved February 5, 2003 from http://www.bts.gov/oai/employees/2001emp.html

Federal Aviation Administration (2002, August 28) *FAA Report to Congress – National Plan of Integrated Airport Systems* (2001-2005). Retrieved June 3, 2003 from http://www1,faa,giv.arp/planning/npias 2001/npias01.htm

General Aviation Manufacturers Association (2003) *What is GA?.* Retrieved April 30, 2003 from http://www.gama.aero/aboutGAMA/whatisGA.php

Jackman, F. (Ed.). (2002, Spring/Summer). *World aviation directory*. Miami: McGraw Hill

Morrell, P. S. and Alamdari, F. (2002, January) *The impact of 11 September on the aviation industry: Traffic, capacity, employment and restructuring.* Geneva: International Labour Office

Moylan, M. J. (2002, October 19) "Bill helps laid-off airline workers," in *Pioneer Press*, Retrieved December 10, 2002 from http://www.twincities.com/

Napier, David (2001) *Aerospace industries association of America year – end review and forecast*. Retrieved November 16, 2002, from http://www.aia-aerospace.org/.

National Aeronautics and Space Administration. (2003) NASA workforce. Retrieved March 25, 2003, from http://nasapeople.nasa.gov/workforce/default.htm.

National Air Transport Association. (2000). *Aviation businesses and the services they provide*. Alexandria, VA.

National Association of State Aviation Officials. (2001). *State Aviation Funding and Organizational Data. Annual report fiscal years 2000 and 2001*. Washington, D. C., National Association of State Aviation Officials.

NewMyer, D. A., Kaps, R. W., and Sharp, S. E. (1997, Spring) "Aviation Industry Employment Data Estimates Revisited" in the *Journal of Aviation/Aerospace Education and Research (7)* (3), Daytona Beach: Embry Riddle Aeronautical University

Office of Management and Budget. (1987). *Standard industrial classification manual.* Office of Management and Budget. (NTIS No. PB 87-100012).

Transportation Security Administration. (n.d). *TSA facts*. Retrieved April 1, 2003, from http://129.33.119.130/public/display?theme=39&content=510.

United States Department of Labor. (2003). *2003 Bureau of Labor Statistics for Industry* Retrieved April 4, 2003, from http://www.bls.gov/.

United States Department of Labor. (2003). *2003 Bureau of Labor Statistics for Industry*. Retrieved February 12, 2003, from http://www.bls.gov/.

United States Department of Transportation (2003) *Budget in Brief.* Retrieved April 23, 2003 from http://www.dot.gov/bib/fte.html

Wells, A. T. (1999). *Air transportation: A management perspective (4th ed.).* Belmont, CA: Wadsworth Publishing Company.

APPENDIX A

State Aviation Agency Employment
State by State Employment according to NASAO 2001

State	Number of Employees	Agency Organization	Operational Employees
AL	6	Other	
AK	2,500	Mode	493
AZ	18	Other	15
AR	4	Mode	
CA	30	Mode	
CO	8	Mode	
CN	3,780	Mode	
DE	1	Function	
FL	30	Mode	
GA	4	Mode	
HI	105	Mode	1018
ID	13	Mode	5*
IL	100	Mode	29*
IN	9	Mode	1*
IA	6	Mode	
KS	3	Mode	
KY	13	Mode	
LA	14	Function	
ME	6	Function	
MD	474	Mode	471*
MA	12	Mode	1*
MI	57	Mode	
MN	52	Mode	
MS	3	Mode	
MO	8	Mode	
MT	12	Mode	3*
NE	28	Mode	
NV	3	Function	
NH	7	Mode	6
NJ	19	Mode	
NM	7	Mode	4
NY	13	Mode	
NC	22	Mode	
ND	5	Mode	1*
OH	30	Mode	
OK	7	Transportation	
OR	17	Other	7
PA	41	Mode	
RI	125	Mode	138*
SC	13	Mode	
SD	12	Mode	
TN	32	Mode&Function	

TX	37 Mode	
UT	11 Mode	
VT	Function	7*
VA	32 Mode	
WA	10 Mode	1
WV	2 Function	
WI	40 Mode	1
WY	11 Mode	
Total	7,792	2,201 GRAND TOTAL=9993

*Personnel assigned to operate State Owned Aircraft + Personnel assigned to operate State Owned Airports.

Source: National Association of State Aviation Officials (2001) State Aviation Funding and Organizational Data

The Prevalence of Writing Across the Curriculum in Collegiate Aviation Flight Education

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ABSTRACT

The purpose of this paper is to report on the use of writing assignments and the prevalence of Writing Across the Curriculum (WAC) in collegiate aviation flight programs. Researchers report a variety of results with the incorporation of writing and speaking assignments in different fields, but similar study in aviation is not well reported. Of 115 University Aviation Association institutions surveyed, 37 responded to a battery of questions regarding the use of writing assignments in their aviation flight programs and WAC. While the majority of respondents indicate that their institution does not have an established WAC program, collegiate aviation flight programs do employ a variety of communication-focused courses to address communication training and assignments to teach/practice communication skills. Additionally, the majority of responding institutions indicate that writing assignments are required.

INTRODUCTION

In higher education, there is a movement to improve students' communication and critical thinking skills through a program known as Communication Across the Curriculum (CAC). CAC combines the earliest forms of Writing Across the Curriculum (WAC) and Speaking Across the Curriculum (SAC), two movements dating back to the 1970's (Fulwiler & Young, 1997; Schneider, 1999), with other forms of communication.

Recently, practitioners and educators are proposing a variety of across-the-curriculum programs to address students' lack of communication skills and to improve thought processes (Riley, 1996; Schneider, 1999). Morello (2000) provides a description of speaking across the curriculum programs, while Bellon (2000) supports the notion of a debate across the curriculum program for improving students' skills. Addressing electronic communication across the curriculum, Rea, Hoger, and Rooney (1999, p. 93) note that "[t]echnlogy and communication are fields that transcend disciplinary boundaries and permeate students' functioning in all of their learning experiences."

McLeod (1992) defines WAC "as a comprehensive program that transforms the curriculum, encouraging writing to learn and learning to write in all disciplines"(p. 5). It is based on the assumption that "writing and thinking are closely allied, that learning to write well involves learning particular discourse conventions, and that, therefore, writing belongs in the entire curriculum, not just in a course offered by the English department" (McLeod, 1992, p. 6). The purpose of this article is to report on the use of writing assignments and the prevalence of WAC in collegiate aviation flight programs.

COMMUNICATION IN AVIATION EDUCATION

The 'General Education Curriculum Criteria' for accreditation by the Council on Aviation Accreditation (CAA) (Council on Aviation Accreditation, 2003, p.9-10) include "studies in communications which emphasize competency in written and verbal communication skills… and demonstrated competence in using computers for problem-solving". English composition, speech, and computer courses have a place in higher education. CAC focuses on the incorporation of these skills in other classes, e.g. Human Factors, Regulations, Weather, etc., allowing for continued practice.

Currently in the aviation industry, established Crew Resource Management training programs incorporate a similar approach to communication training. According to Kanki and Palmer (1993), communication may

(1) constitute a topic on its own (i.e., a communication module), (2) be incorporated into every other topic of the

curriculum (i.e., interwoven into every other module), and/or (3) be treated as a special topic, such as one that focuses on the interface between teams (e.g., pilot-ATC, pilot-flight attendant, pilot-dispatch coordination). (p. 131)

Authentic writing, speaking, and/or computer assignments can be applied in a variety of courses, allowing educators to better prepare students for the types of communication they will encounter in industry.

TYPES OF ASSIGNMENTS

Research in the area of WAC specifically is reported in such fields as medicine, finance, economics, business, psychology, physics, mathematics, chemistry, history, and philosophy. Instructors have used such techniques as assigning poetry writing in psychology (Gorman, Gorman, & Young, 1986), analysis of published articles and peer review of lab reports in biology (Flynn, McCulley, & Gratz, 1986), and use of student journals in mathematics (Selfe, Peterson, & Nahrgang, 1986). Garner (1994) reports the effective use of microthemes in accounting, with steady improvement in a student's writing quality as the term progresses.

Specifically in aviation, there is published material regarding the use of case studies in coursework. Lutte (1996) reported the use of case analysis as the primary means of course delivery for a sixteen-week course, with the following course objectives:

1. develop critical thinking skills;
2. study past and present issues in aviation;
3. be able to communicate opinions and support them with documented information;
4. develop an ability to listen to other's opinions and keep an open mind in a discussion or debate;
5. writing clear and concise analysis based on case materials; and
6. develop team building skills. (p. 15)

The objectives as stated are congruent with the goals of CAC.

WRITING ACROSS THE CURRICULUM APPLICATIONS

Southern Illinois University at Carbondale's (SIUC) CAC program began as a WAC program, but was quickly expanded to allow for the inclusion of oral, visual, and electronic communication ("Communication", 1999). Focusing on the writing component of CAC, courses identified as writing intensive courses in the College of Applied Sciences and Arts at SIUC require that students produce a minimum of fifteen pages of written material meeting certain criteria (Isberner, 2000). Assignments are classified as either learning-to-write or writing-to-learn. The former focuses on the composition of authentic written products, assignments modeled after the types of writing that students may be expected to produce upon entering the workforce. The latter is based on the idea that through writing, students learn. Examples of these assignments might include in-class writing and journals, designed with the purpose of using the student's writing to enhance the student's own learning instead of test knowledge gained (McLeod & Maimon, 2000) Such products may well be more informal than the learning-to-write assignments.

RESEARCH QUESTIONS

For this paper, the researcher wished to determine how and to what extent communication training, particularly Writing Across the Curriculum, is being addressed in collegiate aviation. The research questions to be answered included:

1. In what ways are colleges and universities addressing communication training for aviation students?
2. How prevalent are writing assignments in collegiate aviation flight training?
3. How prevalent is Writing Across the Curriculum in collegiate aviation flight training?

METHODOLOGY

To answer these research questions, a target population was identified using the

University Aviation Association's (UAA) 2001-2002 UAA Institutional Members mailing labels list. Of 119 total institutions, 115 institutions, those located within the United States and its territories, were chosen for this study.

A cover letter, four-page survey, and postage-paid return envelope were sent to each institution's contact person named on the mailing label. The three-part survey requested basic demographic information, general information related to existing communication training within aviation programs, and WAC-specific information. Green paper was used for printing the surveys. King, Pealer and Bernard (2001) note some studies that suggest an increased response rate when using green paper. Four weeks after the initial mailing, follow-up letters were sent to all of the institutions.

To check the validity of the survey instrument, it was distributed to two experts for their review. Their suggestions were incorporated into the instrument. The survey was then given to four colleagues who teach or have taught ground school courses in a flight-training program to test the instrument for reliability.

Results and Analysis

Of the 115 institutions contacted, 37 (32%) returned completed surveys. The low overall response rate can only in part be attributed to the fact that not all UAA-member institutions offer aviation flight training. A review of the Collegiate Aviation Guide (CAG) (Kitely, 1999) and supplementary searches on the World Wide Web yielded the following information. Of the surveyed institutions, 92 do offer some level of flight training, and 22 do not. The researcher was unable to determine whether the remaining one institution offers flight training. This yields a response rate of 40% for surveyed institutions known to offer flight training.

According to Babbie (1992), a 50% response rate is generally recommended for mail surveys sampling a population, but he admits that this is a rough guide. Also, this study surveyed the entire population and not a sample. To determine the possibility of response bias, analysis of various characteristics of the responding institutions was attempted utilizing information gleaned from the CAG, the World Wide Web, and demographic information reported by respondents. Due to incomplete information reported in the CAG and the changing membership in the UAA, it was difficult to exactly match the surveyed population. Only 62 of the surveyed 2001-2002 institutions had information reported in the 1999 CAG, and the information given on these institutions was not necessarily complete. Therefore, internal analysis for response bias was not completed.

Basic demographic data follows, and the research questions are addressed. Statistics used to interpret the data include descriptive statistics (frequency counts and means) and the Pearson Chi-Square. An alpha level (a) of .05 was used to determine significance in statistical tests.

Demographics

The 37 respondents were either department chairs (25) or senior faculty members (12) at their institutions. One had earned an Associate degree, six a Bachelor degree, 17 a Masters degree, 11 a PhD/EdD, and one indicated Specialist. One respondent did not indicate an education level. They averaged 8 years in their current position, with 16 having been employed in the current position up to 5 years, 11 from 6 to 10 years, 4 from 11 to 15 years, 2 from 16 to 20 years, and 4 with more than 20 years.

Institutions represented include both 2-year colleges (17) and 4-year universities (21). One respondent indicated both, explaining the apparent extra response. This respondent was excluded from inferential statistical analysis involving institutional affiliation to meet requirements for independence. Institutional student enrollments reported by the respondents range from 100 students to 55,000 students, and flight-training enrollments range from 10 students to 300 students. Associate degrees in aviation are offered by 18 of the institutions, 21 institutions offer a bachelors degree, 6 offer a masters degree and 1 reported offering a PhD/EdD.

Respondents were asked to indicate the number of single-engine aircraft, multi-engine aircraft, FTD/simulators, and PCATDs their institutions operate. Eighteen respondents (49%) indicated the actual number while the rest simply checked which types of equipment were available. For that reason, only the number of responding institutions utilizing a certain type of equipment is reported here. Equipment utilized in flight training by the responding institutions include single-engine aircraft (32), multi-engine aircraft (27), FTD/simulators (33), PCATDs (22), and one institution reported not using any of the listed equipment.

Research Question 1

In what ways are colleges and universities addressing communication training for aviation students?

Respondents were asked to indicate which courses from a list of communication-focused courses were either required general education, required aviation, or elective courses in the institution's flight training program. Table 1 indicates the responses given. Respondents report the use of a variety of courses in their institutions' aviation and general education programs; many institutions require more than one communication course. In addressing written communication, 30 require a basic or freshman grammar course, 36 require basic or freshman composition, and 22 require advanced composition. To address oral communication, 30 require a speech course, 11 require an interpersonal communication course, and 1 requires a debate course. A basic computing course is required by 29 of the responding institutions. In several cases, respondents indicate that their institution offers one or more of the above courses as electives (see Table 1). Additionally, one respondent noted in the margin that the institution included both a Principles of Communication course and a Business Communication course in its general education requirements.

Differences between two- and four-year institutions are shown in Table 2. Chi-Square analysis of the communication-focused courses was performed to determine whether either type of institution is more likely to require a course or offer it as an elective. The test yields significant differences in course offerings between the two types of institutions in the case of the advanced composition course [$X^2(1, N = 32) = 5.203$, $p = .02$] and interpersonal communication course [$X^2(1, N = 22) = 4.701$, $p = .03$]. The four-year institutions reporting an advanced composition course are much more likely (84%) to require it than the two-year institutions (46%). It should be noted that 54% of two-year institutions responding do offer advanced composition as an elective. Likewise, the four-year institutions reporting an interpersonal communication course are much more likely (69%) to require it than the two-year institutions (22%).

Within the flight training program specifically, respondents report additional coursework and assignments to address communication training in aviation. Of the 37 respondents, four indicated the use of a dedicated aviation communication/standard phraseology course, 33 indicated a communications unit within a course, 18 indicated one-on-one training, 18 indicated commercial videos, and 15 indicated self-study. Under Other, respondents indicated written and oral term projects, papers, student presentations, and technical writing courses as additional ways that the flight-training program addresses communication training. Differences between two- and four-year institutions are shown in Table 3. Chi-Square analysis yielded no statistically significant differences.

Research Question 2

How prevalent are writing assignments in collegiate aviation flight training?

Respondents were asked to indicate methods that are employed within their program to teach/practice communication skills. Written exercises were indicated by 30 respondents, while 33 indicated oral presentations, 26 indicated group exercises, 33 indicated in-class discussion, and 13 indicated computer-based exercises. Under Other, respondents indicated Internet discussion groups and web-based instruction as additional methods used to teach or practice communication skills. Differences between two- and four-year institutions are shown in Table 4. Chi-Square analysis yielded no statistically significant differences.

Respondents were further asked about the use of writing assignments in their institution's aviation program. Specifically, the survey asked whether the program requires writing assignments in aviation courses. Two respondents indicated that their aviation courses did not require writing assignments, while the remaining 35 indicated that their aviation courses did require some writing assignments. Of those 35 institutions, respondents indicated that 11 programs require at least one multiple-draft assignment, and 27 indicated that their aviation programs do offer courses in which a minimum percent of the course grade is based on writing assignments. Differences between two- and four-year institutions are shown in Table 5. Chi-Square analysis yielded no statistically significant differences.

Finally, respondents were asked to indicate examples of writing assignments that faculty at their institution use in aviation courses. All respondents indicated at least one type of writing assignment. Table 6 indicates the types of writing assignments the respondents reported. Under Other, respondents indicated the use of discussion questions for seminar courses, homework questions in the textbook, lesson plans, peer evaluation of certified flight instructor candidates, research/experience reports, term papers, position papers, press releases, resumes, and policy analyses in their courses.

Chi-Square analysis reveals statistically significant differences between two- and four-year institutions for the Airport Planning Document [$X^2(1, N = 36) = 4.91$, $p = .03$] and the Journal writing [$X^2(1, N = 36) = 10.80$, $p = .00$] assignments. In both cases, the four-year institutions were more likely to require those types of writing assignments than two-year institutions.

Research Question 3

How prevalent is Writing Across the Curriculum at institutions offering collegiate aviation flight training?

Respondents were asked to indicate whether their institutions have a Writing Across the Curriculum program. Fourteen respondents reported either an established WAC program or one at some stage of development, and 23 indicated that their institutions do not have a WAC program in place. Differences between two- and four-year institutions, including a breakdown of established WAC programs versus those in development, are shown in Table 7. Chi-Square analysis does yield a statistically significant difference [$X^2(1, N = 36) = 4.91$, $p = .03$]. A greater percentage of four-year institutions (55%) report either an established or developing WAC program than two-year institutions (19%). The one respondent indicating both two-year and four-year institutional affiliations reported no WAC program.

CONCLUSIONS

Colleges and universities employ a variety of communication-focused courses to address communication training and assignments to teach/practice communication skills. Institutions indicate basic grammar, basic composition, advanced composition, speech, and basic computing, as the communication-focused courses most often required of students. Within the flight training program specifically, institutions indicate course units, one-on-one training and commercial videos as the additional coursework most often used to address communication training. Oral presentations, in-class discussion, written exercises, and group exercises were reported as the methods most often used in the programs to teach/practice communication skills.

The majority of responding institutions (35) indicate that writing assignments are required in their aviation courses. However, when asked to indicate methods employed within the program to teach/practice communication skills, only 30 institutions indicated written exercises. One reason for this may be that the writing assignments in some cases are of the writing-to-learn type, developed to enhance the student's knowledge of the subject matter rather than develop communication skills. All respondents did indicate at least one example of writing assignments their faculty use in aviation courses. Finally, ten institutions (27% of respondents) indicate that a WAC program is in place. An additional four respondents indicate that such a program is under development. While the majority of responding institutions (27) indicate that they do not have an established WAC program, most of them do offer aviation courses that require writing assignments, and many of these courses base a percentage of the final grade on those writing assignments.

REFERENCES

Babbie, E. R. (1992). *The practice of social research.* (6th ed.). Belmont, CA: Wadsworth Publishing Company.

Bellon, J. (2000). A research-based justification for debate across the curriculum. *Argumentation & Advocacy, 36*(3), 161-175.

Communication across the curriculum at Southern Illinois University Carbondale. (1999, October 10). Retrieved February 19, 2003, from http://www.siu.edu/departments/ cac/introducing.html

Council on Aviation Accreditation. (2003). *Accreditation standards manual.* Auburn, AL: Author.

Flynn, E. A., McCulley, G. A., & Gratz, R. K. (1986). Writing in biology: effects of peer critiquing and analysis of models on the quality of biology laboratory reports. In A. Young & T. Fulwiller (Eds.), *Writing across the disciplines: Research into practice* (pp.68-85). Portsmouth, NH: Boynton/Cook Publishers.

Fulwiler, T., & Young, A. (1997). The WAC archives revisited. In K. B. Yancey, & B. Huot, (Eds.), *Assessing writing across the curriculum: Diverse approaches and practices* (pp. 1-6). Greenwich, CT: Ablex Publishing Corporation.

Garner, R. M. (1994). An efficient approach to writing across the curriculum: Microthemes in accounting classes. *Journal of Education for Business, 69*(4), 211-216.

Gorman, M. E., Gorman, M. E., & Young, A. (1986). Poetic writing in psychology. In A. Young & T. Fulwiller (Eds.), *Writing across the disciplines: Research into practice* (pp.68-85). Portsmouth, NH: Boynton/Cook Publishers.

Isberner, F. (2000). *College of Applied Sciences and Arts: Communication across the curriculum writing intensive course review.* Unpublished manuscript, Southern Illinois University Carbondale.

Kanki, B. G., & Palmer, M. T. (1993). Communication and Crew Resource Management. In E. L. Wiener, B. G. Kanki, & R. L. Helmreich, (Eds.), *Cockpit Resource Management* (pp. 99-136). San Diego, CA: Academic Press, Inc.

King, K. A., Pealer, L. N., & Bernard, A. L. (2001). Increasing response rates to mail questionnaires: A review of inducement strategies. *American Journal of Health Education, 32*(1), 4-15.

Kitely, G. (Ed.). (1999). *Collegiate aviation guide: Reference of collegiate aviation programs.* Auburn, AL: University Aviation Association.

Lutte, R. K. (1996). How to use case analysis as an entire semester course in aviation. *Journal of Air Transportation World Wide, 1,* 13-21.

McLeod, S. & Maimon, E. (2000). Clearing the air: WAC myths and realities. *College English, 62*(5), 573-583.

McLeod, S. H. (1992). Writing across the curriculum: An introduction. In S. H. McLeod & M. Soven (Eds.), *Writing across the curriculum* (pp. 1-11). Newbury Park, CA: Sage Publications, Inc.

Morello, J. T. (2000). Comparing speaking across the curriculum and writing across the curriculum programs. *Communication Education, 49,* 99-113.

Rea, A. I., Jr., Hoger, B., & Rooney, P. (1999). Communication and technology: Building bridges across the chasm. *Business Communication Quarterly, 62*(2), 92-96.

Riley, S. G. (1996). Craft meets art as professors try writing across the curriculum. *Journalism & Mass Communication Educator 50*(4), 77-81.

Schneider, A. (1999). Taking aim at student incoherence. *The Chronicle of Higher Education, 45*(29), A16-A18.

Selfe, C. L., Peterson, B. T., & Nahrgang, C. L. (1986). Journal writing in mathematics. In A. Young & T. Fulwiler (Eds.), *Writing across the disciplines: Research into practice* (pp. 192-207). Portsmouth, NH: Boynton/Cook Publishers

Table 1

Communication Courses Offered by Responding Institutions

	Required, General Education	Required, Aviation Course	Elective
Basic grammar [a]	29	2	1
Basic composition [a]	35	2	0
Advanced composition [a]	21	2	10
Speech [a]	27	4	5
Debate	1	0	10
Interpersonal communication	9	2	11
Basic computing [b]	25	4	8

[a]One responding institution indicated the course being offered as both a required general education course and a required aviation course.
[b]Two responding institutions indicated the course being offered as both a required general education course and an elective.

Table 2

Communication Courses Offered: Two-year Versus Four-year Institutions

	Two-year			Four-year			Two- and four-year		
Course	R-GE	R-A	E	R-GE	R-A	E	R-GE	R-A	E
Basic (freshman) grammar[a]	12	2	1	16	0	0	1	0	0
Basic (freshman) composition[a]	15	2	0	20	0	0	0	0	0
Advanced composition[a]	5	2	7	16	0	3	0	0	0
Speech[a]	10	4	3	16	0	2	1	0	0
Debate	0	0	6	1	0	4	0	0	0
Interpersonal communication	1	1	7	8	1	4	0	0	0
Basic Computing[b]	8	2	4	16	2	4	1	0	0

Note. R-GE signifies a required general education course. R-A signifies a required aviation course. E signifies an elective course.
[a]One two-year institution indicated the course as both R-GE and R-A. [b]Two four-year institutions indicated the course as both R-GA and E.

Table 3

Additional Coursework Used to Address Communication Training

	Two-year institution	Four-year institution	Two- and four-year institution	Total
Dedicated course	1	3	0	4
Course unit	15	18	0	33
One-on-one training	7	11	0	18
Commercial videos	10	8	0	18
Self-study	8	6	1	15
Other	1	3	1	4

Note: Of 37 total respondents, 16 indicated affiliation with a two-year institution, 20 indicated a four-year institution, and one indicated both.

Table 4

Methods Used to Teach/Practice Communication: Two-year Versus Four-year Institutions

	Two-year institution	Four-year institution	Two- and four-year institution	Total
Written exercises	11	18	1	30
Oral presentations	14	18	1	33
Group exercises	11	15	0	26
In-class discussion	14	19	0	33
Computer-based exercises	4	9	0	13
Other	1	1	0	2

Note: Of 37 total respondents, 16 indicated affiliation with a two-year institution, 20 indicated a four-year institution, and one indicated both.

Table 5

Use of Writing Assignments: Two-year Versus Four-year Institutions

	Two-year institution	Four-year institution	Two- and four-year institution	Total
Require writing assignments in aviation courses	14	20	1	35
Require multiple drafts of at least one writing assignment	3	8	0	11
Base a percentage of a course grade on writing assignments	9	17	1	27

Note: Of 37 total respondents, 16 indicated affiliation with a two-year institution, 20 indicated a four-year institution, and one indicated both.

Table 6

Writing Assignments Reported: Two-year Versus Four-year Institutions

	Two-year institution	Four-year institution	Two- and four-year institution	Total
General assignments				
Article summary	7	14	1	22
Book report	10	11	1	22
Department/unit annual report	0	1	0	1
Expense report	1	1	0	2
Journal	2	13	0	15
Library research report	10	17	1	28
Ungraded writing assignment	3	8	0	11
Aviation specific assignments				
Accident report	8	13	0	21
Aircraft purchase proposal	0	3	1	4
Airport planning document	3	11	1	15
Flight log	4	10	0	14
Incident report	3	10	0	13
Maintenance report	1	3	0	4
Other	4	3	0	7

Note: Of 37 total respondents, 16 indicated affiliation with a two-year institution, 20 indicated a four-year institution, and one indicated both.

Table 7

Status of WAC Programs: Two-year Versus Four-year Institutions

	Two-year institution	Four-year institution	Two- and four-year institution
No WAC	13	9	1
WAC in development	1	3	0
Established WAC program	2	8	0

Taking the "Lost" Out of Lost Communications

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ABSTRACT

When pilots encounter a loss of two-way radio communications during instrument flight, many situations are not clearly addressed in the regulations. The Federal Aviation Regulations, the Aeronautical Information Manual, the Air Traffic Controller Manual, the Canadian Aeronautical Information Publication, and the Aircraft Owners and Pilots Association Pilot Magazine provide information to aid pilots in decision-making during lost communications situations. There are some circumstances where pilots need additional guidance. The purpose of this paper is to present a review of the literature and input from controllers to provide information for pilots in the event of two-way radio communications failure and to present suggestions for areas of the regulations which could be improved.

INTRODUCTION

Federal Aviation Administration (FAA) Federal Aviation Regulations (FAR) provide instruction to the pilot regarding what to do in the event of a two-way radio communications failure (lost com) during Instrument Flight Rules (IFR) operations in instrument meteorological conditions (IMC). A detailed study of the specific regulation brings up several questions regarding preflight planning, flight plan information, and expected actions by the pilot in the event of a lost com situation. Although non-regulatory in nature, the Aeronautical Information Manual (AIM) provides information that can assist the pilot in preflight planning to encompass "what if" scenarios involving a lost com. The Air Traffic Control (ATC) Manual details procedures for air traffic controllers to follow and provides insights to pilots regarding controller expectations. In addition, Transport Canada's (TC) Canadian Aeronautical Information Publication (AIP) and the Aircraft Owners and Pilots Association (AOPA) Pilot Magazine provide useful suggestions for pilots who find themselves in a lost com situation.

LITERATURE REVIEW

Federal Aviation Regulations

With regard to the route to be flown, 14 CFR 91.185 (c) states that the pilot will fly "(i) by the route assigned in the last ATC clearance received; (ii) if being radar vectored, by the direct route from the point of radio failure to the fix, route, or airway specified in the vector clearance; (iii) in the absence of an assigned route, by the route ATC has advised may be expected in a further clearance, or (iv) in the absence of an assigned route or a route that ATC has advised may be expected in a further clearance, by the route filed in the flight plan" (FAA, 1990). While there can be little room for doubt of the intent of subparagraphs (i), (iii), and (iv), subparagraph (ii) raises some questions. In a busy terminal area most low altitude traffic is radar vectored. Quite often a pilot will receive radar vectors to the final approach course consisting of a vector opposite to the final approach course and off to one side followed by one or two vectors to position the aircraft to intercept the final approach course outside of the final approach fix. If the pilot is being radar vectored for an instrument approach, the action expected of the pilot will vary depending on where the aircraft is relative to the final approach fix when the lost com occurs and what type of navigation aids are available for the approach.

Another occasion for radar vectors occurs when an aircraft needs to be vectored off course for traffic. 14 CFR 91.185 (c)(1)(ii) (FAA, 1990) does not specify a procedure for lost com while being radar vectored for traffic. Turning back on course might put the lost com aircraft into a potential collision situation. Furthermore, since the events of September 11, a pilot must also be aware if a radar vector course will take the aircraft into a Temporary Flight

Restriction (TFR) area. Penetration into a TFR, especially in a lost com situation, can result in notification to the watch supervisor and possible notification to the military for intercept procedures.

14 CFR 91.185 (c)(2)(ii) states that the pilot will fly "at the highest of the following altitudes or flight levels for the route segment being flown: (i) The altitude or flight level assigned in the last ATC clearance received; (ii) The minimum altitude (converted, if appropriate, to minimum flight level as prescribed in §91.121(c)) for IFR operations; or (iii) The altitude or flight level ATC has advised may be expected in a further clearance" (FAA, 1990). When following subparagraph (ii) the pilot must determine what minimum altitude for IFR operations applies to the current route.

With regard to leaving the clearance limit, subparagraph (i) of 14 CFR 91.185 (c)(3) states, " When the clearance limit is a fix from which an approach begins, commence descent or descent and approach as close as possible to the expect-further-clearance time, if one has been received, or if one has not been received, as close as possible to the estimated time of arrival as calculated from the filed or amended (with ATC) estimated time enroute" (FAA, 1990). In most cases the clearance limit is the destination airport. If the airport has a navigation aid located on the airport and that aid is an initial approach fix, the pilot would be expected to leave that fix at the expect-further-clearance (EFC) time or the estimated time of arrival (ETA), as appropriate. Furthermore, if the pilot has received an amended clearance or a short-range clearance to a fix other than one located at the destination airport and that fix happens to be an initial approach fix for that airport, the pilot is expected to hold at that fix until the EFC time and then proceed with descent and approach.

Subparagraph (ii) of 14 CFR 91.185 (3) states, "If the clearance limit is not a fix from which an approach begins, leave the clearance limit at the expect-further-clearance time if one has been received, or if none has been received, upon arrival over the clearance limit, and proceed to a fix from which an approach begins and commence descent or descent and approach as close as possible to the estimated time of arrival as calculated from the filed or amended (with ATC) estimated time enroute" (FAA, 1990). If the destination airport is the clearance limit and there are no navigation aids located on the airport, the pilot cannot get to the clearance limit without first executing the approach, making it impossible to comply with the regulation.

The requirement to hold until the ETA in the absence of an EFC leads to the question of how the estimated time enroute (ETE) is determined. The FAR list the information required on a Visual Flight Rules (VFR) flight plan. 14 CFR 91.153 (a)(6) instructs the pilot to file to "the point of first intended landing and the estimated elapsed time until over that point" (FAA, 1963). 14 CFR 91.169(a)(1) instructs the pilot filing an IFR flight plan to include the "information required under 91.153(a)" and differs from 14 CFR 91.153 only by the requirement to file for an alternate under certain weather conditions (FAA, 2000). The Pilot/Controller Glossary defines ETE as "the estimated flying time from departure point to destination (lift-off to touchdown)" (FAA, 2002a). Therefore, the ETE must include the time estimated for performing the approach procedure. Since 14 CFR 91.185 (c)(3) prevents the pilot from beginning the approach until the ETA, a pilot operating under a lost com situation will not arrive at the airport at the ETA (FAA, 1990). This could impact fuel reserves, especially if a pilot has to execute a missed approach and proceed to the alternate.

Aeronautical Information Manual

The AIM, Chapter 6, Section 4, Paragraph 1, Subparagraph (a) states, "It is virtually impossible to provide regulations and procedures applicable to all possible situations associated with two-way radio communications failure. During two-way radio communications failure, when confronted by a situation not covered in the regulation, pilots are expected to exercise good judgment in whatever action they elect to take. Should the situation so dictate they should not be reluctant to use the emergency action contained in 14 CFR Section 91.3 (b)" (FAA, 2002a). 14 CFR 91.3 allows the pilot to deviate from any rule under § 91 to meet the needs of an emergency (FAA, 1963). While this allows the pilot to exercise his/her judgment for situations not covered by the FAR, the pilot should be aware of what ATC might expect and that it will require ATC some time to clear other traffic out of the way.

The AIM, Chapter 5, Section 1, Paragraph 7, Subparagraph (f) (FAA, 2002a) provides explanations of IFR flight plan items. It instructs the pilot to enter the estimated time enroute based on latest forecast winds into block 10 of the flight plan form. This subparagraph also instructs the pilot to "specify an alternate airport if desired or required, but do not include routing to the alternate airport" (FAA, 2002a). Subparagraph (g) states, "The information transmitted to the ARTCC [Air Route Traffic Control Center] for IFR flight plans will consist of only flight plan blocks 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11" (FAA, 2002a). The block for listing an alternate is block 13. In the event a lost com pilot must execute a missed approach, the ARTCC must contact the Flight Service Station (FSS) to ascertain the alternate. Furthermore, the ARTCC would not know what route the pilot might use.

The Pilot/Controller Glossary defines "minimum IFR altitudes". In paragraph (c) the Glossary includes altitudes "as otherwise authorized by the Administrator or assigned by ATC (Air Traffic Control). (See Minimum Enroute IFR Altitude) (See Minimum Obstruction Clearance Altitude) (See Minimum Crossing Altitude) (See Minimum Safe Altitude) (See Minimum Vectoring Altitude)" (FAA, 2002a). The AIM, Chapter 6, Section 4, Paragraph 1, Subparagraph 3, Note states "The intent of the rule is that a pilot who has experienced two-way radio failure should select the appropriate altitude for the particular route segment being flown and make the necessary altitude adjustments for subsequent route segments" (FAA, 2002a). The minimum altitude for IFR operations is determined by the location of the aircraft. If the aircraft is within 22 nautical miles of a Very High Frequency Omnidirectional Range (VOR) station on an airway for which a Minimum Obstruction Clearance Altitude (MOCA) is prescribed, the MOCA can be used as the minimum altitude. If the pilot is within 25 nautical miles of the facility or fix designated for Minimum Safe Altitude (MSA) sectors, the MSA may be used as the minimum altitude. While these altitudes might be the minimum IFR altitude for the location of the aircraft, the pilot must still comply with 14 CFR 91.185 (c)(2) (FAA, 1990). There is an additional minimum altitude which is included in the Pilot/Controller glossary definition but which is not printed on aeronautical charts. Controllers routinely assign altitudes down to the minimum vectoring altitude (MVA). Although clearance down to an MVA might meet both the requirement for last assigned altitude and for minimum IFR altitude as defined by the Pilot/Controller glossary, the pilot does not have any definitive method to determine the boundaries of the MVA.

The Pilot/Controller Glossary defines ETA as "the time the flight is estimated to arrive at the gate (scheduled operators) or the actual runway on times for non-scheduled operators" (FAA, 2002a). This verifies that in a lost com situation the pilot should not expect to touch down at the filed ETA; the touch down time would be the ETA plus the time to execute the approach.

Air Traffic Control Manual

The Air Traffic Control Manual (FAA Order 7110.65N) outlines procedures for air traffic controllers to follow in the event of two-way radio communications failure with an aircraft under ATC control. Chapter 10, Section 4-4 states "when an IFR aircraft experiences two-way radio communications failure, air traffic control is based on anticipated pilot actions" (FAA, 2002b). Such actions are based on procedures and recommended practices from the FAR and AIM. This includes the expectation that the pilot will squawk code 7600 on the transponder. Chapter 10, Section 4-4 directs controllers to attempt to contact the aircraft by all available means including emergency frequencies (121.5 Megahertz) and VORs with voice capability (FAA, 2002b). Controllers are instructed to direct the lost com aircraft to respond by alternate methods. These methods include squawking ident, changing to code 7600 if the aircraft is not already squawking that code, or turning the transponder to stand-by for a specified period of time and then returning to the assigned code. If the pilot responds with the requested transponder action the controller will give additional instructions and monitor radar to check for compliance. The manual also directs controllers to "broadcast a clearance for the aircraft to proceed to its filed alternate airport at the MEA if the aircraft operator concurs" (FAA, 2002b). Operator concurrence implies some sort of response from the pilot, i.e. transponder input.

Canadian Aeronautical Information Publication

The Canadian AIP (TC, 1999) reminds pilots of common sense procedures which might be forgotten in the heat of the situation. AIP RAC 6.3.2.1 informs the pilot to maintain a listening watch on the appropriate frequencies and to acknowledge receipt of any messages in any manner the pilot can devise (TC, 1999). AIP RAC 6.3.2.2 also tells pilots to try to contact anyone, including other air traffic controllers or pilots, to relay information (TC, 1999). If lost com pilots find themselves in visual meteorological conditions (VMC) the AIP clarifies that the requirement to land as soon as practicable does not imply to land as soon as possible, i.e. on an airport not suitable for the type of aircraft.

AIP RAC 6.3.2(b)(ii) provides information regarding loss of communications while operating at an MVA. The corresponding note 2 states that "if the failure occurs while being vectored at a radar vectoring altitude which is lower than a published IFR altitude, then the pilot shall immediately climb to and maintain the appropriate minimum IFR altitude until arrival at the fix, route or airway specified in the clearance" (TC, 1999).

The AIP provides suggestions for pilots experiencing lost com who have other onboard communications technology such as a cellular phone. Pilots can use such devices to contact ATC either directly or through a Flight Service Station (TC, 1999).

Aircraft Owners and Pilots Association

The AOPA website provides several articles from AOPA Magazine regarding lost com situations. A troubleshooting guide to determine the extent of the problem is provided by Cook (1998). The possibilities include: being temporarily out of range of the ATC facility (especially while operating at minimum altitudes in mountainous areas), failure of only one radio when a second is operational, improper selection of the audio panel, failure of only the transmit capability or only the receiver capability, and problems with headsets or intercoms. Cook advocates carrying a portable transceiver for situations where troubleshooting does not solve the problem. He offers suggestions for improving the limitations of hand held devices, such as carrying extra batteries, an external antenna, and a headset adapter. In addition, he reminds pilots to carry a spare microphone and headset. He also suggests carrying a portable global positioning system (GPS) to assist in planning a course of action if VMC is encountered. Finally, he warns that failure of the alternator is one of the most common causes of radio communications failures. If the pilot determines that the alternator has failed the pilot will need to load shed to conserve battery power and determine the best course of action to terminate the flight prior to total electrical failure.

Cook also provides information regarding use of the transponder (Cook, 1998). After ascertaining that a lost com situation exists, he recommends squawking 7600 for one minute then returning to the assigned code. He also recommends squawking 1200 in the event the pilot encounters VMC and is able to proceed under visual flight rules (VFR). The pilot should then notify ATC as soon as possible that IFR is being cancelled. If communications cannot be re-established in flight this would require notification on the ground.

Cook discusses altitude selection following a change in minimum enroute altitude (MEA). He states that if a pilot has climbed to comply with a route segment with a higher MEA than the last assigned altitude "it doesn't really matter" if the pilot chooses to stay at that altitude after the MEA goes down "as long as your transponder is working" (Cook, 1998, para. 15). He warns that the pilot must consider the type of airspace and what effect "remaining at the non-assigned altitude" (Cook, 1998, para. 15) will have on ATC.

With regard to arriving at the clearance limit early, Cook states that "controllers we know say that they would prefer that you begin the approach when you arrive at the fix" (Cook, 1998, para. 16) rather than entering a hold.

Another AOPA Pilot Magazine article also provided suggestions, some of which contradicted suggestions from the other article. In addition to the troubleshooting guide provided by Cook, Marsh (1999) also advises tuning in a nearby voice-capable VOR and listening on that frequency. He states that pilots will often select the wrong frequency when being handed off to another controller and that communications can often be re-established by simply re-contacting the previous controller.

Marsh contradicts Cook regarding transponder squawk codes to be used during lost com. Marsh advises leaving the transponder on code 7600 and states that "nothing in the data block on the controller's radar screen will change, including your N number, if you start squawking 7600 instead of the assigned code" (Marsh, 1999, para. 6).

Marsh states that controllers anticipate "that you will do what you said you would do, and at the time you said you would do it" (Marsh, 1999, para. 7). This implies strict adherence to the altitudes, routes, and times specified in 14 CFR 91.185 (FAA, 1990).

DISCUSSION

RADAR VECTORS

J. T. Moore, Airspace and Procedures Manager of the Seattle ARTCC provided information regarding what ATC would expect a pilot to do in the event of a lost com during radar vectors to an Instrument Landing System (ILS) approach (J. T. Moore, personal communication, January 10, 2003). Moore used the Bremerton National Airport ILS Runway (Rwy) 19 instrument approach procedure (U.S. Department of Transportation, 2001) as an example (see figure 1). He stated that if a pilot were on a downwind vector and had not passed the Initial Approach Fix (IAF) at Checo (a fan marker only), he would expect the pilot to proceed direct to the Kitsap non-directional beacon (NDB) and then proceed outbound for procedure turn. If the pilot had passed Checo (which could be determined by passage of the 279 degree radial of the Seattle VOR), he would expect the pilot to turn to intercept the localizer course and proceed inbound on the approach.

Peter Roberts, a Certified Professional Controller with the Seattle ARTCC and an instrument rated pilot, warned that pilots must be cautious when given radar vectors in the vicinity of TFRs. If a vector points to a TFR the controller should inform the pilot what to do in the event of no communication within a specified time period. He stated that if a pilot does not hear this instruction the pilot should query the controller. (P. Roberts, personal communication, January 10, 2003).

ALTITUDE

14 CFR 91.185 (c)(2) requires the pilot to stay at the last assigned altitude, the minimum altitude for IFR operations, or the altitude prescribed in an EFC (whichever is higher) (FAA, 1990). The Pilot/Controller Glossary broadens the definition of Minimum IFR Altitude to include MOCAs, MSAs, and MVAs. Lisa Foulk, an Airspace and Procedures Specialist with the Seattle ARTCC, stated that in a lost com situation, controllers don't know what other emergency situations the pilot might be experiencing. Controllers will attempt to clear all traffic out from beneath a lost com aircraft in the event the pilot might need to descend under the authority granted by 14 CFR 91.3 (L. Foulk, personal communication, January 10, 2003). However, Foulk stated that in most of the lost com situations she was familiar with the pilots elected to stay at the higher enroute altitudes until the ETA (L. Foulk, personal communication, January 10, 2003).

LEAVING THE CLEARANCE LIMIT

During preflight planning the pilot can clarify the routing to limit confusion in the event of a lost com. Using the Bremerton National Airport ILS Runway 19 instrument approach procedure (U.S. Department of Transportation, 2001) as an example, a pilot arriving from the south via Victor Airway V165 could list the routing to the destination airport as follows:

V165, Carro, direct Carney NDB, direct Kitsap NDB, direct Checo (see figure 1). In the event of a lost com after takeoff there would be no doubt in the pilot's mind or at ATC about the intended route of flight. If the clearance limit is the airport the pilot would proceed from the Kitsap NDB to the initial approach fix at Checo. If Checo is reached prior to the ETA the pilot is expected to hold at Checo on the localizer course until the ETA and then execute the procedure turn and approach (see figure 1).

ESTIMATED TIME ENROUTE

The Pilot/Controller Glossary is clear on the definition of ETE (FAA, 2002a). The pilot should include the estimated time for executing an instrument approach in the ETE. When contemplating fuel requirements the pilot should be aware that in the event of a lost com the approach cannot commence until the estimated touch down time. The pilot should calculate the ETE as accurately as possible to avoid the possibility of excessive time in a holding pattern. The specific routing to an IAF may help the pilot arrive at a more accurate ETE.

MISSED APPROACH

The AIM (Chapter 5, Section 1, Paragraph 7, Subparagraph (g) states that blocks 2 through 11 will be transmitted to the ARTCC for IFR flight plans (FAA, 2002a). Although the block for an alternate airport is not included in the above blocks, block 11 (the section for remarks) is. Tim Knight, Airspace and Procedures Specialist at the Seattle ARTCC, stated that anything placed in the remarks section of an IFR flight plan is transmitted to the ARTCC (T. Knight, personal communication, January 17, 2003). He stated that if a pilot lists in the remarks block the name of the alternate airport and the route and altitude to be used to get to the alternate airport, this information will be transmitted to the ARTCC and will appear on the data strip for the aircraft. Without this information ARTCC has no definitive method to predict the route to the alternate. According to the Air Traffic Control Manual the controller should transmit a clearance to the alternate at the MEA (FAA, 2002b). Operation at the MEA might put a pilot into icing conditions or high fuel burn situations. By listing the desired altitude in the remarks section the pilot can advise ATC of the intended altitude should a lost com situation arise.

TRANSPONDERS

Cook (1998) advocates changing the squawk code to 1200 if VMC conditions are encountered and the pilot is able to maintain VFR to a landing. Resetting the transponder to 1200 risks removing the data block attached to the target, causing the target to blend in with other 1200 squawk codes. Setting the transponder to 7600 and leaving it there until landing will keep the data block attached to the radar target but does not inform the controller that the pilot is operating under VFR.

The Air Traffic Control Manual refers to the expectation that the lost com aircraft will squawk 7600 (FAA, 2002b). Setting any other code into the transponder (except when directed by ATC when the pilot is able to receive but not transmit) contradicts the expectations outlined in the Air Traffic Control Manual.

Pilots should be cautious of assuming that a transponder reply light implies that they are in radar contact. The reply light can be activated by an interrogation from a traffic collision avoidance system (TCAS) or from a radar site other than the one in use by the air traffic controller handling the flight.

CONCLUSION

Careful preflight planning on the ground can make a lost com situation less stressful for the pilot and for controllers. Listing exact routing, including transition routes and the intended IAF, on the flight plan under route of flight will eliminate confusion if the pilot has to resort to the flight plan route. This exact routing will also allow the pilot to compute an accurate ETE which should include the time to execute the approach. Unfortunately, unless the FAA revises 14 CFR 91.185 (c)(3) (FAA, 1990), a lost com pilot will have to hold over the IAF for the time allotted for executing the approach. Fuel requirements for the flight should consider the possibility of this extra time.

An immediate remedy is available to eliminate confusion regarding the intended route and altitude to be flown to the alternate. The inclusion in the remarks block of the instrument flight plan the name of the alternate airport and the route and altitude to be flown to the alternate provides assurance that ATC will know the pilot's intentions. The inclusion of the altitude to the alternate will insure that the pilot can fly the route at an altitude suitable for the type of aircraft and the forecast weather conditions.

Troubleshooting prior to assuming a lost com situation exists can often eliminate the problem. In addition to the suggestions provided in the AOPA articles the pilot might be able to solve a stuck microphone problem by using the external position or off position on the transmitter selector switch to alternate between receive and transmit.

Pilots should be aware of their exact position at all times while being radar vectored. Should the radio go silent during radar vectors to a final approach course the pilot will be able to decide how best to intercept the course. Awareness of proximity to TFRs and coordination with ATC if vectored toward one can prevent a lost com problem from also becoming an intercept situation.

Due to confusion regarding squawk codes an Advisory Circular or clarification in the AIM should be considered. The FAA should address what squawk code or codes are to be utilized if the pilot encounters VMC and will continue under VFR.

Handheld radios and cellular phones provide pilots with a means of contacting ATC during a lost com. Care should be taken to insure that these items have fully charged batteries and that external antennas, microphones and headsets will operate properly if needed.

Even with on-board back-ups pilots should not adopt a cavalier attitude about lost com. The AIM lists information about lost com procedures under the emergency procedures section, and a pilot must evaluate each situation to see if it constitutes an emergency (FAA, 2002a). An occasional review of 14 CFR 91.185 (FAA, 1990) and the AIM (FAA, 2002a) will benefit the pilot should the situation arise.

REFERENCES

14 C.F.R. § 91.3, 91.153. (1963, September 30). Washington, DC: U.S. Government Printing Office.

14 C.F.R. § 91.169. (2000, January 21). Washington, DC: U.S. Government Printing Office.

14 C.F.R. § 91.185. (1990, August 18). Washington, DC: U.S. Government Printing Office.

Cook, Marc E. (1998, October). Instrument insights: techniques for precise flying, part 10 of 12. *Aircraft Owners and Pilots Association Pilot Magazine*. Retrieved April 21, 2003, from http://www.aopa.org/pilot/features/ii_9810.html.

Federal Aviation Administration. (2002, February 21). Aeronautical Information Manual. (5-1, 5-4, 6-4, Pilot/Controller Glossary). Retrieved April 22, 2003, from http://www2.faa.gov/Atpubs/PCG/index.htm

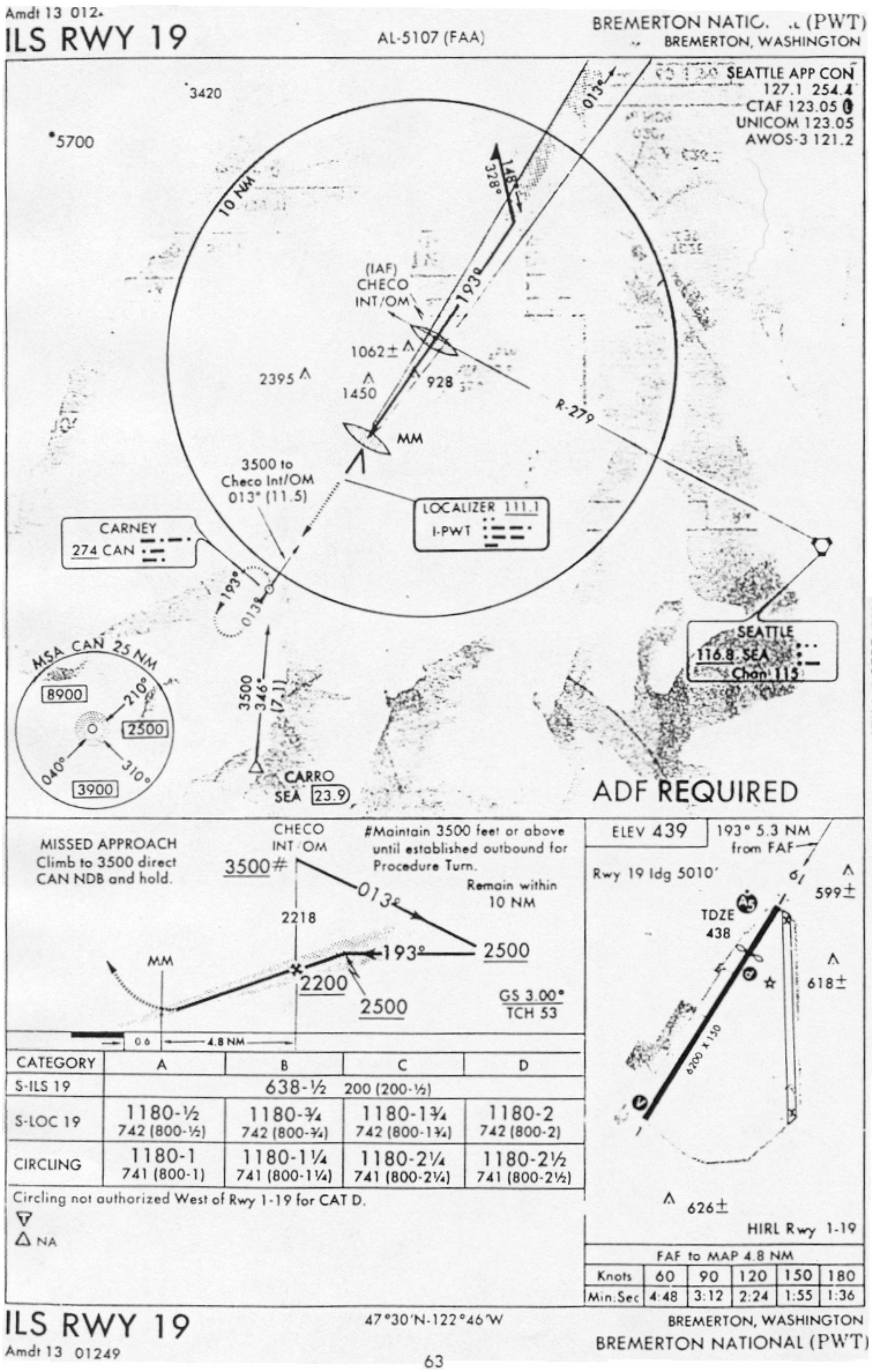
Federal Aviation Administration. (2002, February 21). Air Traffic Control Manual Order 7110.65N (10-4-4). Retrieved April 22, 2003, from http://www1.faa.gov/atpubs/ATC/Chp10/atc1004.html#10-4-4

Marsh, Alton K. (1999, December). In-flight emergencies, com failure. *Aircraft Owners and Pilots Association Pilot Magazine*. Retrieved April 21, 2003, from http://www.aopa.org/pilot/features/inflight9912.html.

Transport Canada. (1999, October 7). Aeronautical Information Publication. Canada (RAC 6.3) Ottawa, ON: Canadian Government Publishing.

U.S. Department of Transportation. (2001, September 6). U.S. Terminal Procedures. NW-1. (p. 63). Greenbelt, MD: FAA National Aeronautical Chart Office.

Figure 1. Bremerton National Airport, ILS RWY 19 Approach Procedure (U.S. Department of Transportation (2001).



Aerobatic Flight Training for U.S. Commercial Pilot Applicants: Should it be Mandatory?

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ABSTRACT

Commercial pilot applicants in the U.S. are not required to have any aerobatic training. Sometimes airplanes flown by these pilots encounter weather, turbulence, or other factors that can cause loss of control. When an aircraft is out of control and in an extreme unusual attitude, the flight controls respond differently. If the pilot is not familiar with aerobatics, an accident can result.

Since pilots have a vested interest in improving the safety of the aviation industry, the hypothesis was that pilot attitudes would be favorable towards mandatory aerobatic training for the issuance of a commercial pilot certificate. Other industry professionals and literature review support the notion that aerobatic training would (or does) improve aviation safety.

A survey designed to measure quantitative and qualitative attitudinal data on a 4-item forced-response Likert scale was used to measure the correlation of pilots' aerobatic experience with their confidence levels. Also measured were open-response items addressing comments or concerns voiced by the subjects. There was significant correlation of the pilots' aerobatic experience level to increased confidence levels. Also, the participants all indicated that aerobatic training would or has made them safer pilots. Thus, the findings support the hypothesis that pilots would be in favor of mandatory aerobatic training for the issuance of a US commercial pilot's license.

INTRODUCTION

In order to become a licensed pilot in the United States, a person must receive 20 hours of flight training from a certified instructor pilot, and accomplish 10 hours of solo flight (14CFR 61.109). The training and soloing consist of learning how to properly plan a flight, takeoff and land, perform certain in-flight maneuvers, and navigate (14CFR 61.107b). All tasks are performed in visual meteorological conditions, meaning that the pilot controls the aircraft primarily by looking outside of the aircraft. This minimal amount of training is required for a private pilot certificate. Next the pilot learns to control the aircraft using only instrument reference, flying without outside reference. This training earns the pilot an instrument rating. Finally, a pilot trains to become a commercial pilot, when he or she can carry passengers for hire. It takes a minimum of 250 hours of flight time to become a commercial pilot (14 CFR 61.129a). The commercial pilot is allowed by the Federal Aviation Administration (FAA) to be in command of (and totally responsible for the safety of) a plane full of passengers, in almost any kind of weather or other situation.

STATEMENT OF PROBLEM

Presently in the United States commercial pilot applicants are not required to have any training in or knowledge of aerobatics, which includes recovering an aircraft from unusual flight attitudes and accelerations. Sometimes airplanes encounter weather, turbulence, or other factors that can cause an upset and loss of control. An upset occurs when the airplane is forced out of normal flight. In an aircraft that has departed from normal flight, the flight controls respond differently, and if a pilot is not familiar with the proper recovery procedures (which can be learned by performing aerobatics), an accident can result. "An airplane is designed to rotate around each of its three axes [three-dimensional motion]. Isn't it then reasonable to assume that a pilot trained to control an airplane throughout these rotations is a safer pilot?" (Cole, 1976).

PURPOSE OF STUDY

In furtherance of aviation safety, this research will help to determine if the current US pilot population would embrace mandatory aerobatic from an authorized instructor for the issuance of a commercial pilot certificate. Since there has been no prior research on this subject, the purpose of this research is to determine whether pilots are or are not in favor of mandatory aerobatic training. No attempt will be made to determine how much training or what should be included in such training.

HYPOTHESIS

Pilot attitudes would be favorable towards mandatory aerobatic training for the issuance of a U.S. commercial pilot license. Pilots have a vested interest in improving both their own safety and that of the entire industry.

THEORETICAL FRAMEWORK

Traditionally during initial civilian pilot training, instructors teach their students the "Decide" model (FAA-H-8083-9). This model is a conceptual framework of how to make effective decisions in the aviation environment. This model has the following steps: Detect the fact that a change has occurred, Estimate the need to react, Choose a desirable outcome, Identify necessary actions, Do the necessary actions, and Evaluate the effects. The model is rather cumbersome initially, but as pilots gain experience, they generally complete several steps concurrently, and thus reaction and decision time are lessened. The Decide Model is related to aviation safety in that a pilot in an extreme unusual aircraft attitude would be unable to successfully use the model past the "Identify" step. If a pilot does not know or cannot do the actions required to recover his or her aircraft from an extreme unusual attitude, that pilot is no longer in control. Being able to identify an unsafe situation only utilizes the model halfway. A safe outcome is dependent on a successful completion of the DECIDE model.

According to the NTSB, maneuvering flight is one of the largest contributors to fatal accidents (NTSB, 2003). Maneuvering flight is a flight regime where aerobatic knowledge and skill may be necessary to the successful outcome of a flight. If pilots had aerobatic knowledge and skill, they would be more likely to successfully complete the Decide Model in some unsafe maneuvering flight situations where lack of aerobatic experience might otherwise prove fatal.

ASSUMPTIONS

In the US, pilots generally are assumed to earn pilot certificates and ratings in the following order: Student Pilot, Private Pilot, Instrument Rating, Commercial Pilot, Multi-Engine Rating, Certified Flight Instructor, Certified Flight Instructor—Instrument, Certified Flight Instructor—Multi-Engine & Instrument, Airline Transport Pilot. This order results from the required aeronautical experience for each certificate or rating under 14CFR FAR 61. Flight Schools operating under 14CFR FAR 141 generally grant certificates and ratings in the same order, but with less aeronautical experience due to an agreement with the FAA to follow a strict training syllabus with concurrent classroom instruction.

Another important assumption to the relevance of this study is that most students are generally trained in non-aerobatic aircraft and thus lack any sort of aerobatic skill in their aeronautical experience.

LIMITATIONS

An attitudinal survey was used to gather the data to determine whether the current pilot population would embrace mandatory aerobatic training. An informal pilot study was done to determine the validity and reliability of the study after Institutional Review Board approval, and the researcher determined that the independently designed survey was appropriate to use. However, due to a small sample size and the use of a convenience sample, the data are less robust than data collected from a larger random sample.

REVIEW OF LITERATURE

BACKGROUND

An aircraft has three axes of motion, and three separate flight controls are used to move the aircraft about these three axes. Fore and aft motions of the control column control the pitch (up and down movements of the nose) of the aircraft. Sideways movements of the column, as in turning an automobile, control roll (side-to-side leanings). Depressing either rudder pedal controls yaw, which can be described as a skidding, fishtailing movement of the rear end of the aircraft.

What exactly is aerobatics? Aerobatics is defined in two ways. First, aerobatics is defined as any "intentional maneuver involving an abrupt change in an aircraft's attitude, an abnormal attitude, or abnormal acceleration, not necessary for normal flight" (14 CFR 91.303). Second, when the pitch attitude, or nose up-and-down, of an airplane exceeds 30 degrees (up or down), and when the bank, or side-to-side leanings of an airplane exceeds 60 degrees, the occupants of the aircraft must wear parachutes (14 CFR 91.307(c

Although no formal studies have been done on the relationship between aerobatic training and aviation safety, an informal survey of readers of the on-line publication Avweb were asked their thoughts on aerobatic training (Avweb, 2002). Statistics from over 800 reader responses indicated 71 percent of the respondents were in favor of aerobatic training included in primary training (private pilot certification).

Indirect sources combine to support aerobatic's role in increasing aviation safety as well. Industry professionals have been noticing a lack of basic stick-and-rudder skills in pilots today (Machado, 2002). This lack of stick and rudder skills is thought to be a result of the general decline of experience among pilots (Machado, 2002; Wells, 1997). Stick-and-rudder skills are physical skills the pilot uses in controlling his or her aircraft.

The decline in experience among pilots mentioned by Machado and Wells could be the result of many factors, but the economic conditions of the past few years have encouraged many instructor pilots to leave the profession as soon as they have enough experience to be employed by an airline (Wells, 1997). A number of years ago a relatively stable instructor force existed; a highly experienced cadre with very good stick and rudder skills. However, these instructors gradually retired, and with the current expansion of air carriers' new hire pilots' average experience levels are decreasing (Wells, 1997).

PROBLEM HISTORY

Currently, pilots become instructors soon after becoming commercial pilots in order to build flight time and make money until they can qualify for a higher paying pilot job. The minimum requirements for being an instructor pilot are quite minimal: Instructor pilots need only have a commercial pilots certificate with an instrument rating, which corresponds to a minimum of 250 flight hours (14CFR 61.183). This same pilot is also qualified to be a pilot crewmember on any jet airliner (14CFR 121.437). Historically, commercial air carriers have stipulated their pilots have more experience than the minimums required by the Federal Aviation Regulations, but the rapid expansion of air carriers has reduced this previously required experience (Wells, 1997). These low time instructor pilots generally do not have the stick and rudder experience to pass along to their students, resulting in loss of skills in new students over time (Machado, 2000).

How do pilots develop stick and rudder skills? There are two primary ways: One is by flying aircraft long enough to develop an intimate feel for the necessary control pressures, and the other is by learning aerobatics. The first way, as recent research by Machado and Wells has illustrated, is not happening. Perhaps things will change in the future, but right now the second method looks best for increasing stick and rudder skills in new commercial pilots.

The U.S. military flight training programs use low time instructor pilots like their civilian counterparts, but the military requires aerobatic training as a part of their curriculum (Millbrooke, 1999). The military views aerobatic training as essential to producing safe pilots. In all branches of military aviation, aerobatics is introduced early in the training as a core building block of an aviator's skills (Millbrooke, 1999). If both militarily trained pilots and civilian trained pilots are eligible to apply for the same commercial pilot license, why the disparity in training?

Since the current trend of low time pilots working as instructors and commercial flight crews is forecast to continue, the low skill level of these pilots needs to be addressed by the Federal Aviation Administration as a potential safety issue.

COST ANALYSIS

Admittedly, the proposal of mandatory aerobatic training will entail some costs to the affected pilots. There are no Federal Aviation Regulations addressing the elements of aerobatic instruction. FAR 23 addresses airworthiness requirements for aerobatic aircraft, and FAR 91.303 defines operational regulations for aerobatics, but the current customer must set his or her own standards. An informal look at aerobatic flight instruction providers conducted late in 2002 indicated aerobatic flight training cost to average $200.00 per hour for aircraft plus instructor, with an average range of $179.00 to $240.00 per hour. The data used to compile this cost was from a selected few states (Arizona, California, Florida, Massachusetts, and Texas) representing a fairly large pilot population geographically.

Customers may access the International Aerobatic Club's website free of charge at http://www.iac.org/begin/schools.html and obtain a registry of aerobatic flight schools and their costs and services. Some aerobatic training programs have a very structured syllabus, and others have only an aircraft and instructor and will tailor the training to fit the customer.

The overall cost of aerobatic training is influenced by the type of trainer used, the reputation and geographic location of the school, and the experience of the instructor. Although the per-hour cost may seem higher when compared to traditional flight training, recognize that you'll be gaining a tremendous amount of new knowledge in a relatively short time. The techniques learned will improve your other flying skills immeasurably and likely could save your life someday (Stowell, 2002).

The cost of obtaining the aerobatic training itself reflects only a part of the entire economic burden on the affected pilots. Travel time and expense to get to the training facility and other expenses will vary greatly for each customer. However, considering that persons training to become commercial pilots have already invested large amounts of money in their education, the added burden of this aerobatic training and all added expenses remains quite small, comparatively. The average cost of training for a commercial pilot certificate ranges from $25,000 to $37,200 (2002 dollars), depending on the curriculum. Aerobatic training at $200 per hour for three hours, for example, costs $600 dollars. [At present there is no data available on how much aerobatic training is required to train a pilot to proficiency. More research needs to be done in this area.] Add on ancillary expenses and a liberal estimate of $1000 dollars results. This $1000 dollars increases the total cost of a commercial pilot's training expenses by only three percent.

Will this increase in cost increase aviation safety significantly? Unfortunately, measuring aviation safety is quite difficult. Accident data, for example, is a poor measure of aviation safety because accidents and fatality rates themselves have no predictive powers (Wells, 1997). Other data measuring risk exposure can have similar problems due to lack of a common denominator. Thus, a way to justify a 3% (or more) cost increase in flight training for U.S. commercial pilot applicants must be determined using some other method.

METHODOLOGY

INTRODUCTION

The question addressed is: "To what extent would the current pilot population embrace required aerobatic training for commercial pilot certification?" A survey having both qualitative and quantitative measures was used to gather data related to the research question. Several statistical tools were then used to determine demographics, to measure the reliability of the survey, to analyze the results, and finally to correlate the results with the research question.

POPULATION

The population this study is relevant to includes all US commercial pilots and airline transport pilots (airline transport pilots must previously have obtained a commercial pilot certificate). Private pilots are not included in the study because of their generally lower level of aeronautical experience. Commercial pilots are assumed to be more aware of their own flying abilities, due to the requisite aeronautical experience. Thus, the commercial pilots' attitudes would be more reliable than lower time pilots' attitudes, although the results would benefit the entire pilot population.

SAMPLE

The sample included 31 civilian commercial pilots, military-trained commercial pilots, and instructor pilots (instructor pilots are required to be commercial pilots). The minimum criterion for participation was a commercial pilot license because only commercial pilots can operate aircraft engaged in operations for compensation. Thus, they have greater responsibility than a pilot flying solely for pleasure. Also, since commercial pilots have a minimum of 250 hours of flight time, they are more aware of their own flying abilities than a lower time non-commercial pilot.

INSTRUMENT

A Likert scaled survey with forced response items (no neutral choice) was given to a convenience sample. The survey addressed the subjects' attitudes on eight quantitative measures, and two open response qualitative response questions. Descriptive quantitative statistics and qualitative analysis allows more thorough analysis of the data (Sirkin, 1999). A more robust measure is accomplished by using both quantitative and qualitative instruments (Wiggens & Stevens, 1999).

DATA COLLECTION METHODS

The principal investigator distributed the survey to participants over a four-week period at airports around the Midwest. Participant selection was random, performed by asking anonymous pilots if they were commercial pilots and, if they were, requesting their participation in the survey.

Pilots at airports are not necessarily geographically fixed samples. They can be from all around the U.S., having flown in to a specific airport for many different reasons. There are generally a variety of commercial operations represented as well, from airline pilot to agricultural pilot to instructor pilot.

The pilots were given the surveys and completed them in a quiet, private place so as to minimize distractions. The investigator left the room during the survey administration to minimize influencing the subject.

PROTECTION OF HUMAN SUBJECTS

An Institutional Review Board first approved the survey. The surveys were totally anonymous, so there was no anticipated risk to the subjects or their aviation careers. The subjects had the option of keeping the information sheet attached to the survey (see appendix) to reference if they had any future questions regarding the survey or the data resulting from it. A subject's participation in the survey assumed the subject's consent.

The surveys and records will be stored in the principal investigator's locked filing cabinet for three years (starting February 15, 2003), and at the end of that period destroyed by shredding. The principal investigator was the only researcher involved in the project.

INSTRUMENT RELIABILITY AND VALIDITY

An initial pilot study conducted on the survey indicated reliability and validity over a widely diverse test group of industry experts: a minimum time 250 hour commercial pilot, a 1,500 hour instructor pilot, a 3,000 hour military fighter pilot, and a 15,000 hour airline pilot all successfully interpreted the survey's intent and predicted the scores of other pilot study participants based on their flight experience.

A convenience sample of 31 commercial pilots was used to gather the necessary data. Since the research is preliminary—only determining if aerobatic training would be beneficial to the safety of the aviation industry—and does not address how much, what type, etc. of the training, a small sample representing all commercial pilot occupations seemed appropriate.

For the purpose of this study, significance levels of P<.05 and alpha levels of >0.7 are considered significant and reliable, respectively. These levels are appropriate for an attitudinal survey (Sirkin, 1999).

A Cronbach's Alpha internal reliability test was performed on the survey instrument, yielding an alpha value of .996. This strong value, obtained using a relatively small sample size, indicates that the instrument is indeed satisfactory.

QUANTITATIVE DATA ANALYSIS

After preliminary data analysis, the decision was made to separate the responses into three separate groups: Those pilots with no aerobatic experience; those with less than ten hours of aerobatic experience; and those with more than ten hours of aerobatic experience. (See Table 1 for more demographic details). An Independent Sample Analysis of Variance (ANOVA) was performed on the data, yielding a significance level of P<.001 (see tables 2 and 3). Further, a Tukey Honestly Significant Difference (HSD) test was performed to compare the individual groups' significance levels (see Table 4). Finally, a Pearson Product Moment Correlation (Pearson's r) was performed to determine the correlation of pilot's individual mean confidence index with their aerobatic experience (see Table 5) .

Table 1
Demographics of Pilot Groups

Group	Mean Flight Hours	Mean Aerobatic Hours	Mean Confidence Score*
0 hours of Aerobatic Experience	865	0	2.46
Less than 10 hours of Aerobatic Experience	523	3.9	3.05
Greater than 10 hours of Aerobatic Experience	7,206	134	3.50

*Scores closer to 4.00 indicate greater confidence values

Table one breaks down the responses into three groups: those with zero hours of aerobatic experience, those with less than ten hours of aerobatic experience, and those with more than ten hours of aerobatic experience. The mean flight hours, aerobatic hours and confidence score are then given for each group. The mean confidence score was calculated by computing the mean of each survey's raw score, separated by group (see table 2).

Table 2
<u>Data Summary for Analysis of Variance (ANOVA) Calculation</u>

	0 hours aerobatic experience	Less than 10 hours aerobatic experience	Greater than 10 hours aerobatic experience	Total
N	12	11	8	31
Sum of X	29.5764	33.5995	28	64
Mean of X	2.4647	3.0545	3.5	2.0645
Sum of X^2	78.9375	43.8438	19.375	142.1563
Variance of X	0.1288	0.18121	0.1964	0.3342
Std.Deviation of X	0.3589	0.4267	0.4432	.05781
Std. Error of X	0.1036	0.1287	0.1567	0.1038

Table two describes the various measurements of the confidence scores. The groups are segregated by the number of aerobatic hours as before. N is the number of surveys in each group. X is the confidence value, which was obtained by summation of each survey's total score from the Likert scale.

Table 3
<u>Analysis of Variance (ANOVA) Results</u>

	SS	df	MS	F	P
Treatment (between groups)	5.41	2	2.71	16.94	<.0001
Error	4.61	28	0.16		
Total	10.03	30			

Table three shows the values used in calculating the One-Way Analysis of Variance on the confidence values of the groups from table two. The obtained value of P is shown to be less than .0001.

Table 4
<u>Tukey Honestly Significant Difference (HSD) Results</u>

M1 vs. M2 P<.05 M1 vs. M3 P<.01 M2 vs. M3 P<.01	M1 = mean of Group 1 M2 = mean of Group 2 M3 = mean of Group 3.
	HSD = the absolute difference between any two sample means required for significance at the designated level (.05 in this case).

Table four takes the ANOVA one step further, testing the significance between each group rather than all three groups together. Each group is significantly different from each other group, with a P value of less than .05 in all cases.

Table 5

Pearson Product Moment Correlation Coefficient (Pearson's r)

	X*	Y**
N	31	31
Mean	36.0645	2.9355
Variance	5436.379	0.3467
Std. Dev.	73.7318	0.5888
Std. Error	13.2426	0.1058
-------------	-------------	-------------
r	.5544	
r^2	.3074	
Slope	.0044	
Y-intercept	2.7768	
Std. Error of Estimate	.4984	
t	3.59	
df	29	
P (1-tailed)	.000601	
P (2-tailed)	.001202	

*X represents data related to aerobatic hours

**Y represents individual survey confidence values (values closer to 4.00 indicate greater confidence levels.

Table five shows the Pearson's r value of .5544 with a P (2-tailed) value of .001, where X represents aerobatic hours and Y represents individual confidence values. Confidence values should approach 4.00 as aerobatic hours increase.

QUALITATIVE DATA ANALYSIS

A Grounded Theory analysis (Glaser & Strauss, 1967) was performed on the qualitative response items. 20 subjects of the 31 total elected to complete the qualitative response items. The data for the qualitative analysis was separated into three groups in the same manner as the quantitative data (pilots without aerobatic experience, pilots with less than ten hours of aerobatic experience, and pilots with greater than ten hours of aerobatic experience).

The results from thematic coding of the qualitative data are summarized below:

1. Pilots with zero aerobatic experience expressed increased confidence levels and a reduction in trepidation as a possible result of aerobatic training.
2. Pilots with less than 10 hours of aerobatic experience noted the differences between theory and simulation (talking about versus actually performing aerobatics), reducing trepidation, and increasing confidence levels all as a result of aerobatic training.
3. Pilots with more than 10 hours of aerobatic training mentioned only the increase in confidence levels as a result of aerobatic training.
4. Two respondents (10% of the sample) mentioned that not all pilots want to engage in aerobatic training, due to various reasons (motion sickness, fear, etc.)
5. Of the 20 qualitative respondents, 50% of them indicated aerobatic training would or has increased their confidence level. This supports the notion that aerobatic experience increases pilot confidence levels.

DISCUSSION

The purpose of this study was to determine if the U.S. pilot population would embrace mandatory aerobatic training for the issuance of a commercial pilot license. No such training is required of the civilian pilot population presently, and the sources mentioned herein suggest that aerobatic training would be beneficial to pilot skills and decision making processes.

Since the majority of the present U.S. civilian pilot population receives no aerobatic training, the hypothesis is that if the next generation of commercial pilots received aerobatic training, some difference in industry safety statistics would exist. The extent of the effect on industry safety was not addressed in this study.

Using a survey designed to measure quantitative and qualitative attitudinal data on a 4-item forced-response Likert scale, the investigator measured the correlation of pilots' aerobatic experience with their confidence levels. Also measured were open-response items addressing comments or concerns voiced by the subjects. Cronbach's alpha test was performed to determine the reliability of the survey. With that, the subjects were divided into three groups according to their aerobatic experience, and an independent sample ANOVA was used to calculate the differences of the mean confidence levels between the groups. Further, the Tukey HSD test was used to test the individual group means with each other. Glasier and Strauss' Grounded Theory Analysis was used to measure the qualitative data.

CONCLUSION

The findings of both the quantitative and qualitative analyses support the hypothesis that pilots would be in favor of mandatory aerobatic training for the issuance of a US commercial pilot's license. The participants all indicated that aerobatic training would or has made them safer pilots, in addition to generally increasing their overall confidence levels.

There was a significant correlation between the number of aerobatic hours a pilot has and his or her confidence level, with more aerobatic hours correlating with greater confidence levels. Thus, the current commercial pilot population in the US would embrace mandatory aerobatic training, and believes such training would improve the aviation industry's safety record.

Although no attempt was made to determine the amount or type of aerobatic training for the proposed mandatory training, the survey data indicated a significant difference in confidence levels between those with no aerobatic training and those with 1 to 10 hours of aerobatic experience. A significant difference also exists between the group with 1 to 10 hours of aerobatic experience and the group with more than 10 hours of aerobatic experience. However, in the group with more than 10 hours of aerobatic experience, the smallest amount of aerobatic training had 25 hours of aerobatic experience. Thus, even though a significant difference exists between the groups, the number of hours where confidence levels become significantly greater is unclear. It appears to be somewhere between 10 and 25 hours, but more research needs to be done in this area to make a strong determination.

REFERENCES

ASA-02-FR-AM-BK. (2002). *Far/Aim 2002.* U.S. Department of Transportation: From Title 14 of the Code of Federal Regulations (14CFR). Newcastle: Aviation Supplies & Academics, Inc.

Avweb Group [On-line] (2002). Question of the Week. Available: http://www.avweb.com/newswire/8_49b/qotw/181824-1.html

Cole, D.. (1976). *Roll Around a Point.* Milwaukee: Ken Cook Company.

Cole, D.. (1970). *Conquest of Lines and Symmetry.* Milwaukee: Ken Cook Transnational.

DeLacerda, F. (2001). *Peak Performance for Aerobatics*. Ames: Iowa State University Press.

FAA-H-8083-9 (1999). *Aviation Instructor's Handbook*. U.S. Department of Transportation. Oklahoma City: Federal Aviation Administration.

Glaser, B. G, and Strauss, A. L. (1967). *The Discovery of Grounded Theory; Strategies for Qualitative Research.* Chicago: Aldine Publishing Co.

Goeters, K-M. (1998). *Aviation Psychology: A science and a Profession.* Brookfield: Ashgate Publishing Limited.

International Aerobatic Club [On-line] (2002). Available: http://www.iac.org

Jeppesen Sanderson, Inc (1998). *Private Pilot Manual.* Printed in Canada.

Kershner, W.. (1985).*The Flight Instructor's Manual, 2nd Edition*. Ames: Iowa State University Press.

Machado, R.. (2002, January 4). Today's Pilots Lack Basic Stick-and-Rudder Skills. *GA News,* 28.

Medore, Lt. Col. A., USAFR. (No date available). *Primary Aerobatic Flight Training with Military Techniques*. (No city available):Aviation Book Company.

Millbrooke, A.. (1999). *Aviation History*. Englewood, Co: Jeppeson Sanderson.

National Transportation Safety Board. (2003). *Aviation Accident Database.* [On-Line]. Available: http://www.ntsb.gov (2003, March 3).

Sirkin, R. M.. (1999). *Statistics for the Social Sciences, 2nd edition*. California: Sage Publications, Inc.

Stowell, R..(1996). *Emergncy Maneuvers Training*. Ventura: Rich Stowell Consulting.

Stowell, R. (2002). How to Shop for Quality Aerobatic Training. [On-line]. Available: http://www.richstowell.com/howto.html. (2002, November 15).

Telfer, R. & Biggs, J. (1988). *The Psychology of Flight Training*. Ames: Iowa State University Press.

U.S. Dept. of Transportation, Federal Aviation Administration. FAA-S-8081-12A. (1997). *Commercial Pilot for Airplane Single and Multiengine Land Practical Test Standards*. Newcastle: Aviation Supplies & Academics, Inc.

Wells, A. (1997). *Commercial Aviation Safety, Second Edition.* New York: Mcgraw- Hill.Wiggens, Mark, & Stevens, Catherine (1999). Aviation Social Science: Research Methods in Practice. Brookfield, Vermont: Ashgate Publishing Company