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The *Journal of Air Transportation (JAT)* mission is to provide the global community immediate key resource information in all areas of air transportation. Our goal is to be recognized as the preeminent scholarly journal in the aeronautical aspects of transportation. As an international and interdisciplinary journal, the *JAT* provides a forum for peer-reviewed articles in all areas of aviation and space transportation research, policy, theory, case study, practice, and issues. While maintaining a broad scope, a key focal point of the journal is in the area of aviation administration and policy.

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- Other areas of air and space transportation research, policy, theory, case study, practice, and issues

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Brent D. Bowen

Dr. Brent Bowen is Director and Distinguished Professor, Aviation Institute, School of Public Administration, University of Nebraska at Omaha, and the University's Director of Aviation and Transportation Policy and Research. Bowen attained his doctorate in Higher Education and Aviation from Oklahoma State University and a Master of Business Administration degree from Oklahoma City University. His Federal Aviation Administration certifications include Airline Transport Pilot, Certified Flight Instructor (Gold Seal), Advanced Instrument Ground Instructor, Aviation Safety Counselor, and Aerospace Education Counselor. Dr. Bowen's research on the development of the national Airline Quality Rating is regularly featured in numerous national and international media, as well as refereed academic publications. Dr. Bowen has in excess of 250 publications, papers, and program appearances to his credit. His research interests focus on aviation applications of public productivity enhancement and marketing in the areas of service quality evaluation, forecasting, and student recruitment/retention in collegiate aviation programs. He is also well published in areas related to effective teaching and has pioneered new pedagogical techniques. Dr. Bowen has been recognized with awards of achievement and commendation from the American Marketing Association, American Institute of Aeronautics and Astronautics, Federal Aviation Administration, Embry-Riddle Aeronautical University, W. Frank Barton School of Business, Travel and Transportation Research Association, World Aerospace Education Association, and others.

Igor Kabashkin

Dr. Igor Kabashkin is Vice Rector of the Transport and Telecommunications Institute, Latvia, and a Professor in the Aviation Maintenance Department and member of the Technical Committee on Transport of the European Commission for Cooperation in the Field of Scientific and Technical Research. Kabashkin received his Doctor Degree in Aviation from Moscow Civil Engineering Institute, a High Doctor Degree in Aviation from Moscow Aviation Institute, and a Doctor Habilitus Degree in Engineering from Riga Aviation University and Latvian Academy of Science. His research interests include analysis and modeling of complex technical systems, information technology applications, reliability of technical systems, radio and telecommunication systems, and information and quality control systems. Dr. Kabashkin has published over 274 scientific papers, 19 scientific and teaching books, and holds 67 patents and certificates of invention.

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ENTITY-CENTRIC ABSTRACTION AND MODELING FRAMEWORK FOR TRANSPORTATION ARCHITECTURES

Jung-Ho Lewe
Georgia Institute of Technology
Atlanta, Georgia

Daniel A. DeLaurentis
Purdue University
West Lafayette, Indiana

Dimitri N. Mavris
Georgia Institute of Technology
Atlanta, Georgia

Daniel P. Schrage
Georgia Institute of Technology
Atlanta, Georgia

ABSTRACT

A comprehensive framework for representing transportation architectures is presented. After discussing a series of preceding perspectives and formulations, the intellectual underpinning of the novel framework using an entity-centric abstraction of transportation is described. The entities include endogenous and exogenous factors and functional expressions are offered that relate these and their evolution. The end result is a Transportation Architecture Field which permits analysis of future concepts under the holistic perspective. A simulation model which stems from the framework is presented and exercised producing results which quantify improvements in air transportation due to advanced aircraft technologies. Finally, a modeling hypothesis and its accompanying criteria are proposed to test further use of the framework for evaluating new transportation solutions.

Jung-Ho Lewe is a member of the research faculty with the Aerospace Systems Design Laboratory (ASDL), School of Aerospace Engineering, Georgia Institute of Technology. He earned his B.S. and Ph.D. from the Seoul National University and the Georgia Institute of Technology, respectively.

INTRODUCTION

The U.S. transportation system witnessed unprecedented growth in the 20th century. In particular, since the 1960s, the modern aircraft—just like its predecessors, trains and automobiles in their times—has dramatically boosted mobility of the general public. As indicated in Figure 1, the air transportation system picked up momentum after Lindberg's transatlantic flight and yearly domestic enplanements have continued to outnumber the population since 1976, and the spread is expanding.

Figure 1. Yearly Domestic Enplanements and Population by Year
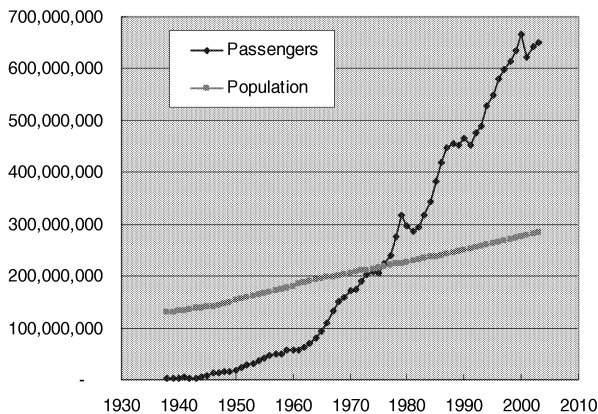
Note. **Source: US Census Bureau, Bureau of Transportation Statistics**

Daniel DeLaurentis is now an assistant professor at School of Aeronautics and Astronautics, Purdue University. He was with the ASDL when most of the research work for this paper was conducted. He received his B.S from the Florida Institute of Technology and his Ph.D. from the Georgia Institute of Technology.

Dimitri Mavris is a professor and the director of the ASDL, School of Aerospace Engineering, Georgia Institute of Technology. He is also a Boeing Professor for Advanced Aerospace Systems Analysis. He earned his B.S., M.S. and Ph.D. from the Georgia Institute of Technology.

Daniel Schrage is a professor and the director of the Center for Aerospace Systems Engineering (CASE), School of Aerospace Engineering, Georgia Institute of Technology. He received his B.S., M.S., M.B.A., and Ph.D. from the United States Military Academy at West Point, the Georgia Institute of Technology, the Webster University, and the Washington University, respectively.

With further enhancement in mobility, the public could spend less time on travel over a given distance, take longer trips in a given time, and/or travel in ways otherwise not currently possible or affordable. Such a positive scenario, however, is in jeopardy as the rate of expansion of mobility under the current transportation system is reaching a limit on the ground and especially in the air due to (partly unforeseen) growth in congestion, pollution and network delay (AIA, 2001). The aerospace community is undertaking various remedies in the face of this challenge including design of new commercial jets (e.g., Airbus A380 and Boeing 787), enhancement of capacity in both the airspace and terminal area, and development of environment-friendly technologies. Further, targeted research extends to general aviation, where some are experimenting with new types of aircraft and advanced operational structures (e.g., very light jets, on-demand regional air services, and even personal use air vehicles; Holmes, Durham, & Tarry, 2004). The premise motivating most of these initiatives is apparent: advanced technology spurs mobility enhancement. The temptation to look for innovation through technology alone, however, must be resisted. Systems thinking is required, as recognized in NASA's Aeronautics Blueprint: "The aviation system is a *system-of-systems*. . . . Furthermore, consideration must be given to the intermodal relationships within larger transportation systems (land and sea). These analyses require the construction of *complex, intricate and comprehensive system models*" (NASA, 2002).

If the system-of-systems premise is adopted, then the *design space* in which solutions may be found is much more open. Infusion of new technology into the existing infrastructure organization is but one possibility; a reorganization of how new, improved and existing systems interoperate is also an alternative. However, existing analysis methodologies and tools, developed for systems, can only bring us so far, and thus new approaches are required to fully examine new solution sets. Further, the system-of-systems perspective expands the problem boundary to fully include areas such as policy and economics—public and private interest groups must be examined together along with the networks that connect them. Altogether, creating complex, intricate and comprehensive models requires first a new holistic framework so that problems within systems domains can be properly formulated and then solved by designers of aircraft, airspace and so forth. At the same time, results that flow from the system-of-systems framework must be concrete and actionable, targeted at identifying the research and development necessary to realize the most attractive transportation futures.

In sum, the pursuit of a desired, future national transportation system and a full comprehension of the preferred paths to guide this pursuit together represent a tremendous challenge, one that surely requires the wisdom and innovation of many. The essential ingredients at the start, however, are clear: effective frames of reference, thought processes and problem formulations. It

is from this motivation that the present paper is written. The authors attempt to lay out a novel paradigm to address the challenge, starting from the idea that existing approaches are incomplete for the job is neither entirely new nor exclusive observations of the authors. Hence, the first part of this paper summarizes relevant research works indicative of the aerospace engineers' perspective, which then motivated the development of a broader intellectual construct. The second part formulates the transportation architecture and expresses the entities and their interaction dynamics in a generic, comprehensive manner. The final section presents initial results achieved through simulation and hypothesis of a more complete approach. The overall aim is to foster a generic, conceptual framework for the examination of air transportation architectures in the context of a larger National Transportation System (NTS), allowing problems to be recast so that today's designers can contemplate the future without preconceived boundaries.

BACKGROUND AND EXPLORATORY RESEARCH

Vehicle concept analysis

The design of advanced air vehicles was the initial research interest of the authors, especially focused on a new generation of small, general aviation craft after the inauguration of a focused project at NASA, the Personal Air Vehicle Exploration (PAVE) project (NASA, 2004). The major undertaking of the research was not to invent the latest in a line of futuristic airplanes or flying cars, as many enthusiasts have been attempting almost immediately since the beginning of flight (Bowers, 1990). Instead, the project focused on formation of complete baseline models for a family of air vehicles in order to calculate possible improvements of each through new technology infusion. Hence, six baseline Personal Air Vehicle (PAV) concepts were selected, ranging in configuration from an autogiro to a very light jet airplane, and their performance and economics were analyzed. The study process employed was composed of four major steps: (a) calibration of sizing codes for the baseline concept, (b) re-sizing of the baselines for the new PAV mission profiles, (c) update to state-of-the art models through technology infusion, and (d) a final sizing/performance study (Mavris & DeLaurentis, 2002). An example result from this process is shown in Figure 2, where the gross weight and direct operation cost metrics for baseline and state-of-art versions of a 1-to-8 seat autogiro are presented.

Figure 2. [Top] Six Baseline Concepts Studied (clockwise from upper-left). Cartercopter Gyroplane, Lancair Columbia 400, Groen Bros. Hawk 4 Autogiro, Robinson R-44, Eclipse 400 VLJ, and Boeing Dual-mode Rotorcraft Concept. [Bottom] Payload and Technology Sensitivities for an Autogiro Concept Aircraft
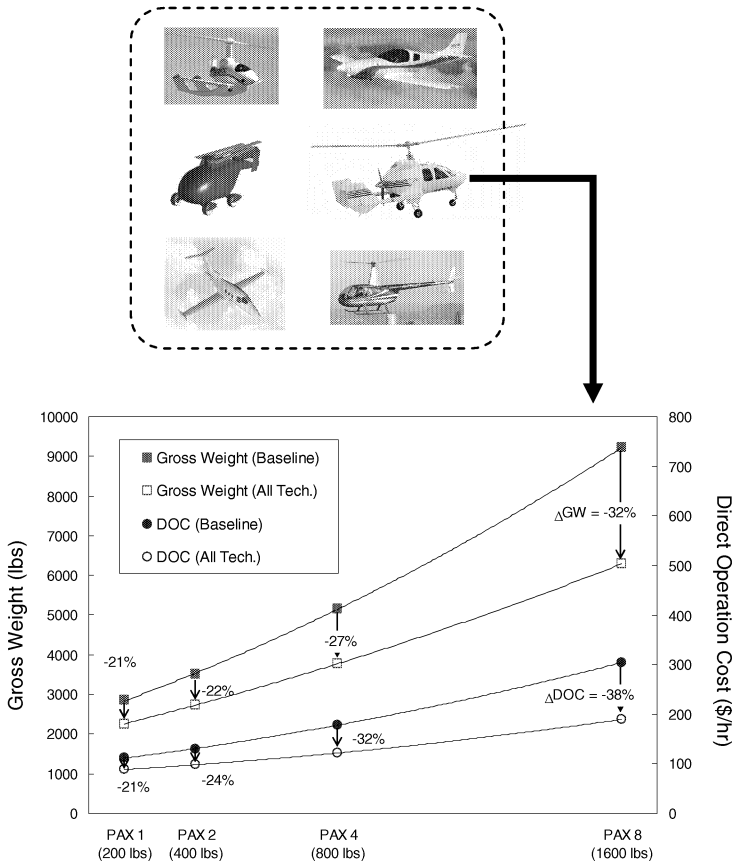
While the capability envelope for each advanced technology configuration was established from the studies, what remained elusive was how to rank relative merit across all baseline platforms. For consideration of alternatives within a configuration class, the traditional approach in concept evaluation defines a scalar metric which measures the quality of each alternative, m_{perf}. When multiple objectives are involved (vector $\overline{m}_{perf}$), and a design tradeoff is required, Multi-Attribute Decision Making techniques are employed in the evaluation process to investigate a set of candidate designs. The result is a functional relation between the performance metrics and the

set of vehicle configuration, $\overline{x}_{veh}$ (e.g., aspect ratio, wing area, thrust-to-weight ratio) and technology, $\overline{x}_{tech}$ (e.g., advanced flow control, thrust-vectoring) design variables, Equation 1.

$$\overline{m}_{perf} = f(\overline{x}_{veh}, \overline{x}_{tech}) \qquad (1)$$

These scoring approaches generally require the use of physics-based codes to evaluate the function, which implies that the evaluation process can be performed within a specific vehicle platform, not across a wide variety of different platforms, let alone revolutionary concept vehicles. Even if there exists a universal physics-based code that can simultaneously evaluate a wide variety of PAV concepts, a designer would still face the *incommensurability* issue—a certain metric is only meaningful within the same family of vehicles. For example, time-in-hover capability has no meaning for a fixed-wing vehicle.

Transition from vehicle to mobility

Redress of the incommensurability issue was found in the concept of mobility as metric. Indeed mobility, defined as the ability to travel from *doorstep-to-destination* (D-D), captures the inherent intent in the pursuit of superior aircraft while also explicitly representing the reality of the traveler in his/her trip. A recent study by the Volpe Center on comparative travel times across a range of commercial air trip types demonstrated the importance of understanding reality in a D-D mobility context. The data displayed in Figure 3 is for connecting service in the 500-999 mile range and shows that about half of the time spent on such trips occurs *outside* of the aircraft.

Figure 3. Distribution of total time (337 minutes) for Air Trips
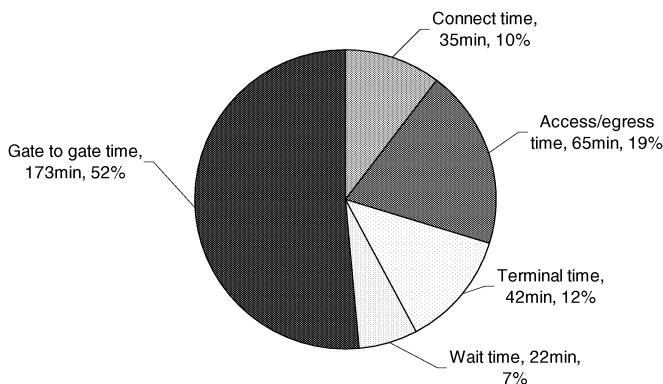
Thus, the study of advanced air vehicles in this context had its emphasis on reducing D-D trip time, not simply gate-to-gate and spawned the Benefit Exploration Tool (BET) considering an origin-destination trip network with portals. The tool enables a user to construct any multimodal transportation means through synthesis of a set of vehicle metrics, $\overline{m}_{perf}$ (e.g., speed and refueling range), and infrastructure characteristics (e.g., portal wait/transition time, *TWAIT*, and access distance). It then compares D-D time on a user-selected mission range. The BET interface is shown in Figure 4, where the panel on the top is used to change trip options while the slider bar below the bar chart modifies the mission range (and the D-D time comparison bar chart is updated in real time).

Figure 4. D-D Travel Time Visualization using BET
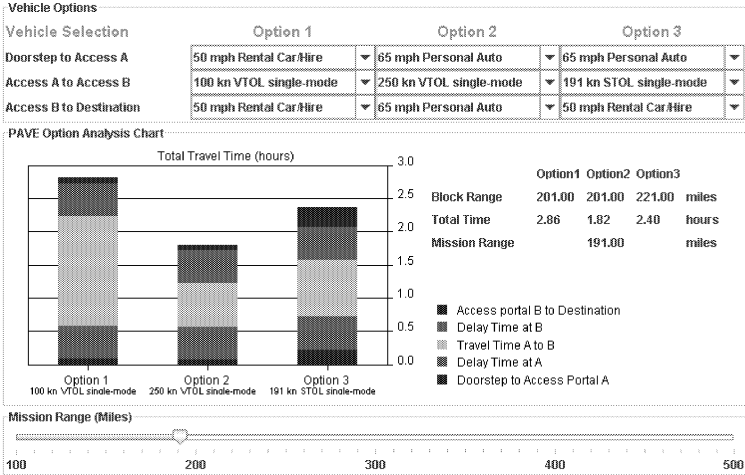
The BET laid the foundation for the study of mission (trip) parameters and vehicle performance metrics simultaneously, encapsulated in the Benefits Visualization Tool. This tool also emphasizes D-D time within a PAV concept investigation process with the addition of a net-present value (NPV) analysis, based on the premise that travel time saving over time is converted to monetary profit to a specific user. This user is designated as λ, and the set of trips he/she takes is θ of which element is μ. Summarizing, the set of user mobility metrics $\overline{m}_{mob}$ (e.g., average travel time) result from a function (g) of trips taken and the mode performance over those trips, Equation 2,

$$\overline{m}_{mob} = \sum_{\mu \in \theta(\lambda)} g(\mu) \circ f(\overline{x}) = \sum_{\mu \in \theta(\lambda)} g(\mu, \overline{m}_{perf}) \qquad (2)$$

where $\overline{x} = [\overline{x}_{veh}, \overline{x}_{tech}]^t$. Hence the amount of the hypothetical benefit from a prescribed PAV utilization pattern can be quickly computed and visualized. For this purpose, a trade-space analysis was developed, underpinned by the *Unified Trade-off Environment* (Mavris & DeLaurentis, 2000), through specialized *solution space* diagrams as illustrated in Figure 5. In this example, one element of $\overline{m}_{mob}$, the NPV after a certain time period, is examined. The detailed process was demonstrated by DeLaurentis, Kang & Lim (2004).

Figure 5. Mobility Solution Space Diagram. Constraint Boundary is Line of Constant NPV=0 after 5 years. A Shift of the Design Point X to Feasibility is Accomplished by a Small Increase in Cruise Velocity (*V*) and Modest Decreases in *TWAIT* and *DOC*. The BVT Illuminates the Fact that Increasing *V* Alone Cannot Achieve the Goal.
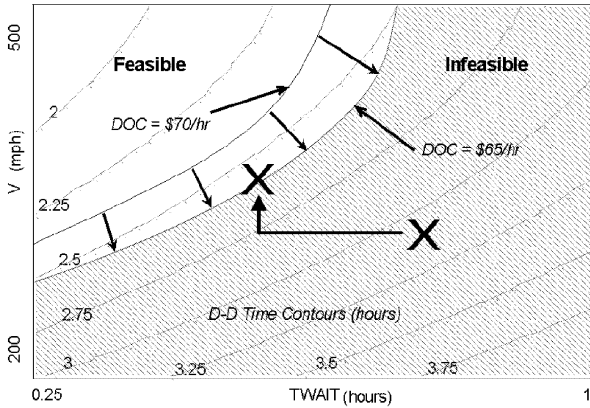
This line of research under the mobility theme resolved the incommensurability issue with some limitations: that is, a particular user and utilization pattern must be specified. Recognizing that utility differs among consumers, there is a need to characterize personal mobility solutions in the context of mode choice and the value of time. This focus has been addressed in the literature several times, dating to the early 1970s (Drake, Kenyon & Galloway, 1969; NASA, 1971; Winich, 1983). For example, Drake, Kenyon and Galloway (1969) focused on mapping preferred modes on the utility space defined by value of time and distance. More recently, Downen & Hansman (2003) performed a web-based survey of active general aviation (GA) pilots and then developed a mode choice model.

Figure 6. Market Space Plot for Choice Transportation Modes

(a) Drake et al. (1969)

(b) Downen and Hansman (2003)
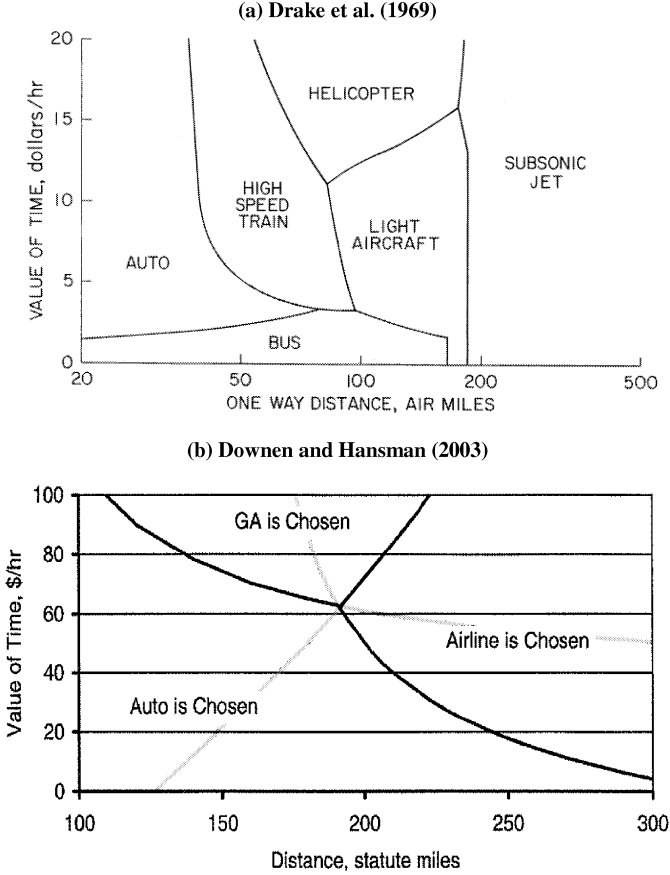
Mathematically, the models underlying the results in Figure 6 are expansions of Equation 2, introducing the parameter Ω and function $h(\Omega)$ to represent performance of other-than-air mode. Also, we can now express mobility summed over a class of users, their trips, and modes used, Equation 3.

$$\overline{M}_{mob} = \sum_{\lambda} \sum_{\mu \in \theta(\lambda)} h(\Omega) \circ g(\mu) \circ f(\overline{x}) \qquad (3)$$

Stakeholder dynamics as mobility drivers

While the mobility-focused research includes the travelers explicitly into the concept evaluation loop, it is only the tip of the iceberg. In fact, there is a

multitude of players involved, individuals and organizations that have a stake in what transpires. Further, they generate a dynamic behavior: as travelers' preference changes over time, the response of service providers shifts, and subsequent actions of vehicle manufacturers occur to meet new needs of service providers, etc.

Several threads of work that explore these stakeholder dynamics in air transportation have been ongoing. For example, Bhadra et al. have developed a means to estimate future air transportation timetables, which represent in an aggregate way future traveler demand based on historical trends as well as supplied assumptions (Bhadra, Gentry, Hogan & Wells, 2005). Additionally, other researchers at MITRE have investigated service provider stakeholder's dynamic through an agent-based simulation called Jet:Wise (Niedringhaus, 2004). Taking airline companies and leisure passengers as agents, the model attempts to explore the evolution of the airline industry within the National Airspace System (NAS). In each cycle of simulation, airline agents make successive decisions to achieve their respective goals. The work by Hansman (2005) generated conceptual ideas for a model of dynamic behavior in air transportation based on careful analysis of the historical data and a particular examination of information technology across all organizations in the system. Likewise, Kang, Lim, DeLaurentis & Mavris (2003) considered dynamic interaction between manufacturers and research agencies in the new mobility resource development cycle and attempts to identify promising operational policies. This Systems Dynamics (Sterman, 2003) approach was an initial foray into the world of feedback dynamics known to exist in real transportation markets and a first step in search for a synthetic view. All together, though, each of these experiences in the realm of stakeholder dynamics are not yet enough to obtain meaningful results within the system-of-systems space, specifically geared towards the overall D-D mobility issue. Further development and investigation is necessary.

In summary of this section, beginning from the traditional starting point of vehicle design, a set of improved perspectives (and tools) for exploring new transportation solutions has evolved. Yet, the comprehensive model for the problem as it is, a system-of-systems, remains illusive. Pieces of the puzzle are at hand, but the complete puzzle as a whole is not apparent nor is the dynamics which define its evolution. More specifically, the analysis and design tools do not represent all of the design degrees of freedom, including physical resources, organizational entities, and the inter- and intra-connected networks that tie them together. The remainder of this paper describes the new advancement in response to this intellectual need, through abstraction and hypothesis of a solution methodology. The start is the formulation of a generic transportation architecture.

GENERIC TRANSPORTATION ARCHITECTURE AND ITS ABSTRACTION

An architect is concerned with overall patterns of form and function and therefore must think using a holistic perspective. We embrace the holistic perspective by adopting the *everything-on-the-table* thinking about the future evolution of transportation. However, the immediate question is raised: What is everything? To answer, an examination of what constitutes the NTS, generally, is the first step. Subsequently, the concept of *Transportation Architecture* can be articulated and then analyzed properly.

Constitution of the NTS

Transportation resources

As mentioned, the usual focus for improvements in the NTS has historically been on vehicles and their infrastructure, and later their operation in the NAS. These are called transportation resources altogether. Transportation resources in the NTS comprise many heterogeneous types of vehicles and corresponding infrastructure. Traditionally, resources within a general category have been treated in their own realm. However, improvement in mobility will demand an integration of these now distinct dimensions. Consequently, a view that encompasses all resources in the NTS together is useful, as shown in Figure 7 where a hypothetical new mobility resource is positioned without linking to any existing system toward the center of the figure. Exploring a new mobility resource in this larger context can reveal its competitive advantage relative to existing resources.

Figure 7. NTS Resource Hierarchy
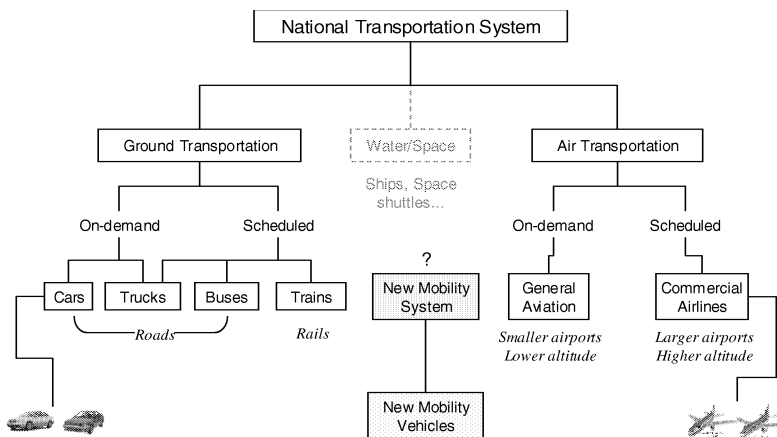
Transportation stakeholders

The mobility perspective included the travelers, or the transportation consumers, in the research scope and the dynamic organizations thrust sought to extend this further. Though the travelers and vehicle operators are not shown in Figure 7 (they are not resources, but users of resources), they are important nonetheless. Any individual or organizational entity has its own will, a sentience, which guides actions that affect the NTS. These entities are called the transportation stakeholders. The relevant stakeholders are identified in Table 1, representing both private and public sectors, ranging from the actual consumers of transportation services to those involved in technology *research and development*.

Table 1. Transportation Stakeholders

Stakeholders		Descriptions	Objectives
Public	Consumers	Individual travelers or shippers (for commercial goods) that are the end user for the transportation system.	max. utility as fcn (time, cost, safety, comfort)
	Society	Represents the aggregated interests of citizens, from research agencies, to communities, to the national level.	min. noise, emission max. quality of life
Industry	Service Providers	Own/operate resources and sell transportation services to consumers.	max. profit, market share
	Manufacturers	Design/produce/sell transportation resources to service providers and/or consumers.	max. profit, market share
	Insurance Companies	Provide protections against mishap operation of transportation resources by collecting insurance fee.	max. profit, market share
Government (Policy-makers)	Regulatory Agencies	Impose rules on the system that restrict stakeholder activity and resource characteristics.	max. safety, security
	Infrastructure Providers	Plan and approve employment and enhancement of infrastructure resources.	max. capacity, min. delay
Indirect Stakeholders	Media	Report information, forecast and plan from/to the public.	Varied, but vague
	Research Agencies	Develop and provide transportation related technologies.	Provide firm foundation for transportation development

Each stakeholder has objectives that dictate the manner in which they influence the transportation architecture. Indirect stakeholders influence the

NTS by their outputs or goals being accepted or filtered by other direct stakeholders. An intangible network that defines the connection between stakeholders can be imagined. This connectedness comes in two forms. First, one particular stakeholder may interact with another directly. Second, if a stakeholder influences a particular resource, after permeating through the resource network, the state of the transportation architecture will be modified.

Besides stakeholders and resources, many other influences that are traditionally treated merely as given assumptions, circumstances and constraints can be juxtaposed within the transportation environment. These are introduced next.

Transportation drivers

In a market-driven world, most transportation phenomena are governed by many economic factors. Household income and gasoline/ticket prices drive consumer behavior while demographic-related issues (e.g., population shifts, urbanization) and commodity prices influence businesses. Further, transportation activities are motivated by cultural and psychological reasons. Some trips are made as a lifestyle choice and are influenced by specific cultural events: summer vacation, Thanksgiving, etc. Psychological factors are also important. The surge in air travel after Lindbergh's successful transatlantic crossing is a prime example. These factors are called drivers (Table 2) and are largely concerned with economic, societal and psychological circumstances that influence the stakeholder network. With perturbation in any of the drivers, each stakeholder seeks to adapt to the changed circumstances, which brings fundamental reconfiguration of the transportation architecture.

Table 2. Transportation Drivers

Effect	Examples
Determining overall demand profile for transportation activities	• Economic factors. GDP, household income, fuel price • Societal factors. demographic characteristics, urbanization trend • Psychological factors. culture, perception of safe/secure system

Transportation disruptors

There is a range of discrete events that also impact transportation. Weather influences the resource network on a real-time basis: visibility problems, icing, and thunderstorms are primary issues that degrade punctuality and safety. Natural disasters also have their place in the

transportation environment. These natural events affect the local environment, and the influence may cascade into the remainder of the national system. In contrast, there exist artificial events under two categories. The first group influences the resource network directly (e.g., traffic accident, mishap operation). The second category of events affects psychological concerns, an element of the driver group. The drop in air travel after the 9/11 attacks on the U.S. in 2001 is a primary example. Taken together, those disruptors (Table 3) affect the resource network and/or a portion of the drivers. They reduce the efficiency of the resource network, disable particular nodes and links of the network, and may even bring the entire system down.

Table 3. Transportation Disruptors

Effect	Examples
Causing delay and/or cancellation of transportation activities	● Natural disruptors. weather related events that affect operational condition of resources ● Artificial disruptors. accident, terrorism, pollution

Disruptors and drivers are related with an analogy of the electrical circuit. Drivers are akin to electrical current sources which generate electrical current (transportation activity) and disrupters are akin to impedances which change the magnitude and phase of the current. These two groups together determine circumstances and constraints for all transportation activities. Drivers and disruptors are significant parts of the NTS, they are difficult to describe and are often too transient to predict, and thus they are frequently poorly represented in air transportation analysis.

The union of all ingredients described in this section comprises the Transportation Architecture, and we now use this term to avoid confusion associated with NTS which is usually used to refer the transportation resources (only) in many occurrences. Identification of the generic types of systems involved in the transportation architecture point to, but do not establish, the desired framework for effective analysis. First, there must be some organizing formalism that includes all design degrees of freedom, including physical resources, organizational entities, and the inter- and intra-connected networks that tie them together. This formalism is presented next in more depth through abstraction and hypothesized use of a modeling approach.

Entity-centric abstraction

The traditional approach to modeling a large, complicated system is to assemble many small-scale, hierarchically decomposed sub-system models.

This approach is anchored in reductionism that has dominated the modern sciences. While a multitude of achievements over hundreds of years testify to its success, the reductionism strategy is not complete for the study of system-of-systems. It creates box-inside-a-box mentality and becomes simply impractical when an unmanageable number of heterogeneous elements are involved. This leads to engaging the power of abstraction for it requires a rigorous mental activity that enables attainment of the holistic perspective. The essence of abstraction is the notion of both classifying things (creating sets) and representing organization (forming networks) using articulate lexicon for the purpose of examination at the holistic level. Proper abstraction aims for generic, universal, uniform semantics, and its ultimate goal is generation of functional expressions which allow practitioners and theorists of this field to navigate, communicate, model and design collaboratively as well as produce a useful product to the decision makers.

Concept: Entity and entity descriptor

Under the entity-centric abstraction framework, all of those factors on the table find themselves a home, unified through the concept of entity. In the modeling and simulation field, the term entity generally refers to a structural component of a discrete event simulation that has attributes and that causes changes in the state of the simulation (Ingalls, 2002). Also, entity is analogous to object in the computer science domain as defined as a concept or thing with crisp boundaries and meaning for the problem at hand (Rumbaugh, Blaha, Lorensen, Eddy, & Premerlani, 1991). In objected-oriented programming, the internal view of any object uncovers states (or variables) and behaviors (or methods) as the defining elements. Similarly, an entity is composed of attributes and functions, which correspond to states and behaviors, respectively. Moreover, the entity can have sentience and interfaces. The role of these four key rudiments of the entity is to symbolize its being (*attribute*), doing (*function*), thinking (*sentience*), and linking to externalities (*interface*). Anchored in this conceptual foothold, the entity-centric abstraction is instantiated with particular entity characterizations.

Therefore, an entity can be thought of as an extended form of object, though not necessarily having the crisp boundaries for the purpose of obtaining inherent flexibility. For example, a car is modeled as an entity that has attributes, functions and interface, without sentience. Attributes of a car contain certain characteristics that are unique to (or that defines) the car: make, model, vehicle identification number, gas mileage, etc. However, speed and position at a particular time belong to the interface since the values of those variables result from interaction with other entities: road conditions, other cars, the driver, etc. The entity-centric abstraction captures any instance among everything, and upon completion of identifying things of interest, modelers simply include the corresponding entity or entity groups.

In the prior section, four groups of entity were established: Resource, Stakeholder, Driver, and Disruptor. Based on observation of these entity groups, a certain generality can be extracted, which will be relevant in modeling. In doing so, we imagine a supreme transportation architect—a hypothetical individual (or group) who wishes to shape the transportation architecture under her/his design. There are things under partial or full control of the imagined transportation architects and there are things that beyond their control. For example, resources are obviously controllable; the architect can design and operate them. Stakeholders are not fully controllable but the architect can influence stakeholders in a direct or indirect way. On the contrary, there are things within which have no control variables even for the mighty architect. For instance, weather has unidirectional influence on resources; the nation's wealth has wide-reaching effects on transportation but take imperceptible feedbacks from the transportation architect, if any. To capture these mutually exclusive categories, the terms *endogenous* and *exogenous* are applied to the four entity groups.

In a similar vein, we can imagine a user of the architecture experiencing a transportation activity. When a user (consumer) travels or send a shipment, there are tangible things that are directly encountered (e.g., vehicles and weather). But there are also other things that have indirect influences: operator's policy, economy, etc. Their existence can be inferred but they are not tangible. To capture these mutually exclusive categories, the terms *explicit* and *implicit* are applied to the four entity groups.

There are, then, four logically deduced entity descriptors. The nature of an entity's influence on the architecture can be either explicit or implicit and its source of influence can be either endogenous or exogenous. In contrast to the reductionism mindset, the role of the descriptors is not to facilitate break-down of the entities into smaller pieces. Instead, it only intends to organize them by articulating their generic, endowed natures. The descriptors are complete since they can notionally embrace everything on the table in its entirety. They also naturally embrace these externalities in conjunction with those internal factors in an attempt to describe the whole.

Synthesis: Transportation architecture field

The specification of all entities, juxtaposed on the time-variant transportation environment, is depicted in a pseudo 3-D space format (Figure 8). This space is called the *Transportation Architecture Field* (TAF) where the entity descriptor axes generate four quadrants situating the corresponding entity group. Note that the arrows connect the adjacent quadrants only. The solid arrows indicate the direction of primary influence. For instance, adverse weather (disruptor) instantly affects the resource network; a good economy (driver) has a direct impact to the stakeholders which then affect the resource network. In contrast, the dotted arrows indicate weak influence,

probably with large latency. For instance, a secure, robust resource network may scale down the probability of disrupting incidents; an efficient resource network will positively influence the economy to an ambiguous extent.

Figure 8. A Conceptual Snapshot of the Transportation Architecture Field (TAF) with Respect to Given Time $t = t_o$ **Where Time Axis (Not Shown) is Out of the Plane of the Figure**
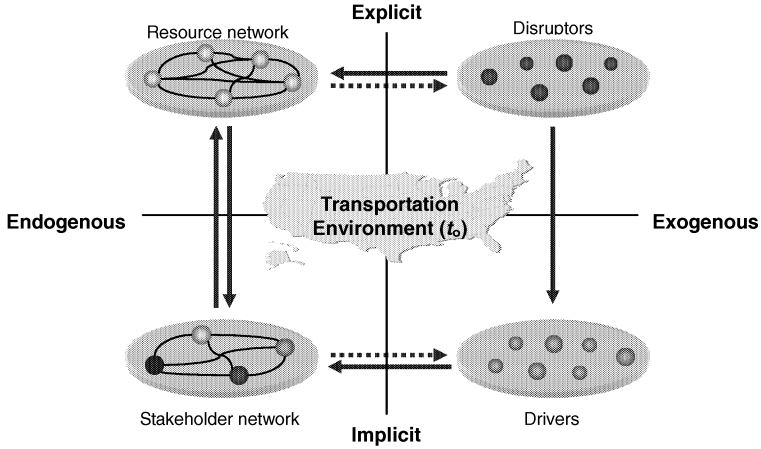
The TAF is constructed through networking (organizing) the networks, under the recognition that the organization of things can be just as important as the nature of things to be organized. In particular, linking the resource and stakeholder network gives the transportation architecture a system-of-systems character. The stakeholder network embodies independent decisions concerning the status of the transportation architecture, while the resource network determines how the transportation architecture is actually configured when accessed by consumers. These multiple networks organized in different layers are co-mingled and evolve over time, resulting in the evolving TAF. The type, structure and attributes of the networks can be treated as the architecture design parameters to the extent that such freedom is consistent with reality.

The TAF is summarized by representing the interactions mathematically through integration, over a time period of τ, of the influence of design and/or state variables in each network $(\overline{X}_R, \overline{X}_S)$, metrics of the other network, disruptors $\overline{\delta}(t)$, and drivers $\overline{\gamma}(t)$. An example variable in the resource network is the service connectivity between two airports while an example in the stakeholder network is the pricing of such connectivity in relation to competitors. Metrics for the resource network are given in Equation 4 while

those for the stakeholder network are given in Equation 5, with a note that the weak feedback from stakeholders to drivers is ignored for now.

$$\overline{M}_{RN} = \int_{\tau} \phi(\overline{X}_R, \overline{M}_{SN}, \overline{\delta}(t)) \; dt \tag{4}$$

$$\overline{M}_{SN} = \int_{\tau} \varphi(\overline{X}_S, \overline{M}_{RN}, \overline{\gamma}(t)) \; dt \tag{5}$$

$$TAF(\tau) = F(\overline{M}_{RN}, \overline{M}_{SN}) \tag{6}$$

While the equations can be written in compact notation, these integrals are clearly coupled and unsolvable analytically; they represent complex behavior and must be approximately evaluated through simulation, for which a first attempt is to be described in the next section. Despite the best intentions, however, it is the authors' view that the entire transportation universe can never be modeled completely. Yet, the continued effort to fully integrate all entities is meaningful from a pedagogical point of view. Under these circumstances, the best practices appear to be the considered construction of interfaces to link diverse domains, the inclusion of uncertainty to account for incomplete information across interfaces, and the implementation of programming flexibility to accommodate changes that arise. Just as the transportation architecture is a living system, so must be the methodology that models it.

INITIAL SIMULATION MODEL AND MODELING HYPOTHESIS

Brief description of the model

The time and space boundary of the present modeling exercise is quite large: the entire continental United States over a single year. Long distance, passenger transportation activities are examined, considering intercity trips of 100 or more miles. Before constructing a working model, a database review was done. The most important database identified and used was the 1995 American Travel Survey, built by the Bureau of Transportation Statistics through interviews of approximately 80,000 randomly selected household nationwide (BTS 1999). Based on the ATS and other transportation data, instantiation of resource and stakeholder models proceeded.

Transportation resources

Transportation resources are made up of vehicles, portals, and enroute spaces. Each element of the resource is created from class/template as illustrated in Tables 4 and 5.

Table 4. Attributes of Vehicle Resource Entity

Category	Attributes
Operational Performance	Cruise speed Maximum range License requirement Payload capacity Near all-weather operations
Economic Characteristics	Acquisition cost Direct operation cost Insurance/maintenance cost Price/fee schedule
Infrastructure Compatibility	Types of portal Types of enroute space Dual mode capability

Table 5. Time Attributes of Portal Entity

Element	Description
Mode change	Required time to transfer from/to secondary mode
Wait-ahead	Required time for most scheduled services
Wait-in-line	Required time for processing ticketing, baggage claims and security check
Portal delay	Undesirable waiting time due to capacity limit, weather, etc.

Instantiation of resources created from the templates are integrated in a generic trip route—an origin-destination network as shown in Figure 9. Note that one can infuse a new mobility resource as the generic focal point for exploration of mobility-related questions.

Figure 9. Generic Origin-Destination Trip
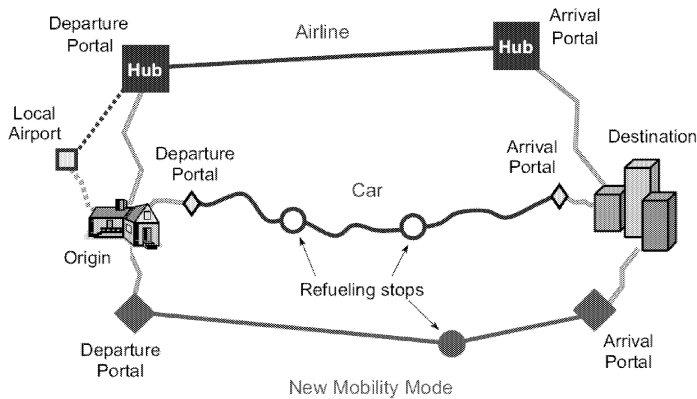
Four transportation modes were considered for the study. The primary groups consisted of personal cars (code CAR) and commercial airlines (code AIR), which make up the vast majority of household travels (about 96%) according to the ATS data. The GA aircraft, split into a piston single-class aircraft (code GAP) and a business jet-class aircraft (code GAJ), makes up the final standard groups. Although only a small portion of the total NTS traffic (less than 1%), general aviation is critical for explorations of future aerospace technologies, as it is widely considered a leading indicator of an on-demand, point-to-point, and distributed air transportation system. Other transportation modes, such as trains, buses and ships, were omitted from this study since the area of concern of this work is primarily the interface between cars, commercial airlines, and general aviation.

Transportation stakeholders

The use of agent-based modeling (ABM) is well suited for manifesting the behavior of a collection of sentient entities—the stakeholders. The idea behind ABM is that the global behavior of a complex system derives from the low-level interactions among its constituent elements. Upon construction of a virtual world on the computer, the user invokes the simulation and observes the result: That is, let them play and watch. Agent-based simulations (ABM/S) can reveal both qualitative and quantitative properties of the real system, so ABM/S can be deemed as computational laboratories to perform experiments to test nearly any kind of imaginable hypotheses (Dibble, 2001).

Any stakeholder in Table 1 can, in theory, be treated as an agent. The most practical way to begin the modeling process, however, is having a

manageable number of agent groups. As an aggregated group, travelers are the chief and most active players among the stakeholders. Other agent types, despite being less numerous, have more complicated behavior patterns that are beyond the scope of the present work. The primary attributes of a traveler include household income, vehicle ownership, location (whether a traveler lives in a big city or rural area), and a list of trips over a period of time. Each trip has its own attributes as well: personal/business travel motivation (the potential ability to have the trip expensed), trip distance, number of travel party and location of destination. There exist somewhat soft attributes for a traveler and a trip such as whether a particular traveler feels uncomfortable to fly in a small plane and the amount of urgency associated with the traveler—defined here as on-demand travel, the desire for travel without the time necessary to get the lower, advanced-purchase prices. The implemented behavior of traveler agents is to choose the best alternatives for a trip, which is mathematically treated through a multinomial conditional logit model (Train, 2003).

Transportation environment

All model components are placed in a set of locales—abstracted collections of people, transportation resources and other socioeconomic factors. It is in these locales that travelers and the relevant structures are populated and created during the simulation runs. The model used four locales as a physical space of large metropolitan areas (L), medium-sized cities (M), small-sized cities (S), and non-metropolitan or rural areas (N). Travelers were dispersed within these spaces as they were dispersed in reality, using the databases to follow population trends and movements within the time period of the experiment. The synopsis of locale description is summarized in Table 6. The origin-destination matrix reveals the travel demand profile in terms of spatial distribution. Also, four distinct locales have different portal accessibility and the amount of delay.

Table 6. Locale Characteristics

(a)   Origin-destination matrix

Orig. \ Dest.	(L)	(M)	(S)	(N)
(L)	9.16%	7.77%	4.03%	12.17%
(M)	5.94%	3.96%	2.46%	7.91%
(S)	2.73%	2.52%	1.17%	4.62%
(N)	7.49%	7.61%	4.64%	15.83%

	(b) Portal accessibility			
Access Distance	(L)	(M)	(S)	(N)
to Hub airport (mi)	2–40	2–60	50–100	100–200
to Small airport (mi)	2–10	2–12	2–30	4–75
to Freeway ramp (mi)	1–5	1–5	1–10	1–40

Simulation studies

A simulation code, named *Mi*, has been developed which is implemented in Java. Initially, the code was calibrated to year 1995.

Calibration Results (code BSLN)

Calibration of the code was straightforward, though time-consuming. The basic agent decision-making algorithm responded quite well with no interference. Cases were run repeatedly on the order of one to ten million agents to fine-tune the model to closely match the 1995 ATS data. The most important response monitored during the calibration was overall market shares of the four transportation modes, shown in Table 7.

Table 7. Overall Mode Share Result

	CAR	AIR	GAP	GAJ
ATS1995	75.88%	23.48%	0.64%*	
BSLN	75.92%	23.44%	0.42%	0.22%

Note. No further breakdown available in the ATS database.

This modal split result should also correspond to the differentiated behaviors of the traveling public, which necessitated closer investigation from different angles. Acceptable results are also shown for the chosen mode with respect to the travel motivations, as revealed in Figure 10(a). A long-distance traveler is likely to use a commercial airline, so the market share of commercial airlines (AIR) should grow as travel distance increases. This trend from the 1995 ATS data and the calibration result are plotted together in Figure 10(b).

Figure 10. Model Calibration Result
(a)   Trip Purpose and Modal Split
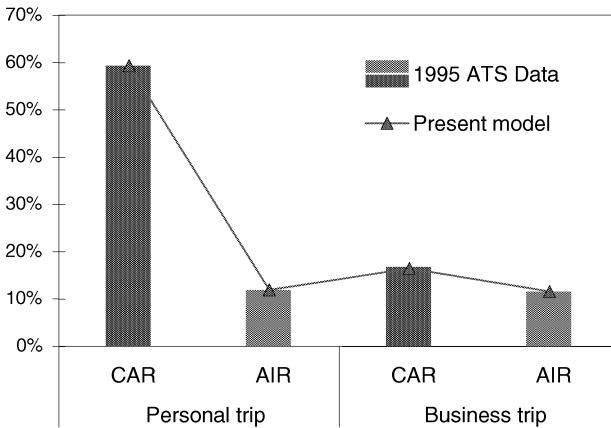
(b)   Market Share Analysis Result for Airline

One-way trip distance in miles
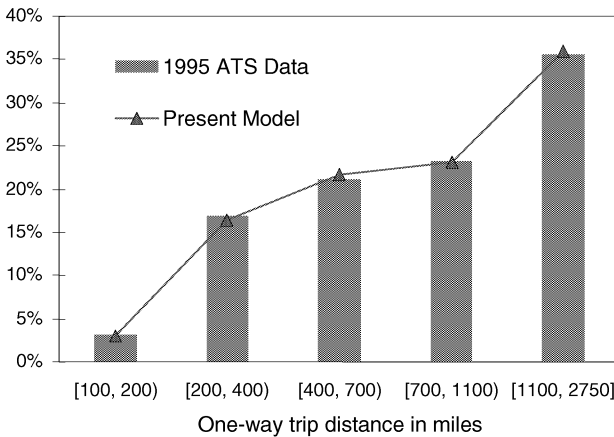
Overall, considering the level of abstraction inherent in the model, the results were remarkably satisfactory. Small mismatches were the inevitable price stemming from simplifying the real world, and they could be diminished by increasing the model granularity. Recalling the key assumptions of the previously discussed models in the second section of this paper (λ includes income only, μ includes distance only, and these two are static or fixed), the initial simulation model presented overcomes these limitations. For example, compared to Figure 6 models, it consists of

parameters such as distance, purpose, size of trip party, etc. Further, big advantage is that λ and μ were calibrated based on actual data. So, the model is a better approximation of the real TAF, and then we can run some scenario simulation and watch the results.

PAV simulation (code PAV)

This simulation scenario consists of the replacement of the existing GAP with a new mobility vehicle based on NASA's Rural/Regional Next Generation concept. The image of the advanced general aviation aircraft is portrayed below, with its target performance characteristics.

Figure 11. NASA's Low-cost, Tail-fan Concept GAP

Cruise Speed: 200 mph
Range: 500 miles
Passenger Seats: 5
Acquisition Price: $75,000
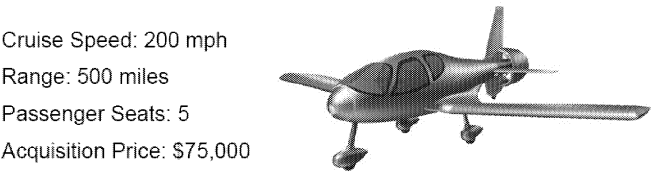
The preparation of simulating this scenario can be done with straightforward alteration of design requirements of the GAP. To be more specific, an investigator simply needs to change the values in the input area of the program. The corresponding field values are Speed (from 180 to 200 mph), Refuel Range (1200 to 500 mi), Seats (from 4 to 5) and Cost Index (from 100 to 90). The simulation infusing this future GAP revealed that it would attract about 2.4 times as many travelers as the previous GAP. This was due primarily to the design's low projected costs and the faster cruise speed. Other transportation modes were not affected much, and the result is shown in Table 8. The numbers in the round brackets indicate the net relative changes or the sensitivities of the market shares in comparison to Scenario BSLN.

Table 8. Overall Mode Shares of Scenario PAV

	CAR	AIR	GAP	GAJ
PAV	75.49%	23.30 %	1.01%	0.20%
	(-0.56%)	(-0.60%)	(+140%)	(-7.10%)

SATS vision (code SATS)

NASA's Small Aircraft Transportation System (SATS) project envisions the use of small aircraft to alleviate congestion around large cities and enable new business opportunities by allowing access to communities

currently underserved by commercial aircraft while having usable, yet underutilized public-access GA airports. Adjusting for this vision of the future involved the enabling of easy-to-fly technology, reflected in a ten-fold increase in pilots licensed to fly the vehicle, and near-all-weather access to almost three times as many airports, shortening the travel distances to airports for those people in smaller communities. One other condition imposed for this scenario was price penalty of 25 percent to account for the cost of sophisticated onboard avionics. As expected, this scenario was the most dramatic in its effect on the transportation architecture. The results show that 2.5 percent of long distance travelers will find GAP the most attractive as their travel option. Table 9 details the overall modal split result.

Table 9. Overall Modal Share for Scenario SATS

	CAR	AIR	GAP	GAJ
SATS	74.30%	23.02 %	2.50%	0.18%
	(-1.57%)	(-1.24%)	(+147.5%)	(-10.46%)

However, caution is needed to interpret the result. Since SATS technologies were applied to NASA's advanced GAP. Scenario SATS is, in fact, a hybrid vision of both NASA's vehicle- and system-level goals. To separate the impact of the SATS technologies from this hybrid scenario, an additional simulation was run (code SATS*) which replaced NASA's advanced vehicle with the previous GAP, a vehicle representative of current general aviation aircraft. Hence, one can consider Scenarios PAV and SATS* to make up Scenario SATS. The SATS* simulation discovered an interaction that had not been predicted. As shown in Table 10, the impacts cannot be simply superimposed; that is, an additive assumption did not work. This behavior within the model shows there exists a close coupling of these technologies to future GA aircraft use, which highlights the capabilities of the ABM/S framework being used to model the transportation architecture.

Table 10. GAP Mode Share Changes from BSLN

	PAV	SATS*	SATS
Modal Share of GAP	1.01%	1.04%	2.50%
(Sensitivity to BSLN)	(+140%)	(+130%)	(+447%)

Finally, the result from any scenario can be visualized in a market space plot, showing the distribution of the agents' mode choices over household

income and travel distance. Figures 12 and 13 portray the market spaces for Scenarios BSLN and SATS, respectively. From these plots, a decision-maker quickly monitors the changes in the potential GAP market region in a visual and dynamic way.

Figure 12. Market Space Plot of Scenario BSLN. Only 20,000 Agents out of Ten Million were Randomly Selected and the Data Points with Trip Distance Over 1,200 Miles were Discarded for Visual Clarity and Closer Investigation. Each Dot Represents a Unit Trip Party. Agents that Choose Cars and Commercial Airlines are Dominating.
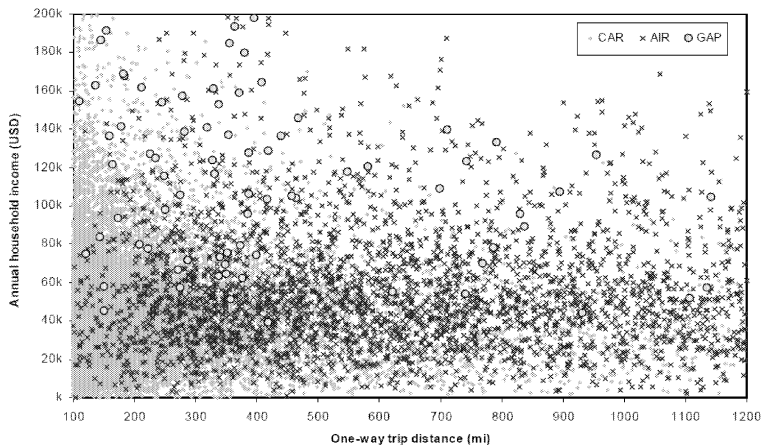
Figure 13. Market Space Plot of the SATS Vision Scenario. One Can Retrieve Useful Information from this Plot. For Example, a Circle Located in (120mi, $20K) was Found out to be a Business Traveler who has a Pilot License Flying with Two other Colleagues.
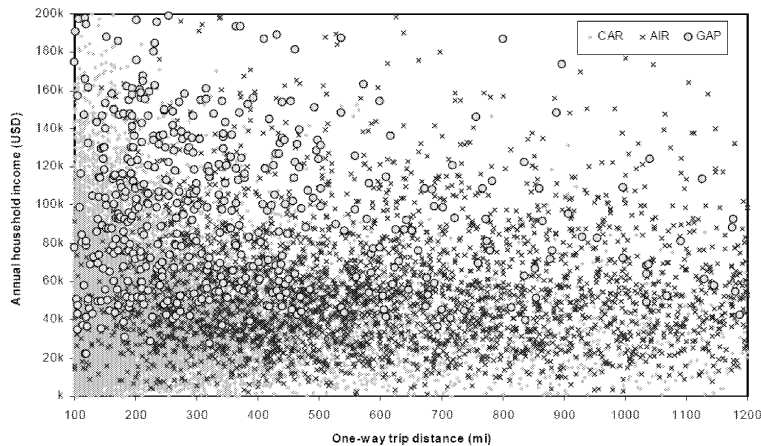
Modeling hypothesis for future work and a status

Though the initial results in using the TAF and associated simulation are encouraging, additional challenges remain in tackling this system-of-systems problem and generating a useful, quantitative output for the decision-makers. Thus, the next focus for the research should be on how the entity-centric abstraction framework realizes its full value. To guide this work, the following modeling hypothesis is proposed: *A modeling methodology treating the four major classes of transportation architecture entities can be created to synthesize alternative conceptual solutions and facilitate evaluation of the alternatives against multiple criteria.* While such a comprehensive hypothesis may difficult to prove (certainly in near term), strategies for testing the hypothesis can make use of the following four essential criteria (summarized in Table 11).

Table 11. The Four Criteria for Hypothesis Testing

Criteria	Description
Efficacy	The methodology must lead directly to required products in support efficient decision-making.
Flexibility	The methodology must be amenable to change in response to new customer requirements, new modeling constructs or new dynamics that emerge.
Comprehensibility	The methodology must be understandable, usable and interpretable by non-experts.
Traceability	The methodology must make transparent the rationale & path taken towards decisions reached.

The efficacy of the methodology can be evaluated by how well it represents the characteristics of the TAF. For example, it must capture the time variant nature of the problem, including simulation of latent effects due to the distributed nature, feedback mechanisms and consequences of uncertainty. The desired methodology must also embrace sufficient flexibility to support the emergence of revolutionary resource entity designs, the ability to impose or remove constraints easily and the capturing of all types of architecture design variables (vehicles, travelers, infrastructure, etc). Overall, the decision-support method must be able to adaptively employ the balanced level of abstraction that gives meaningful results without becoming overburdened by confounding detail—that is, it must be comprehensible. Finally, an often overlooked trait, but one that is generally found to be very important, is decision traceability. The ability to present rationale and trace the history of decisions reached can increase the legitimacy to external parties. The agent-based model *Mi* provides fidelity to the TAF in capturing essential entities in all four quadrants of the abstraction and proper links amongst them. However, the transportation environment is represented at a significantly aggregated level and the stakeholder network interactions are

simplistic. The modular architecture does point to significant flexibility in future studies. Other investigators are working towards essentially the same goal, although they employ different frameworks and with a deeper depth and a narrower focus. For example, Trani, Baik, Swingle, & Ashiabor (2003) proposes a nationwide, multi-modal, inter-city transport model (called TSAM) to investigate the viability of NASA's SATS project, as an extended form of the conventional transportation demand analysis. The TSAM treats resources, stakeholders, and drivers with a high geographic granularity in characterizing the transportation environment. But it has a limited capability in representing the stakeholder network since an agent-based approach is not adopted.

While the above approaches have the goal of improving the future transportation architecture taking into account the multimodal aspect, others have focused on the NAS perspective. The Airspace Concept Evaluation System (ACES) is the most crucial NAS model, which utilizes an agent-based modeling paradigm to cover aircraft operations from gate departure to arrival (Meyn, Romer, Roth, Bjarke & Hinton, 2004). The ACES seeks best concepts for the (air) resource network, suitable for capacity and delay issue examination that relate the dynamic between disruptors and the resource network. The previously introduced Jet:Wise model is capable of capturing the emergent behavior of the real airlines. For instance, the hub-and-spoke system emerged as an airline routing behavior without explicit mechanisms leading to that phenomena. These NAS related enterprises, however, do not deal directly with the dynamics within implicit entities and some exogenous ones. Nevertheless, one commonality found in these large scale modeling efforts is adoption of an agent-based modeling technique, indicating that the inclusion of flexibility and evolutionary mechanisms in the testing of the hypothesis is well-founded.

CONCLUSIONS

Under the expected high degree of complexity in the study of potential transportation architectures, the entity-centric abstraction framework was proposed as a means for comprehensive treatment without narrowly prescribed boundaries. The primary premise for the framework was the necessity of a holistic perspective, which was formed after a body of research on more restrictive assumptions was conducted. The four classes of entities abstracted are the network of resources, the network of stakeholders, the drivers and the disruptors. The concept of the TAF was set forth to properly connect them. In the absence of an omnipotent transportation architect, the ultimate goal of analysis within the TAF concept is to provide an effective means for stakeholders to make optimal decisions that are also robust to cascading perturbations.

An initial, simulation-based investigation is then reported in which a TAF model that concerns the most important entity groups in each of the four quadrants was built. The agent-based simulation model is fully calibrated and validated to the real data, successfully replicating the passenger transport activities of the whole U.S households on the continental United States. Results reported from the simulation quantify shifts in mode choice as a result of advances both in air vehicle designs and operational technologies (especially those from NASA SATS program). Additionally, interactions captured in the simulation due to its foundation in the TAF concept uncover the fact that changes due to these two different types of advances are not additive.

Based upon reflection of the initial exploration of the TAF, a general modeling hypothesis was formed directed towards the ultimate purpose of an ability to compute a wide variety of value metrics to delineate between alternative architectures.

ACKNOWLEDGMENTS

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THE COUNCIL ON AVIATION ACCREDITATION: PART TWO – CONTEMPORARY ISSUES

C. Daniel Prather
Middle Tennessee State University
Murfreesboro, Tennessee

ABSTRACT

The Council on Aviation Accreditation (CAA) was established in 1988 in response to the need for formal, specialized accreditation of aviation academic programs, as expressed by institutional members of the University Aviation Association (UAA). The first aviation programs were accredited by the CAA in 1992, and today, the CAA lists 60 accredited programs at 21 institutions nationwide. Although the number of accredited programs has steadily grown, there are currently only 20 percent of UAA member institutions with CAA accredited programs. In an effort to further understand this issue, a case study of the CAA was performed, which resulted in a two-part case study report. Part one addressed the historical foundation of the organization and the current environment in which the CAA functions. Part two focuses on the following questions: (a) what are some of the costs to a program seeking CAA accreditation; (b) what are some of the benefits of being CAA accredited; (c) why do programs seek CAA accreditation; (d) why do programs choose not to seek CAA accreditation; (e) what role is the CAA playing in the international aviation academic community; and (f) what are some possible strategies the CAA may adopt to enhance the benefits of CAA accreditation and increase the number of CAA accredited programs. This second part allows for a more thorough understanding of the contemporary issues faced by the organization, as well as alternative strategies for the CAA to consider in an effort to increase the number of CAA accredited programs and more fully fulfill the role of the CAA in the collegiate aviation community.

C. Daniel Prather, A.A.E., formerly an Assistant Director of Operations at Tampa International Airport, is currently an Associate Professor of Aerospace at Middle Tennessee State University. Mr. Prather earned a Bachelor of Commercial Aviation degree from Delta State University and a Master of Public Administration degree in Aviation Administration from Southern Illinois University. He is presently pursuing a Doctor of Philosophy degree in Educational Studies with a specialization in Educational Leadership and Higher Education and an emphasis in Aviation Education, through the University of Nebraska. He is an instrument-rated private pilot, as well as an FAA-certificated advanced and instrument ground instructor.

INTRODUCTION

Part one of this case study of the Council on Aviation Accreditation (CAA)[1] examined the history of the CAA, the accreditation process, and the current environment in which the CAA operates. Part two of this study considers that during the past 17 years, the CAA has been actively accrediting various aviation academic programs and today boasts 60 accredited programs at 21 institutions nationwide. However, out of 105 institutional members of the University Aviation Association (UAA), which is an organization representing collegiate aviation with over 800 members, only 20 percent of UAA institutions currently have CAA accredited programs ("Candidates," n.d.; UAA, n.d.). This is in contrast to an average 59 percent accreditation rate in other academic fields [based on a random sample of 11 accrediting organizations recognized by the Council for Higher Education Accreditation (CHEA)].

In an effort to more fully understand why only one-fifth of aviation academic programs are accredited by the CAA, the second part of this case analysis asked the following research questions:

1. What are some of the costs to a program seeking CAA accreditation?
2. What are some of the benefits of being CAA accredited?
3. Why do programs seek CAA accreditation?
4. Why do programs choose not to seek CAA accreditation?
5. What role is the CAA playing in the international aviation academic community?
6. What are some possible strategies the CAA may adopt to enhance the benefits of CAA accreditation and increase the number of CAA accredited programs?

METHODOLOGY

In an effort to fully understand the CAA, including the complex issues surrounding the organization and the accreditation process, a comprehensive research strategy was necessary (Yin, 2003). A case study design was chosen because, as Yin (2003, p.1) explains, "case studies are the preferred strategy when 'how' or 'why' questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context."

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[1] This case study was undertaken during 2005. In 2006, the Council on Aviation Accreditation (CAA) announced a change of name and identity. Although the CAA is now known as the Aviation Accreditation Board International (AABI), references to the CAA within this article also refer to the AABI.

Yin (2003) acknowledges that case studies can be conducted by gathering both quantitative and qualitative evidence, yet all case study inquiries rely on multiple sources of evidence, with data converging in a triangulating fashion. The evidence for case studies may come from six sources: (a) documents, (b) archival records, (c) interviews, (d) direct observation, (e) participant observation, and (f) physical artifacts (Yin, 2003, p. 83). Although each of these sources, according to Creswell (2003), has various strengths and weaknesses, it appeared most appropriate for this case analysis to gather evidence from documents, archival records, and interviews.

Specifically, documents analyzed included all CAA documents (such as the *Accreditation Standards Manual* (CAA, 2003a), *Bylaws* (CAA, 2003c), and *Outline for a Self-Study Report* (CAA, 1999b)] that were accessible on the CAA website. In addition, journal and magazine articles related to accreditation in general, and CAA accreditation in particular were analyzed. Archival records (including the CAA membership list and the listing of CAA accredited programs and candidate programs) were analyzed as well. Interviews were also relied upon extensively during this case study. As Yin (2003, p. 89) explains, "One of the most important sources of case study information is the interview." Two types of interviews were utilized in this research effort. First, a focused interview was conducted via telephone with both the President and Executive Director of the CAA, as well as two administrators of aviation programs (one of which is CAA accredited). These participants were purposefully selected, as described by Creswell (2003), to represent CAA leadership, as well as the views of a CAA accredited and non-accredited program (with the director of the non-CAA accredited program also serving as a CAA trustee). Each telephone interview was completed during a 30-60 minute time period. The second type of interview, recognized by Yin (2003) as having more structured questions and resembling a formal survey, was also utilized. First, a brief questionnaire was sent via email to the entire population of 101 U.S. institutions offering non-engineering degrees in aviation (as determined by the 2003 UAA Collegiate Aviation Guide and UAA Institutional Member List) that currently do not have programs which are either CAA accredited or candidates for accreditation (UAA, n.d., 2003). Accounting for invalid email addresses, a total of 92 institutions received the email questionnaire. The email survey resulted in an initial response rate of 19.6 percent. A follow-up email encouraged an additional 5 responses (for a total of 23), resulting in a total response rate of 25 percent. Although lower than the preferred response rate, the purpose of the survey was simply to gain a more in-depth understanding of why non-accredited programs chose to remain non-accredited, and even with a lower than desired response rate, this purpose was fulfilled.

Next, email questions were sent to various specialized accrediting organizations recognized by the CHEA, as well as to the staff of both the CAA and UAA. These email questions garnered a 100 percent response rate. Last, using the most recent CAA Board of Trustees listing available on the CAA website, each of the officers and educator trustees of the CAA were asked to complete an on-line survey developed specifically for this research effort. One of the educator trustees selected explained that he has recently retired and is no longer a member of the CAA Board of Trustees. Of the 11 individuals selected for this survey, 9 responded, resulting in an 82 percent response rate.

Since the original purpose of the case study was to describe the CAA and the contemporary issues being faced by the organization, the general analytic strategy guiding this research was that of developing a case description. Within this analytical framework, Creswell's (2003) six steps of data analysis and interpretation served as a theoretical guide in making sense of the many sources of evidence and compiling the data into an organized and informative narrative that maintained a focus on the original research questions. First, the many sources of evidence were prepared for analysis by organizing interview notes, collating survey responses, and arranging the data into different types depending on the sources of information. Second, although this was an ongoing aspect of the analysis, all the data was read through to obtain a general sense of the information. As a follow-up to this, the data was analyzed in great detail with a subsequent coding of the data into categories. Fourth, the coding process was used to generate both a description of the CAA and themes appropriate to the research focus. Next, in consideration of the description and themes, a decision was made as to the best manner in which to convey the description and themes in the narrative (which included both a chronology of the events leading up to the formation of the CAA and a discussion of interconnecting themes in response to the research questions). The final step in this case analysis involved interpreting the data by formulating recommendations to improve the organization and enhance the number of accredited programs. As Creswell (2003, p. 195) notes, "Interpretation in qualitative research can take many forms, be adapted for different types of designs, and be flexible to convey personal, research-based, and action meanings."

In an effort to ensure trustworthy data, the concept of triangulation was employed through the gathering of data via interviews, surveys, and documents to observe patterns in the data. Reliability, specifically concerning the accuracy of observations, was enhanced by the use of detailed notes and audio recordings of the interviews, use of participant quotations in the final case study report, and member checking. Member checking was accomplished by allowing interviewees the opportunity to read the draft case study report and correct any inaccurate statements attributed to

them. Additionally, CAA officers and educator trustees were asked to indicate agreement or disagreement (via an on-line survey) with the results of a SWOT (strengths, weaknesses, opportunities, and threats) analysis conducted as part of this case study. To enhance internal validity, six months were allotted for the case study to allow collection of a large amount of evidence and an in-depth analysis of the data. Additionally, detailed notes were taken, abundant use of detail and verbatim language of participants were included in the case study report, and as often as possible, trends identified in one source of data were corroborated by at least one other data source. Last, external validity was strengthened through a concerted effort in this case study to accurately describe the data and provide for a more in-depth understanding of the CAA and the issues the organization currently faces. In this way, readers should be able to understand these findings so that they can be applied in other settings.

CONTEMPORARY ISSUES

When considering non-CAA accredited programs, the CAA states that, "the fact that an institution does not choose to seek accreditation is not of itself a commentary on the quality of education offered in that institution and must not be so interpreted" (CAA, 1999a, p. 1). However,

> Although accreditation is not the definitive answer as to whether the program is the best nor should it imply that schools not accredited by CAA are unworthy of consideration, it does provide reassurance for students, scholarship grantors and employers that a specific institution is "up to par." (Knauer, 2005, p. 28)

Thus, our main research question concerned why so few aviation programs are accredited by the CAA. This is indeed a strategic issue for the CAA, as this organization examines its past, studies the course it has taken, and strategizes about the future. Additionally, as the organization transitions into the international arena of aviation accreditation, it would be helpful to understand the reasons behind the level of success at home, prior to attempting success on an international scale. In an effort to examine this issue, and bring certain options to light, part two of this case study presents various questions that should be addressed, and highlights alternatives that may be adopted by the CAA to positively address this pressing issue.

What are some of the costs to a program seeking CAA accreditation?

When considering the costs of accreditation, we must consider both direct monetary costs and indirect costs of time, energy, and intellectual resources. The direct monetary costs are both annual CAA membership dues and accreditation fees. The current annual membership dues for an educator

member is $720. The accreditation fees include an application fee of $1,750 for one program (with $350 additional per program), a visit fee of $1,250, and actual visiting team expenses which usually average $3,500 (G. Kiteley, personal communication, August 9, 2005). Thus, the approximate total monetary costs for one program to be accredited is $7,940 (based on two years of membership dues). Accreditation fees for international programs are considered by the CAA on a case-by-case basis (CAA, 2002).

As noted by both the CAA and institutions that have undergone the accreditation process, specifically the self-study process, the time, energy, and intellectual resources required for accreditation can amount to a substantial amount. Faculty and/or staff must devote a substantial amount of time and energy toward the self-study as they effectively analyze every aspect of the program over a 6-9 month period. Although the self-study should be completed within one academic year, it will likely require that full academic year to complete, especially for institutions seeking initial CAA accreditation and never having completed such a detailed self-study of the aviation program in the past (CAA, 1999c). As Knauer (2005, p. 28) states, "CAA accreditation is a lengthy and costly process for sure."

Regarding the costs experienced by programs seeking CAA accreditation, Dr. Paul Craig, Chair of the Department of Aerospace at Middle Tennessee State University, explains that the direct monetary costs are really insignificant compared to the time and expense necessary for the self-study, and in fact, he explains, sending his faculty to several conferences and paying various membership dues may equal the direct monetary costs necessary to apply for CAA accreditation (personal communication, June 27, 2005). Dr. Tim Brady, Dean of the School of Aviation at Embry-Riddle Aeronautical University and President of the CAA, echoes this sentiment, explaining that the costs required by the CAA are no more than any other content accrediting body (personal communication, July 7, 2005). Brady also proposes that the institution will pay the costs as long as they are convinced that CAA accreditation has value. However, Dr. Juan Merkt, former chair of the Department of Aviation at Ohio University and current Director of the Aeronautics Program at Jacksonville University, points to costs associated with changes to curriculum, faculty, and staff that may be required to meet CAA standards (personal communication, July 18, 2005). Administrators of smaller programs are concerned about this and even feel that CAA dues can prove burdensome. One program administrator even suggests eliminating CAA fees. Lastly, Craig states that when personnel are already stretched thin, expecting them to work on a major project (self-study) for a year is asking a lot. The program must have administrative backing and a person or committee devoted to working on this project for a year's time.

What are some of the benefits of being CAA accredited?

The CAA feels that CAA accreditation offers the following benefits: (a) increasing the attractiveness of the program to prospective students and their parents by ensuring that the program meets accepted standards of quality; (b) ensuring employers that graduates possess a broad background in the aviation industry as well as skills needed for aviation specializations; (c) assuring institutions that their aviation program will periodically perform a comprehensive self-analysis to achieve their objectives; and (d) keeping aviation educators in contact with other faculty, industry advisors, and practicing aviation professionals. Although these benefits should naturally flow to an accredited program, considering the goals of the CAA, it may be possible that these benefits do not flow as naturally as the CAA would advocate or that aviation programs would prefer ("About accreditation," n.d.).

Specifically, are the graduates of CAA accredited programs more successful than graduates of non-accredited programs in both obtaining and maintaining positions in their chosen career? Interestingly, Phillips (in Fagan and Wells, 2000, p. 48) states "that 'we do not know whether student characteristics, or the characteristics of programs from which students graduate, make a difference in later job performance'." Even so, as Kiteley explains, the graduate of an accredited program can explain he is a graduate of a program that has been measured against a common set of standards (personal communication, July 28, 2005).

Regarding the benefits of CAA accreditation, Craig explains that his program must hold its own as it competes with 38 other departments at the university, and the CAA (which is an outside, national accrediting body) helps him do just that. His department is able to stand shoulder to shoulder with these departments, rather than being a stepchild. Brady agrees and explains that CAA accreditation gives an aviation program strength within the institution—a sort of badge of approval. This has tremendous value, as most aviation programs are, in general, looked down upon by faculty in other academic programs, as well as administrators lacking an aviation focus (Smith, 2002, p. 13). In addition, Craig shares that past reports of the CAA visiting team have had a direct impact in his program moving into new facilities, as well as acquiring a new fleet of aircraft. CAA serves as a strong voice to represent his program in a sea of voices at this large, comprehensive university. As Merkt explains, CAA accreditation provides leverage for aviation programs. Last, CAA accreditation results in graduates of programs that have met certain standards and adequately prepared their graduates to meet the needs of industry. For these reasons, Craig explains to all freshmen they are at a CAA school, and their curriculum includes certain courses because of stated industry preferences. Brady explains that graduates of CAA accredited programs have a better chance of being hired, and notes that

some airlines are hiring flight graduates from CAA accredited programs first. Merkt points out that CAA accreditation reassures students and parents that the program has a certain level of quality and has met certain benchmarks to achieve that quality. These benchmarks, as Merkt explains, result from the industry demanding that graduates meet certain requirements (P. Craig, personal communication, June 27, 2005; T. Brady, personal communication, July 7, 2005; J. Merkt, personal communication, July 18, 2005).

Why do programs seek CAA accreditation?

The answer to this question is not necessarily discovered in CAA documents, although we are aware of the benefits of being CAA accredited, according to the CAA. The answer therefore lies in the hearts and minds of administrators of CAA accredited programs. Craig is strongly committed to the CAA, and knows that his program reaps the benefits when he and his administration are committed to his program's CAA accreditation. It benefits industry, it provides greater assistance to students in the long term, and results in stability and equitable pay for faculty. Although the previous chair of the program at Middle Tennessee State University made the initial decision to seek CAA accreditation, Craig agrees that this was a beneficial decision for the program and the institution, and as a result, he continues to seek CAA re-accreditation on a regular basis (personal communication, June 27, 2005).

Brady explains this from a leadership perspective. He explains that if a program endeavors to be a leader in collegiate aviation education, the program must take the lead by stepping out and seeking accreditation. Echoing thoughts from Craig, Brady also shares that aviation programs once suffered (and still do to some extent) from a lack of academic credibility. These aviation programs have to fight it out with other programs for finite budget dollars. In the past, as there was no formal aviation accreditation, aviation programs fell victim to those programs that were accredited. Now, however, once accredited, programs have a solid base from which to argue for those dollars and are doing so successfully. The institutional president likely takes action on CAA recommendations. Indeed, as Kiteley shares, programs that were first accredited by the CAA in 1992 have substantially improved in many areas, specifically in those areas previously recognized in past CAA visiting team reports (T. Brady, personal communication, July 7, 2005; G. Kiteley, personal communication, July 28, 2005).

Why do programs choose not to seek CAA accreditation?

On the surface, one may assume that non-CAA accredited programs have not sought CAA accreditation simply because they are not of sufficient quality that would permit them to become accredited. In other words, is it

possible that over three-quarters of aviation programs are not CAA accredited because they simply could not pass the muster? This is doubtful, and in fact, in examining this question from the CAA perspective, we read that "the fact that an institution does not choose to seek accreditation is not of itself a commentary on the quality of education offered in that institution and must not be so interpreted" (CAA, 1999a, p. 1). If that is in fact true, that quality programs are not seeking CAA accreditation, then other, possibly less obvious reasons must be evaluated. (Please see Appendix A for actual comments by administrators of non-CAA accredited programs regarding this topic.)

One reason for not seeking accreditation, from an administrative perspective, is that "college rankings and specialized accreditation rate high among the things college presidents love to hate" (Ewell, 1998, para. 1). Ewell explains that specialized accreditation is attacked because "it is seen as an increasingly expensive and duplicative distraction from core institutional purposes" (1998, para. 7). If this is true, we would expect to see a similar high percentage of non-accredited programs in other academic fields. In fact, the opposite is true, with academic fields such as veterinary medicine, industrial technology, and forestry, boasting a relatively high percentage of accredited programs (averaging 59 percent).

Is it possible then, that a large number of programs desire CAA accreditation, but are hesitant to apply for accreditation, thinking they may be denied accreditation? Although this is a plausible reason, it is not supported in historical CAA actions. Kiteley (personal communication, July 28, 2005) explains this is an invalid perception shared by some programs. Indeed, Brady estimates a very small number of programs (possibly less than three) have been denied CAA accreditation in the past, once approved for candidate status. Likewise, Brady states that only a small number of programs, once accredited, have not sought re-accreditation once a term of accreditation expired. In certain instances, the lack of support may have occurred due to the retirement of a champion of the CAA at a particular institution (T. Brady, personal communication, July 7, 2005).

More plausible reasons include the lack of industry demand for graduates of CAA accredited programs, and thus lack of student demand to attend institutions with CAA accredited programs. Indeed, 89 percent of CAA board of trustee members responding to a survey agreed that the majority of aviation employers are unaware of the CAA. As Craig states, those front-line managers interviewing to fill entry-level positions are unaware of the CAA. Graduates of CAA programs should have an advantage over the competition, but, as Craig admits, this is not always the case. He has never heard a front-line manager state, "We're only hiring graduates of CAA schools." Interestingly, however, Merkt believes that this will eventually occur industry-wide as airlines, airports, and others only hire from CAA

accredited institutions. And while he agrees this may take some time, Merkt notes that one airline, in particular, is reluctant to even establish an internship program with any programs that are not accredited by the CAA (P. Craig, personal communication, June 27, 2005; J. Merkt, personal communication, July 18, 2005).

Yet another issue involves the lack of knowledge about the CAA possessed by students and parents. According to respondents to a survey of CAA officers and educator trustees, 100 percent agreed that the majority of prospective collegiate aviation students are unaware of the CAA. Likewise, 100 percent agreed that the majority of parents of college-bound aviation students are unaware of the CAA. When recruiting, Craig tells students and parents about the CAA, but very seldom do these parents and students possess prior knowledge about the CAA. Indeed, as Merkt explains, many parents are confused about the roles of the FAA and CAA in assuring program quality.

Additional reasons, according to Merkt, revolve around lack of institutional support (both internal and external to the program), the time and expense required to make required curricular (and faculty, staff, and facility) changes, and the desire to make sure the program meets minimum requirements before applying. Also, although less common, some programs have frequent turnover that prevents a champion of the CAA from having the time necessary to both bring the program up to CAA standards and then apply and see the process through until accreditation is granted. As Merkt shares, a new program director may need approximately four years to become thoroughly acquainted with a program (P. Craig, personal communication, June 27, 2005; J. Merkt, personal communication, July 18, 2005).

Additional reasons why programs choose against seeking CAA accreditation include already possessing accreditation from other agencies (such as the Accreditation Board of Engineering and Technology [ABET] and the National Association of Industrial Technology [NAIT]); having a currently successful program, thus making CAA accreditation unnecessary; lack of institutional support; time and fiscal constraints; negative view of the CAA; and lack of awareness about the CAA accreditation process. From surveying the entire population of prospective programs that are not currently accredited by the CAA, it was discovered that the majority of these programs are satisfied with the current level of quality and success of their respective programs and feel no need to pursue CAA accreditation. This view could have far-reaching impacts on the CAA. In essence, those institutions currently accredited may be the only institutions interested in doing so. If the CAA is to increase the number of accredited programs, as suggested in the strategies to follow, the organization must make a concerted

effort to enhance the value of accreditation by adopting various value-added services and benefits.

What role is the CAA playing in the international aviation academic community?

The CAA is "committed to its role as the world's leader in the advancement of aviation accreditation [and] this global commitment is integral to all organizational activities" ("Mission," n.d.). As Brady (personal communication, July 7, 2005) explains, aviation is by its nature a worldwide activity. In this vein, the CAA decided as a body to become an international accrediting organization, and, in addition to having an international office in Montreal, has recently undertaken an international review of its CAA Standards as the organization continues a more concentrated focus on the international aviation academic community. The Standards Committee has been actively involved with revising the Accreditation Standards to allow institutions outside the United States to apply for accreditation. Removing all specific references to U.S.-specific names and terms and replacing them with state-neutral terms has been one approach to this effort. Further efforts continue on changing the name of the CAA to reflect its international scope, as well as discussions about the quality of the language as written and concerns about changing the intent/content of many of the existing Standards. Specifically regarding a name change, Kiteley (personal communication, July 28, 2005) explains that in some countries the CAA is synonymous with the country's civil aviation authority. Thus, the CAA is transitioning to become the Aviation Accreditation Board International (AABI). To successfully accomplish this re-branding effort, The Day Group (a marketing firm in Seattle) has been retained by the CAA to further develop this new brand and effectively market the AABI on a worldwide scale.

Although the CAA currently does not have any international aviation academic programs accredited, the organization has accepted Hankuk Aviation University in South Korea and Seneca College of Applied Arts and Technology in Toronto as candidates for accreditation, while applications have also been received from additional institutions in Canada, as well as New Zealand and possibly Brazil. Brady suggests that the organization will likely evaluate its first international program (Hankuk) this year. This, according to Merkt, will further enhance the overall awareness of the CAA both within the U.S. and around the world. With a strong international membership component, this move toward international accreditation was only natural and expected. ("Candidates," n.d.; Knauer, 2005; "Mission," n.d., para 1; "Standards committee continues," 2005; T. Brady, personal communication, July 7, 2005; J. Merkt, personal communication, July 18, 2005).

This move toward international accreditation is also occurring in other specialized accrediting organizations. According to a 2001 survey by the CHEA, almost 43 percent of specialized accreditors are operating internationally. In fact, those organizations responding to the survey (which also included national and regional accreditors) reported accrediting activity in 65 countries (ranging from Australia to Venezuela). As a result, the CHEA developed International Principles in 2001 in an effort to provide a framework for U.S. accreditors working internationally (CHEA, 2002).

What are some possible strategies the CAA may adopt to increase the number of CAA accredited programs?

The CAA Membership Committee is responsible for seeking additional ways to involve CAA members, provide a forum for issues regarding membership to be reported to the Board, and to work with the Executive Director to actively recruit new members in all categories (CAA, 2003b). The CAA has recognized the need to increase the number of accredited programs as one of the organization's top five goals (G. Kiteley, personal communication, July 28, 2005). This is admirable, as the CAA has one of the lowest percentages of accredited programs in their field of study (compared to other specialized accrediting organizations). That said, however, Kiteley (personal communication, July 28, 2005) reminds us that the CAA did not plan on seeing 100 percent of programs becoming accredited. More realistically, he explains, is a 40-50 percent accreditation rate (among UAA institutional members).

According to those interviewed, one possible strategy the CAA might consider to increase the number of CAA accredited programs, is enhanced marketing to educate industry of the benefits of hiring graduates from CAA accredited programs, so that CAA preferences become part of the hiring criteria from top to bottom. If this occurred, schools on the fence would attempt accreditation; otherwise, their graduates would be at a disadvantage. In essence, CAA accreditation must benefit students once they graduate (P. Craig, personal communication, June 27, 2005).

Yet another strategy is to enhance the existing industry-educator forums, which are conducted at each CAA meeting. Industry is able to provide input to academia in this setting, something which, according to Brady, is difficult for aviation programs to get anywhere else. As explained by Kiteley, CAA has reached a turning point in which the organization is receiving support and recognition from industry. As an additional strategy, efforts should be focused on educating institutional members of the UAA of the value-added service of CAA accreditation. According to Craig, it is a tool used inside the university that proves a big advantage for the aviation program. Possibly a forum could be held at an annual UAA meeting allowing administrators of CAA accredited programs to discuss the many benefits of CAA

accreditation. Another suggestion is to implement a more robust internet search engine for the CAA. As prospective students search for "quality aviation program," for instance, a link to CAA accredited programs would provide tremendous enhancement to their search effort. Additional strategies include being more attentive to smaller programs and their unique needs and constraints, attending and exhibiting at various industry trade shows, and evaluating the current fee structure (T. Brady, personal communication, July 7, 2005; G. Kiteley, July 28, 2005; P. Craig, personal communication, June 27, 2005).

The CAA could also assist accredited programs in further educating prospective students by sharing suggestions presented by the CHEA. Students, according to the CHEA, usually ask three questions: (a) how does accreditation work; (b) what are the assets and the weak points of the institutions or programs in which I am interested; and (c) what skills and capacity can enrollment in your institutions or program help me to achieve (Eaton, 2004, p. 2).

A strategy which has been adopted by the CAA (based on recommendations by the CHEA) is the transition from content-based standards to outcomes-based standards. Once this transition is complete (expected in Fall 2007), programs seeking accreditation will no longer be required to offer certain courses, require a certain number of credit hours, or have certain facilities available to students. Rather, the CAA will set various goals (or outcomes) and programs will be required to meet these goals and achieve the stated outcomes. In stark contrast to the current standards, the CAA will be less concerned with how you get there, than the fact that you are there and have achieved certain objectives in the process. As indicated by 67 percent of respondents to the survey of CAA officers and educator trustees, the transition to outcomes-based standards will likely renew interest in CAA accreditation and result in more aviation programs pursuing CAA accreditation.

Obviously, the move toward outcomes-based standards will introduce flexibility in the process of accreditation (both for programs and the CAA). Although the self-study will be more critical, requiring the visiting team to be assured of program objectives and measurements, it is believed that these new standards will enable more programs to successfully seek CAA accreditation. One administrator, in particular, is awaiting these new standards prior to applying for accreditation. Further, according to Kiteley (personal communication, July 28, 2005), the new outcomes-based standards will also mesh well with international accreditation efforts. Appendix H of the current CAA Accreditation Standards Manual (2003a) may provide some insight into the direction these new standards will take (see Appendix B).

RECOMMENDATIONS

In consideration of these issues (as well as the comments which may be found in Appendix C), several recommendations resulted from this research effort. In an effort to further enhance the role of the CAA and increase the number of CAA accredited programs, most of these recommendations appropriately center around education—educating industry, educating prospective students and parents, and educating non-CAA accredited programs.

Industry
1. Advertise the benefits of CAA accredited programs in industry publications (such as AAAE Airport Magazine).
2. Attend and exhibit at various industry trade shows (such as the American Association of Airport Executives [AAAE] and National Business Aviation Association [NBAA]) for the purpose of educating industry as to the value of graduates of CAA accredited programs.
3. Further enhance the CAA Industry/Educator forum.

Prospective students and parents
1. Create a marketing brochure explaining both the purpose of the CAA and value of CAA accredited programs and send to high school guidance counselors nationwide.
2. Create a more user-friendly website that is indexed in all major internet search engines. The website should have a students section that persuasively presents the benefits of attending and graduating from a CAA accredited school, as well as an up-to-date searchable database of accredited institutions and programs.
3. Advertise in publications attractive to high school students interested in aviation (such as Aircraft Owners and Pilots Association [AOPA] Flight Training magazine).
4. Reach out to Alpha Eta Rho (aviation fraternity) in the form of mentors, and marketing brochures, for example.
5. With the assistance of industry, create a scholarship program for high school seniors that choose to enroll in a CAA accredited aviation program.

Non-CAA accredited programs
1. Present success stories from accredited programs to administrators of non-accredited programs (possibly in the form of marketing brochures and presentations at UAA meetings).

2. Create a seminar to be held at UAA conferences to enable attendees to better understand the accreditation process and the benefits of obtaining CAA accreditation.
3. Create a marketing brochure revealing how effective CAA accreditation is and the many benefits it has for programs and their graduates and send to program and institutional administrators of non-CAA accredited programs.
4. Establish a sort of mentor network that allows institutions considering applying for CAA accreditation to receive personal guidance and wisdom from those most familiar with the CAA accreditation process.
5. Attend National Intercollegiate Flying Association [NIFA] regional and national competitions to promote CAA accreditation and become more familiar with those programs that are not currently accredited.

Additionally, various recommendations focus on the purpose and objectives of the CAA, as well as the strategic direction of the organization.

CAA purpose
1. Be more attentive to smaller schools and newer programs (including associate degree programs).
2. Continue the successful transition to outcomes-based standards.
3. Evaluate the current CAA fee structure (possibly implementing, similar to other accrediting agencies, varying fee levels depending on the size of the program or number of graduates).
4. Adopt and display a culture of helping programs (in addition to accrediting programs).
5. Further develop value-added benefits to CAA accreditation.

CONCLUSION

Based on the extensive case analysis performed on the CAA, examining past, present, and future issues, it is obvious that this organization has achieved a significant feat in a short amount of time. After accrediting the first program only 13 years ago, the organization currently recognizes 60 accredited programs at 21 institutions nationwide. However, raising the standards involves continuous improvement, and the CAA, although clearly meeting the needs of some institutions, must examine itself in an approach similar to this research effort to enable this organization to more fully meet the needs of aviation programs in the U.S. and throughout the world.

In looking toward the future, 15 years from now, Kiteley estimates that students will want to be graduates of CAA accredited programs because the

industry will expect that. In addition, he estimates that 70-80 percent of aviation programs will be accredited by the CAA. Industry support will be even stronger as companies desire to be part of the process. He also estimates the CAA will become totally independent and will have a staff three times the current size (G. Kiteley, personal communication, July 28, 2005).

In sum, this author firmly believes the CAA is meeting a critical need in the aviation academic community. Setting national academic standards for aviation programs elevates both accredited programs and the entire aviation academic community to a higher level. By acting on the various alternative strategies presented above, the CAA can more fully meet the needs of the aviation academic community, as well as industry, resulting in greater demand for graduates of CAA accredited programs and subsequently increasing the number of CAA accredited programs.

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APPENDIX A

WHY HAS YOUR PROGRAM/INSTITUTION DECIDED NOT TO PURSUE CAA ACCREDITATION?

Source: Actual comments provided as responses to email survey of non-CAA accredited institutions (July/August 2005). Response rate: 25 %

Curriculum requirements/standards

In the case of . . . [our] Aviation Management [program], we have been wrestling with the CAA requirement that we require some sort of calculus class in the Aviation Management program in order to be accredited. That is the largest of the issues. There are some other curriculum adaptation issues that we might well be able to take care of but the calculus issue makes it such that, for us, the benefits of accreditation still are not large enough for us to proceed with the process given this requirement. As you can imagine, one of the ancillary issues for . . . [this institution] is that we also offer the . . . program at off campus locations. To restructure the program around CAA requirements AND to add calculus would likely make the program both more expensive and less accessible than it currently is. This is not an acceptable alternative. . . .

The CAA-recommended curriculum for Aviation Management is not much different than a business degree with some aviation courses thrown in at the end. I do not believe that the CAA has fully developed this curriculum option to the fullest extent to which they are capable of taking it.

We are an Associate Degree granting institution and our programs are designed according to specific state-wide standards. The programs are limited to a total of 68 credit hours and within that maximum, further limited in relation to the mix of occupational core, support, general studies and elective credits...with the emphasis being upon the occupational core and core support. We cannot change the programs to accommodate for the more 'academic' mission/level taxonomy CAA certification is based around.....nor would we want to.

I felt that . . . [the CAA was] trying to control our program and what we offer, they sometimes fail to realize we are regionally accredited.

The curriculum approvals would require major changes in our curricula for our degrees.

[Our program] . . . has gone through a recent curricular revision that would not make us eligible for accreditation until Fall 2006 at least. Also, we have had problems with retaining faculty. We hope that we will be able to have a stable faculty group if and when we decide to seek accreditation in 2007 or 2008.

Similar accreditation

. . . [We] are thinking of pursuing ABET accreditation instead of CAA accreditation. I believe [we] . . . are doing so because [we] . . . have been encouraged to do so by The Boeing Company.

Our program and department is accredited under National Association of Industrial Technology (NAIT). There is no reason to seek further accreditation. With the budget crunch in our State, it would not make economic sense.

We are accredited by the Southern Association of Colleges and Schools (SACS) and approved by the FAA (FAR Part 141 and 147). These are sufficient for our students to transfer their credits to four year institutions, receive grant funding at the state and federal levels and be recognized by the FAA to issue certificates and ratings.

We rely on our own college accreditation process, and the FAA licensing and standards, to obtain the accreditation we need.

Since my program is already certified by the FAA, accredited by the state and NCATE, why should I seek CAA accreditation?

Currently successful

We have discovered no compelling reason to pursue CAA certification from the perspective of the matrix we use to measure our program's success. For example, our recently released 2005 Graduate Employment Report indicates near 100% employment of our graduates (3 programs) with graduate reported wage levels well beyond the College average wage (72 programs represented).

[We] . . . are already an accredited institution which establishes a high quality of education. We are an FAA approved 141 Flight School which governs our curriculum used for flight training. We belong to other organizations: NBAA, AOPA, UAA, EAA, etc. The program started in 1967

so our graduates have provided excellent connections with various entities within the industry. Based on these and other issues we have chosen to not spend the money to join CAA.

Our students fair quite well in the job market after graduation and we are not accredited. We have a very high job placement rate.

We believe we have unique and valuable degree programs.

Lack of support/demand

At least in principle, we have no objections to CAA accreditation. I tried twice to initiate accreditation. However, we lacked faculty support for CAA, and no one else was willing to take the baton when I got [another, higher priority] . . . assignment. But the second time, I was 'shot down' by the Associate Dean, who thought we would embarrass ourselves by going for accreditation at that point in time. It was his opinion that we needed to get our act together first. I tried to point out that doing the self-study would force us to face that very issue, but I was ignored by him, peers, and colleagues. [Now] the Chair has decided it's time to re-address this issue and pursue accreditation. Unfortunately, no one has seriously done anything that would move us in that direction.

I have never had a prospective student ask if we were accredited by CAA.

Time/expense/effort versus benefits

All advice I get is it is a very large project, and will take a couple of years and some money. Money and time, of course, limit everything.

Cost/effort vs benefit.

Time restraints delay the [seeking of accreditation] . . . .

For us, accreditation would just be a money drain with no really tangible benefit. From my perspective, the CAA needs us…..NOT that we need them.

I need to see what CAA would bring to us before I could gauge its value for us on top of what we have now.

It is . . . not a good fiscal cycle to look at such major changes.

For an aviation program, there is no external reason why a program should be accredited by CAA. That is, my program does not receive any negative impact in the aviation community by not seeking accreditation. The only reason to become accredited is to meet my home institution's needs.

Smaller programs

As you know most of the schools not accredited are medium to small programs. Two years ago when we upgraded to a full BS degree I joined CAA thinking it would help us and went to their convention in Florida. At the convention they seemed only interested in the larger schools, were not friendly to the new schools, and had next to nothing on the agenda that related to us. They do not realize that our budgets and programs are not like the big schools. The accrediting process is very extensive and expensive.

Schools that have small aviation programs (perhaps less than 100 students) usually don't have the funds to spend annually on memberships in the UAA and CAA and the fees for the accreditation team to visit. This may be small change for large programs, but not so for small programs. We contract the flight training so we don't easily meet the standards for accreditation, but we could should we hire additional faculty to participate in the flight training. But, why should we? The FAA has its standardized program for pilot training for each rating. An FAA examiner awards the ratings, NOT the schools.

My perspective from attending the CAA meetings is that the accreditation process is skewed towards institutions that offer flight as part of their program. Also, it appears that one institution, Embry Riddle, has a disproportionate influence on the CAA guidelines and that the guidelines are skewed towards that institution.

Lack of awareness

What is the CAA?

Until I got your email, I was unaware of [the CAA] . . . .

Reputation of the CAA

Although in general it is better to be accredited than a non-accredited program, the reputation of the accrediting agency does matter. Unfortunately, one cannot buy perception and CAA suffers from a lack of

reputation. Since CAA is very small and unknown, there is no pressure on us to pursue accreditation. Also, the operations of CAA appear to be informal rather than those of a professional organization. As an example, their web site is unprofessional and frequently there is outdated information on the site. We do have a tentative plan of seeking accreditation in a few years; however, this is not definite.

APPENDIX B

COUNCIL ON AVIATION ACCREDITATION FUNDAMENTAL SKILLS AND VALUES OF AVIATION GRADUATES
APPENDIX H – FORM 101

Industry and education leaders in the aviation field identified the following important skills and values for aviation professionals that are typically not well developed in graduates of current programs. Consequently aviation programs are expected to pay particular attention to the development of these skills and values.

Critical Thinking Skills
        Problem analysis; problem solving
        Judgment and decision making (including resource identification and management)

Interpersonal Skills
        Oral and written communications
        Conflict management/conflict resolution
        Team building; team maintenance; individual accountability

Values and Attitudes
        Ethical standards; integrity
        Flexibility; versatility; openness to change
        Curiosity, imagination, creativity
        Motivation
        Passion
        Dedication

APPENDIX C

WHAT ARE SOME POSSIBLE STRATEGIES THE CAA MAY ADOPT THAT WOULD ENHANCE THE VALUE OF CAA ACCREDITATION FROM YOUR PERSPECTIVE (AND POSSIBLY RESULT IN MORE PROGRAMS BECOMING ACCREDITED)?

Source: Actual comments provided as responses to email survey of non-CAA accredited institutions (July/August 2005). Response rate: 25 %

Marketing/PR

Another . . . [strategy] would be a larger participation of industry employing aviation program graduates.

Be more aggressive about getting the word out about the benefits of accreditation.

It appears as though CAA is geared to all aspects of the industry. We only deal with one - Flight Training - For an operation such as ours, I would think more focus on the "Pilot" side of the industry would be more appealing.

Be more new school friendly and recruit us.

Have something on the agenda at the conventions that relate to our size school, not just what . . . the larger programs are dealing with.

Attend NIFA regionals and nationals to promote and get to know the other schools.

Publicize [the CAA] . . . [and] its mission and goals, [as well as] the benefits of accreditation by [the] CAA, etc.

Have representatives at [Professional Aviation Maintenance Association] PAMA and [Aviation Technician Education Council] ATEC conferences. Does [the CAA] . . . have an annual conference?

CAA Purpose

Concentrate on accreditation rather than professional development activities.

One already being addressed is the international aspect of the accreditation organization.

Remove all sense of historical and resident politics.

Non-accredited programs

Do what you are doing: Find out why non-accredited programs have remained non-accredited.

Curriculum

Refine the Aviation Management requirements to be less business degree-oriented and more oriented to AVIATION management.

Make the criteria more Associate Degree applicable and involve Associate Degree program representation in a meaningful advocacy process.

UAA

UAA could advocate/develop scholarships applicable to Associate Degree level program students participating in a CAA accredited program.

I'd recommend more one-on-one dialog with Department Chairs and College Deans. If they do not support it, their faculty won't either: there's no incentive for faculty to pursue the initiative without risking bad annual reviews. UAA has a role to play as well. Our (local) lack of faculty support comes largely from the perception that UAA is little more than a 'good old boys' flying club' with no solid academic respectability like other disciplines. So accreditation by CAA is actually irrelevant: it gains us little stature among peers in the college or the institution of which we are a part.

I think CAA could benefit from helping UAA improve the academic respectability of aviation educators as a discipline.

A one-hour overview seminar at the annual UAA conference might be helpful. I suppose I need to be convinced about the benefits of all that work. I want to do it, but it just isn't a priority today.

Fees

$700 dues are very high for our budgets when we sense no value added.

If the CAA would eliminate the fees I think many more would seek accreditation. I know this probably won't happen, but for us small programs it's a big deal.

Enhance benefits

It comes down to how the college will benefit from the accreditation.

Develop a culture that we want to help your program, not just accredit it.

Provide some added benefit for having the accreditation. This process is usually time consuming and costly. Without an added benefit for students or for institutional funding, there is no logical reason to undertake the process.

HUMAN ERROR: A CONCEPT ANALYSIS

Frederick D. Hansen
Oklahoma State University
Tulsa, Oklahoma

ABSTRACT

Human error is the subject of research in almost every industry and profession of our times. This term is part of our daily language and intuitively understood by most people however, it would be premature to assume that everyone's understanding of human error is the same. For example, human error is used to describe the outcome or consequence of human action, the causal factor of an accident, deliberate violations, and the actual action taken by a human being. As a result, researchers rarely agree on the either a specific definition or how to prevent human error. The purpose of this article is to explore the specific concept of human error using Concept Analysis as described by Walker and Avant (1995). The concept of human error is examined as currently used in the literature of a variety of industries and professions. Defining attributes and examples of model, borderline, and contrary cases are described. The antecedents and consequences of human error are also discussed and a definition of human error is offered.

Frederick D. Hansen, Ph.D. is currently an Assistant Professor of Aviation Education at Oklahoma State University-Tulsa. Dr. Hansen received a B.S. degree in Aerospace Engineering from Iowa State University, a Masters of Public Administration, and a Ph.D. in Public Administration from the University of Nebraska. Dr. Hansen retired from the US Navy after 24 years of service as a naval aviator. His research interests are in Aviation Safety, Aviation Security, and Airport Operations.

INTRODUCTION

When words and terms are commonly used to describe a particular phenomenon, assumptions may be made by both the authors and their audience. Indeed, it is not unusual to find articles that do not even include a specific definition of the word or term. The assumption that all parties both understand and agree with a specific term may be erroneous. Human error is one term that has become part of the common vernacular in aviation yet it has a wide variety of meanings within the industry. For example, human error is used to describe the outcome or consequence of human action, the causal factor of an accident, and as an action itself.

This lack of a common definition of the term complicates the attempts of researchers to identify meaningful approaches to reducing the effect of human error within our individual professions. Without a working concept of human error, how is it that we can announce that 72% of Navy and Marine Corps flight mishaps between 1995 and 1999 were the result of pilot error (Erwin, 2000); or that human error in road accidents "was the sole cause in 57% of all accidents and was a contributing factor in over 90%" (Green & Senders, n.d., p.1); or that "medical errors are the eighth leading cause of death in the United States" (McFadden, Towell, & Stock, 2004, p.2)? Other industries and researchers declare human error to be the cause of anywhere from 30% to nearly 100% of accidents.

Concepts, like words in our language, evolve over time and may have more than one accepted definition. This paper therefore, does not purport to identify the one true meaning of human error but will offer a definition that includes defining attributes of the concept along with a discussion of the antecedents and consequences of the concept. The use of model, borderline, and contrary cases will illustrate both what human error is and what it is not.

RESEARCH DESIGN

Concept analysis is a research strategy that can be used as an essential element of theory development. The analysis involves a formal, linguistic exercise that enables a researcher to examine the attributes and characteristics of a concept in order to determine which phenomena clarify a concept and which do not. Concept analysis is used to clarify overused and vague concepts that are part of our vernacular so that those using the term in the future start from the same definition. The result of the concept analysis process is an operational definition that has, as a minimum, at least some construct validity.

A concept analysis should not be considered as a final, completed project because concepts change over time, sometimes quite rapidly.

Different researchers may develop slightly different attributes for the same concept or the scientific and general knowledge surrounding the concept has changed. "Concept analysis encourages communication . . . will make if far easier to promote understanding among our colleagues about the phenomena being observed" (Walker & Avant, p. 37-38).

Concept analysis produces additional benefits to future researchers dealing with the concept. First, concept analysis helps the investigator in understanding the underlying attributes of the concept. Second, concept analysis helps to clarify what the concept is, what the concept is similar to, and what the concept is not. Finally, concept analysis identifies the antecedents and consequences of the concept. Antecedents are those events that occur before the concept can occur and consequences are events that happen as a result of the occurrence of the concept (Walker & Avant, 1995).

Wilson (1963) developed an eleven-step process for concept analysis. This was later streamlined and simplified by Walker and Avant (1995) into an eight-step process. The first two steps used by Walker and Avant deal with selecting the concept for analysis and determining the purpose of the analysis. These are both preparatory steps and are not tied to the actual research methodology of concept analysis. The following simplified six-step process will be followed:

1. Identify all uses of the concept that you can discover.
2. Determine the defining attributes.
3. Construct a model case.
4. Develop constructed cases.
5. Identify antecedents and consequences.
6. Define empirical referents.

USES OF THE CONCEPT

Etymology is the study of word origins and is an important element of a concept analysis because it offers clues to the evolution of language. Dictionaries, on the other hand, are the repositories of how words are used well after they have become part of our vernacular. According to the Online Etymology Dictionary (2001), *error* dates to circa 1300 from the Old French word *errur* from the Latin word *errorem,* "wandering, straying, mistake," and from the Latin *errare* "to wander." Although error meant to wander or stray in most languages, the Irish word for error, *dearmad,* derived from the Irish word, *dermat,* meaning, "a forgetting."

The Oxford English Dictionary (OED, 1986) provides the following definitions of the word error:

> 1. The action of roaming or wandering; hence a devious or winding course, a roving, winding. 2. Chagrin, fury, vexation; a wandering of the feelings; extravagance of passion. 3. The action or state of erring. 3a. The condition of erring in opinion; the holding of mistaken notions or beliefs; an instance of this, a mistaken notion or belief; false beliefs collectively. 3b. Something incorrectly done through ignorance or inadvertence; a mistake; a flaw, malformation. (p. 277-278)

According to the American Heritage College Dictionary (1997) *error* is:
> 1: an act, an assertion, or a belief that unintentionally deviates from what is correct, right, or true. 2: the condition of having incorrect or false knowledge 3: the act or an instance of deviating from an accepted code of behavior: 4. a mistake. (p. 466)

The Oxford English Dictionary (OED, 1986) provides the following definitions of the word *human*:
> 1. of, belonging to, or characteristic of man. 2. of the nature of man. 3. belonging or relative to man as distinguished from God or superhuman beings. 4. having or showing the qualities or attributes proper to or distinctive of man. (p. 1,345)

The etymology of human dates back to approximately 1250:
> From Middle French *humain* "of or belonging to man," from Latin *humanus,* probably related to *homo* (genitive, *hominis*) "man," and to *humus* "earth," on notion of "earthly beings," as opposed to the gods (cf. Classical Hebrew, *adam* "man," from *adamah* "ground"). Cognate with Old Lithuaian *zmuo* "man, male person. (Online Etymology Dictionary, 2001)

Combining the meanings of the word "human" with the word "error" leads to an examination of "human error"—characteristics of human beings that involve unintentional deviations from what is correct, right, or true.

It is common for investigators to identify different types of human error in their research (Reason 1990; Strauch 2002; Wiegmann & Shappell 2003; McFadden, Towell, & Stock 2004). Synonyms therefore are useful in developing the attributes of a concept because they provide clues to what is almost the concept but differs in some way from the concept. Webster's New World College Dictionary (2001) provides the following synonyms for error:

> Error implies deviation from truth, accuracy, correctness, right, etc. and is the broadest term in this comparison [an error in judgment, in computation, etc]; mistake suggests an error resulting from carelessness, inattention, misunderstanding, etc. and does not in itself carry a strong implication of criticism [a mistake in reading a blueprint]; blunder implies stupidity, dumbness, inefficiency, etc., and carries a suggestion of more severe criticism [a tactical blunder cost them the war]; a slip is a mistake, usually slight, made inadvertently in speaking or writing; a faux pas is a social blunder or error in etiquette that causes embarrassment. (p. 483)

The use of the concept by authors, politicians, and other historical figures also provides clues to the characteristics of human error. Probably the most familiar quotation, certainly the most cited, is the Latin phrase *errare est humanum*—to err is human. The British philosopher John Locke wrote, "All men are liable to error; and most men are, in many points, by passion or interest, under temptation to it" (Nidditch, 1979, p. 706). President Thomas Jefferson noted "error is to be pitied and pardoned: it is the weakness of human nature" (Jefferson, 1950/1775, p. 283). Physician and educator Lewis Thomas (1979) wrote that errors are part of the human makeup when he noted that humans are coded for error. He considered it an inescapable reality that human beings are built to make mistakes. Stephen Casey (1998) did not specifically define human error but noted that there are incompatibilities between the characteristics of people and the characteristics of the technology we use. The difference between success and failures then lies in how well we minimize those incompatibilities.

It is also appropriate to learn how human error is used in the literature of various professions. The books and articles dealing with human error are obviously too numerous to adequately address all of the diverse opinions about the human error but a sampling across several professions is important. The following sections will focus on the broad fields of transportation, accident investigation, and human factors and then expand into a sampling of other professions that deal with human error.

Transportation

All modes of transportation deal with human error, particularly as it relates to accidents. Human error or pilot error is readily pointed to as the cause factor of most aircraft accidents although maintenance errors and Air Traffic Control errors also receive attention. The role of human error in highway accidents, shipping accidents, train accidents, and pipeline accidents is well researched.

Humans commit driving errors because humans have three fallible mental functions (perception, attention, and memory) that limit the ability to processing information. It is the situation that exceeds the limits of human mental functions that leads to road accidents. (Green & Senders, n.d.).

Jim Hall (1995), Chairman of the National Transportation Safety Board stated that:

> Humans bear the ultimate responsibility for recognizing, interpreting, compensating for, and correcting or mitigating the consequences of deficiencies, failures, and malfunctions in the hardware and software, and ironically in their own performance. Because the human retains responsibility for the system, regardless of its level of automation, human/machine system failures are often reported as human error. (p. 4)

Senders and Moray (1991) wrote, "error is something that has been done which was not intended by the actor, nor desired by a set of rules or an external observer, or that let the task or system outside its acceptable limits" (p. 25).

Ahlstrom & Hartman (2001) in their discussion on human error in airway facilities, noted that human errors are frequently less associated with human characteristics than with error-likely conditions. "People are set up for error by the system design" (p. 2).

Goulielmos and Tzannatos (1997) in a discussion on shipping safety noted human errors have become more critical in the man-machine interface of the bridge. Typical operator errors may be presented as perceptual-motor errors related to skill, procedural errors related to rules, and inadequate monitoring errors.

Accident investigation/prevention

Sidney Dekker (2002) does not specifically define human error but differentiates between an old view of human error as the *cause* of a mishap and a new view of human error as a symptom of externalities acting upon a human being in a specific situation.

Woods, Johannesen, Cook, & Sarter (as cited in Strauch, 2002) define human error as:

> A specific variety of human performance that is so clearly and significantly substandard and flawed when viewed in retrospect that there is no doubt that it should have been viewed by the practitioner as substandard at the time the act was committed or omitted. (p. 20-21)

Strauch (2002) defines human error as "an action or decision that results in one or more unintended negative outcomes" (p. 21). The fundamental

attributes of error involve what a human does or intends to do but that leads to outcomes that differ from what was intended.

Petersen (1996) argues that "human errors are caused by the situations in which people find themselves—a particular situation at a particular moment that makes it totally normal and logical to commit an error that may result in an accident and an injury" (p. 4).

Departing from the normal emphasis on human error in accidents, Hollnagel (2004) generally finds the term human error too simplistic. In a pseudo concept analysis, he defines an *accident* as "a short, sudden, and unexpected event or occurrence that results in an unwanted and undesirable outcome. The short, sudden, and unexpected event must directly or indirectly be the result of human activity . . ." (p.5). Hollnagel further comments that "an accident can thus refer to either an event, the outcome of an event, or the possible cause. This unattractive quality is characteristic of other important terms as well, for instance 'human error'" (pp. 4-5).

Human factors

One of the most cited definitions of human error is "the failure of planned actions to achieve their desired ends—without the intervention of some unforeseeable event" (Reason, 1997, p. 71). Reason noted that the intervention of an unforeseeable event component of his definition is necessary to separate controllable actions from "luck"—either good or bad. Reason further identifies specific modes of human error that include slips, lapses, mistakes and violations—a common taxonomy for human error researchers.

Cacciabue (2004) considers human error, especially in the management of human-machine interactions as "inappropriate performance/behavior, dependent on the context and dynamic contingencies and imbedded in a specific socio-technical environment" (p. 23). Human errors can involve either performance elements (errors of omission or commission) or behavior elements (slips, lapses, mistakes, and violations as discussed by James Reason).

Nursing and medicine

Medicine and aviation have similar problems when it comes to human error. Both deal with time critical decisions, both view human error as a significant problem, both know that errors can result in the deaths of their customers, and both experience significant financial losses directly related to human error. One primary difference between the two is that fatal errors in aviation frequently result in the death of those who commit the error but this is seldom the case for medical practitioners.

In the medical field, medical errors are generally synonymous with human errors. With respect to medical errors, one definition is "the failure of

a planned action to be completed as intended (that is, an error of execution) or the use of a wrong plan to achieve an aim (that is, an error of planning)" (Institute of Medicine, 2000. p. 28).

In the patient safety movement within the medical field, the reported death toll of patients under medical care spurred Congress and other federal agencies to take swift and strong action. Unfortunately, much of that effort was focused on the human component of medical error. "High error rates are predictable whenever human beings provide services via complex delivery systems. Human beings routinely make mistakes, even when they exercise due care"." (Hyman & Silver 2005, p. 56).

Attributing problems exclusively to human error may lead investigators into shallow and misleading interpretations of the root causes of accidents. As with aircraft accidents, the medical profession is quick to identify the human error cause associated with adverse events.

> The focus on human error arises from natural laws that capture how people make causal judgments, notably hindsight bias. Knowledge of outcome biases our judgments about the processes that led to that outcome. In looking back, reviewers tend to oversimplify the situation the practitioners faced, blocking their ability to see the deeper story behind the label "human error." (Billings & Woods, 2001)

Minor variations in performing tasks are of little concern in medicine because the outcomes are acceptable, however when some limit of acceptability is exceeded that variation is considered a human error. "Human error is any human action or lack thereof that exceeds the tolerances defined by the system with which the human interacts" (p. 28). While human error may include both intentional and unintentional acts, intentional malevolent behavior is not a human error—it is a deliberate act intended to cause an adverse effect. (Rooney, Vanden Heuvel, Lorenzo, Stoecklein, & Christensen, 2002)

Mhyre and McRuer (2000) define human error as a failure to perform an action within the tolerance limits necessary for adequate and safe performance. Lapses (failures of memory) and mistakes (deficiencies or failures in judgment) are included in this definition.

Based on disciplinary case files from state nursing boards, Woods and Doan-Johnson (2002) identify eight categories of nursing errors. These categories include system, individual and practice errors. The categories identified are:

> 1. lack of attentiveness, 2. lack of agency/fiduciary concern, 3. inappropriate judgment, 4. medication errors, 5. lack of intervention on the patient's behalf, 6. lack of prevention, 7. missed or mistaken

physician or health care provider orders, and 8. documentation errors. (p. 46)

Engineering

Engineers typically view error as the difference between desired and actual performance. Human factors engineering is used during the design phase to reduce human error by making machines and systems error tolerant. Possible human error actions in a man-machine system must be predicted during the design stage to permit appropriate measures to be taken on the machine design, training of operators, or the organizations. (Kohda, Nojiri, & Inoeu, 1997)

In a discussion on the nature of the engineering design process, Sydenham (2004) noted that it is virtually impossible to avoid errors in complex projects because "design is a matter of making many assumptions in often problematic situations" (p. 121). Slips and lapses are identified as the two main sources of error in design.

In the field of reliability engineering, human error is defined as "the failure to perform a task (or the performance of a forbidden action) that could lead to the disruption of scheduled operations or damage to property and equipment" (Dhillon, 2003, p. 530). The specific types of human error identified are design errors, fabrication errors, inspection errors, handling errors, maintenance errors, operator errors, and miscellaneous or contributory errors (p. 531).

Educational testing

Random errors differ from human errors in multiple ways. Most significantly, human errors do not occur randomly and their presence is not known. Human errors tend to be capricious and their consequences are unseen and potentially very serious. The two types of human error are active (derived from individual mistakes) and latent (arising from poor management decisions). While active errors are the most dominant, latent errors are problematic and are connected to active errors (Rhoades and Madaus, 2003).

Computer programming

"At the source of every error which is blamed on the computer you will find at least two human errors, including the error of blaming it on the computer" (Anonymous).

Although computer programming does deal with human error, the classification of computer errors offers an insight into the types of errors that are either produced or that must be corrected. An *error* may involve a piece of incorrectly written program code, or a bug. *Syntax errors* are ungrammatical or nonsensical statements in a computer program. A *logic*

error is a mistake in an algorithm that causes erroneous results or an undesired operation. An error may also be an *exception*, a condition which arises during program execution due to an unexpected event. For instance, it is an error to attempt to write more files onto a disk that is full. Continuing past an unhandled error can cause error avalanche, a condition in which errors pile up and behavior becomes more erratic.

DEFINING ATTRIBUTES

Defining attributes are those characteristics of the concept that appear repeatedly. In simple terms, defining attributes provide guidance in determining how to identify the concept from other similar or related concepts. "The defining attributes are not immutable" (Walker & Avant, p. 41). Attributes may change over time or they may change when used outside the specific context of the study.

Based upon the literature reviewed and discussed in this paper, the defining attributes of human error are as follows:

1. An action that is performed by a human being.
2. The action occurs at the interface between the human and another system (human, machine, environment).
3. The action is voluntary and deliberate.
4. The action exceeds tolerance limits.

The action is performed by a human being

While some people will argue that faulty reasoning is also a human error, it is actually a precursor of error. Humans do not have the capacity to know all things nor are they capable of processing every piece of information available in order to arrive at perfect decisions. The evaluation of human error must begin with the action or series of actions performed. Although some medical literature refers to a failure to perform an action as part of human error, the deliberate decision to do nothing is an action that is frequently appropriate under certain circumstances.

The action occurs at an interface between a human and another system

A critical attribute of human error is the interaction between a human and some other system (whether another human being, a machine, or the environment). The SHELL model identifies typical interfaces between one human and software, hardware, the environment, and other human beings. Human error occurs at one or more of these interaction points.

The action is voluntary and deliberate

Actions that are performed involuntarily (e.g., because of force or coercion) are not human errors. An action that is not made intentionally is

not a human error. Actions that are performed after the mental, physical, or physiological capabilities of the human are exceeded are also not human errors. This is important because it separates *human error* from *human limitations*. Aviation is filled with examples in which a pilot was unable to process all of the audio, visual, sensory, and other inputs of a given situation and crashed the airplane. Although these accidents are normally classified as pilot error accidents, they deal more specifically with internal limitations of all human beings.

The action exceeds tolerance limits

Tolerances are defined by the system with which the human is interacting. A pilot who lands an aircraft with a 20-knot crosswind has not committed an error if the aircraft has a defined crosswind landing tolerance of 30 knots. Human error may also be defined within social, legal, or professional tolerances. Acceptable tolerances will vary widely depending on the system and the circumstances. Tolerances in the nuclear power industry differ from those of commercial aviation, which also differ from those of highway driving.

CASES

Cases are used in a concept analysis to provide examples of what the concept is, what it is not, and what it is similar to. The model case provides a real example that is absolutely an instance of the concept. All components of the defining attributes will be present in the model case.

Borderline cases provide additional insight into the concept by presenting examples that contain some of the defining attributes but not all of them. Borderline cases help us to understand the difference between the defined concept and something close, but not quite the concept.

Contrary cases are used to delineate boundaries of the concept. A contrary case is an example of what is clearly not the concept. Contrary cases are helpful because "we often find it easier to say what something is not than what it is" (Walker & Avant, p. 44).

MODEL CASE

A model case of human error is the Jessica Dubroff aircraft accident in April 1996. Jessica was a seven year-old uncertificated student pilot attempting to set a new record as the youngest pilot to fly an airplane across the United States. Accompanying Jessica were her father (a non-pilot) and her flight instructor. Jessica was an instant celebrity with media coverage from ABC, CNN and others. Shortly after takeoff from Cheyenne, Wyoming, the aircraft crashed approximately 4000 feet north of the runway,

killing all three people. The aircraft investigation revealed that the aircraft was 96 pounds over the allowable gross weight and the density altitude at Cheyenne was higher than the instructor pilot was accustomed to. The weather at the time of the takeoff was deteriorating with heavy rain, gusty winds, and air turbulence.

The National Transportation Safety Board (NTSB) determined that the probable cause of the accident was:

> The pilot in command's improper decision to takeoff into deteriorating weather conditions (including turbulence, gusty winds, and an advancing thunderstorm and associated precipitation) when the airplane was overweight and when the density altitude was higher than he was accustomed to, resulting in an a stall caused by failure to maintain airspeed. (NTSB, p. 53)

Analysis

This accident meets all of the defining characteristics of human error. The pilot took an action (attempting to take off) that was both voluntary and deliberate. Although there were pressures to keep to a rigid schedule, the pilot had the option to delay the flight. The pilot also had a duty to compute the weight and balance on the aircraft and the performance characteristics of the aircraft for the conditions present at the airport. The action occurred at the interface between a human and a system (the aircraft) and the action was outside of established tolerances. In this case, the aircraft was overweight and the combination of high-density altitude, gusty winds, turbulence, and heavy rain left no margin for safety. This accident provides a pure example of human error in transportation.

CONSTRUCTED CASES

Borderline case

The worst aircraft accident in the history of commercial aviation occurred March 27, 1977, at Tenerife in the Canary Islands when two Boeing 747 aircraft collided on a fog-enshrouded runway (Bruggink, 2000). The KLM aircraft was cleared to taxi down the runway and perform a 180-degree turn in preparation for takeoff. The Pan Am aircraft was cleared to follow the KLM aircraft down the same runway but was told to taxi clear of the active runway at the third taxiway. The Pan Am aircraft did not clear the runway at the assigned taxiway and was still on the runway when the KLM captain commenced takeoff without clearance. The ensuing collision on the runway killed 583 people. Because of the fog at the airport, the two aircraft did not see each other until it was too late to avoid the accident.

Analysis

   While it might be assumed the pilot of the Pan Am aircraft committed a human error that led to this accident, the circumstances do not match all of the criteria identified in the critical attributes. The pilot did taxi down the active runway but he did so under the direction of the tower controller. The pilot obviously was taking action at the interface of himself and his aircraft. There is no evidence from the pilot of the Pan Am (who survived the accident) or from cockpit and tower voice recordings that the Pan Am crew ever saw the third taxiway. Many factors could explain why the crew might have missed the taxiway including unfamiliarity with the airport, the fog, and the height of the cockpit. The circumstances involving the Pan Am aircraft and its crew do not support a conclusion that they deliberately and voluntarily violated their taxi instructions.

   The action of the Pan Am pilot might be considered a *mistake* because the action was inadvertent but not a *human error*. Both mistakes and human error involve actions committed by humans and occur at the boundary between a human and another system. The two terms differ significantly because mistakes do not imply voluntary and deliberate action even if the action actually exceeds acceptable tolerance levels of a system.

CONTRARY CASE

   Before setting off on a cross-country flight, the pilot obtains a detailed weather briefing for the proposed route of flight. Based on this information, the pilot decides to delay the flight until the weather improves.

Analysis

   A contrary case is a clear example of an instance that is not the concept. The pilot in this scenario demonstrated sound judgment and a concern for safety. The defining attributes of human error are not present in this case.

ANTECEDENTS AND CONSEQUENCES

   According to Walker and Avant (1995), "antecedents are those events or incidents that must occur prior to the occurrence of the concept" (p. 45). The antecedent for human error is a cognitive ability to distinguish between courses of action based upon external inputs. If a person is unable to process available inputs and make some sort of decision on what action is or is not needed, it cannot be human error.

   Another antecedent for human error is experience and prior knowledge. Transportation professionals (pilots, ship captains, truck drivers, etc.) develop their skills through education, practice, and experience. Drawing upon this knowledge and experience permits the human interacting with a

system to reduce those situations that could exceed the tolerance limits of the system.

Consequences are, "those events or incidents that occur as a result of the occurrence of the concept" (Walker & Avant, 1995, p. 45). The consequences of human error include events or outcomes that are unintended and undesired. Unintended but desirable outcomes are not uncommon for humans and form the basis of those "unexpected pleasures in life" that we enjoy. An action that produces an intended but undesired consequence likewise should not be considered a human error. These actions may be noble, malicious, desperate, or criminal but not human errors. The soldier who throws himself on an enemy hand grenade to save his comrades commits a deliberate act with an intended but undesired consequence did not commit an error.

Another consequence of human error could be harm or loss. Although death, injury, or some other form of loss is not a consequence of all human errors, they are frequently used as a metric to determine that a human error has occurred. A consequence of human error can also include *no* harm or loss. A pilot who nearly lands his aircraft with the landing gear retracted but is warned by the tower at the last moment and executes a successful go-around commits a human error but does not suffer a loss.

EMPIRICAL REFERENTS

The final step in a concept analysis is to define the empirical referents of the concept. Empirical referents are "classes or categories of actual phenomena that by their existence or presence demonstrate the occurrence of the concept itself" (Walker & Avant, 1995, p. 46). In many cases, the empirical referents are the same as the defining attributes of the concept. No unique empirical referents for human error have been identified in this paper. Human error is identified retrospectively through a largely subjective process conducted by other humans familiar with the specific system with which the human interacted. The subjective nature of this identification has made human error research difficult at best.

CONCLUSION

As a result of analyzing the concept of human error, a new definition is offered. *Human error is a voluntary and deliberate action by a human interacting with another system that exceeds established tolerances defined by that system.* The consequences of human error encompass a continuum that runs from no injury or loss to major damage and casualties. The action taken by the human involves the cognitive ability to decide between alternate courses of action based upon experience, knowledge, and the combined external and internal inputs available to the human. The ability of humans to

decide which of the numerous inputs are significant in choosing the correct action to take is important in understanding *why* we have human error. Bounded rationality and satisficing describe the problem of decision-making but do not help to reduce human error.

Human error is a term that is overused and over-emphasized. The inclusion of slips, lapses, violations, and blunders into previous definitions of human error provide interesting glimpses into the dynamics of human involvement in accidents but also unnecessarily overstate the true dimension of human error. Human error and human limitations both play a role in aviation accidents but should not be treated as the same phenomenon. Developing a narrower definition of human error may allow future researchers to develop specific strategies to reduce the impact of true human error in accidents.

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A CORRELATIONAL STUDY OF HOW AIRLINE CUSTOMER SERVICE AND CONSUMER PERCEPTION OF AIRLINE CUSTOMER SERVICE AFFECT THE AIR RAGE PHENOMENON

Joyce A. Hunter
Saint Xavier University
Chicago, Illinois

ABSTRACT

Between 1995 and 2000, customer service declined throughout the airline industry, as reported in February 2001 by the U.S. Department of Transportation (2001). One of the biggest problems today within the airline industry is the constant complaining from customers regarding the deterioration of service (McCollough, Berry, & Yadav, 2000). Since 1995, unfortunately no airline has been immune from service deterioration, as reported by the Airline Quality Rating, an annual report by two airline industry experts who analyzed Department of Transportation statistics (Harrison & Kleinsasser, 1999). The airlines' refusal to recognize the issue of customer service has perpetuated an environment that has become dangerous and detrimental to the traveling public as well as to airline employees, which in turn has fueled a new phenomenon, now referred to as "air rage."

Dr. Joyce A. Hunter is a full-time faculty member at Saint Xavier University in Chicago, Illinois. As an Assistant Professor in the Graham School of Management, she teaches courses in marketing, hospitality management, advertising and promotional strategies. During the summer of 2006, Dr. Hunter presented papers on the "air rage" phenomenon at conferences in Nagoya, Japan and Budapest, Hungary. Dr. Hunter has over 30 years of experience working in the airline industry. She retired from Delta Air Lines, Inc. in December 2000. During her career, she held a variety of positions related to marketing, including working as a Corporate Account Manager and an Association Account Manager. During her tenure with Delta Air Lines, her accounts included Standard Oil Company, Leo Burnett, Wrigley Company, Archer Daniel Midland, Price Waterhouse, Arthur Anderson, Johnson Publishing, the American Medical Association, American Dental Association, American Marketing Association, National Restaurant Association, National Realtors Association, and American Hospital Association. Dr. Hunter earned her doctorate degree in business administration from Argosy University in Year 2004. Her dissertation, which focused on air rage – a phenomenon that has drawn considerable media attention since 9/11 – is currently being adapted for publication. She continues to do research on the causes and prevention of the "air rage" phenomenon.

INTRODUCTION

The phenomenon has been increasing, but little is known about the role customer service may play in the genesis of air rage. In recent years, aberrant and abusive behavior by passengers on commercial airlines has become an increasingly common problem (Anonymous & Thomas, 2001). This behavior, popularly known as air rage, is by far the greatest threat to the safety and security of the 1.5 billion passengers who travel by air each year (Anonymous & Thomas, 2001).

This research study will present an empirical investigation of why airline customers perceive an erosion of airline customer service over the last few years. Has the decline in customer service contributed to the air rage phenomenon? It is believed that the perception of customer service deterioration can be reversed with the changes in customer orientation of service providers (Brady & Cronin, 2001). Will the air rage phenomenon decline?

HAVE THE HIGH LEVELS OF SERVICE DECREASED?

There is an overall perception from the general public that there has been erosion in airline customer service since 1999 (McCollough, Berry, & Yadav, 2000). The traveling public has seen a growing gap between the level of service expectations of some passengers, who see luxury in the advertisements, and what they actually experience on the aircraft and in the airport (University of Nebraska at Omaha, 2002). What passengers see in terms of what is advertised to them about comfort and service they can expect usually does not match reality, especially in coach class (Wang, 2001).

WHY AIRLINE CUSTOMERS PERCEIVE EROSION IN AIRLINE CUSTOMER SERVICE

The way airlines advertise air travel to the general public is not very realistic in today's society. A discrepancy in passenger expectations exists between the level of service that can actually be provided onboard and what the passenger actually receives (Wang, 2001). After viewing airline ads and commercials, customers arrive at airports with very unrealistic expectations for service.

Airline advertisements usually feature a smiling, satisfied customer, normally in a semi-reclined position, enjoying a glass of French champagne (Luckey, 2000). The passenger is pictured gazing over an epicurean delight of some type, nestled on a fine china plate presented on a linen table cover (Luckey, 2000). The reality of an average airline passenger's personal

experience is a lot less tasteful (Luckey, 2000). In the 21st century, air travelers are frequently crammed into narrow, high-density seats, surrounded by carry-on-luggage, grasping tiny bags of pretzels while trying to quench a powerful thirst from a 3-ounce glass that also contains two ice cubes (Luckey, 2000). Welcome to the real world of travel today.

The quality of airline service has declined since deregulation due in part to the emergence of many airlines from near bankruptcy. Customer expectations have followed this downward-spiraling effect. Delays, poor communication protocol, policies of slashing services, over-crowdedness and what can be perceived as an abysmal commitment to customer satisfaction cause airline passengers to no longer expect quality services. They simply opt to more often choose no-frill carriers that have clearly understood policies and more affordable rates in those services in economy class that remain less than desirous (D'Agostino, 2006).

Patricia Friend, president of the Association of Flight Attendants, the country's largest flight attendant union with 43,000 members, believes airlines deserve at least some of the blame for the growing number of disgruntled, and often violent, passengers (Hester, 1999). "Airline advertising unrealistically raises expectations," she says. Because of the unrealistic advertising among airlines, passengers tend to believe the advertisements and expect a pleasurable experience, however, in today's environment this is not the case. Passengers are now subjected to long check-in lines, invasive passenger search, tight airline seats, no food, and poor customer service. In addition, passengers are now faced with the possibility of a terrorist attack.

Customer service on the airlines is not what it used to be, primarily due to the growth of the travel industry (Anonymous & Thomas, 2001). Customers constantly complain about the quality of airline services. Certainly the body of literature in this area is not lacking for media reports of ongoing service failures (Schoenfeld, 2002). According to the U.S. Department of Transportation (2001), last year one of every four flights was delayed, cancelled or diverted with impact on 163 million passengers. In a recent poll, 57% of travelers said they think the experience of flying has gotten worse over the past five years (Bryant, 2001). Amenities have been on the decline for years. The events of 9/11 have given airlines the excuse to do away with them further, by justifying these actions as economically necessary in the wake of the tragedy (Schoenfeld, 2002). Delayed flights, cancellations, mishandled baggage, and poor customer relations lead the list of travelers' complaints (Taylor, 2001). Another source of customer frustration may result from the security screening process. One study indicates that "the implementation of new technologies may exacerbate the incidence of security related errors" (Turney, Bishop, & Fitzgerald, 2004, p. 60).

Relative to customer relations are studies of airline personnel treatment by management, and the impact of that treatment of customers. Management's treatment of employees affects morale and also affects the treatment of customers. This was inferred in the best-selling customer-service book, *It's Not My Department* authored by Peter Glenn (as cited in Spector & McCarthy, (1995). Customer relations and perceived treatment are also closely related to the airport and the way it is operated. One study indicated that airports experience problems because of inadequate testing of various operational systems and personnel not "property trained to manage the operations or handle the problems that did arise" (Quilty, 2003, p. 7). Problems within the airport may be transmitted by customer behavior to the airlines. "For customer service oriented airports, both education and training are necessary" (Quilty, 2003, p. 5).

Airline companies are continuing to fight for every possible customer, yet many are not investing in customer service improvement. Continental Airlines is the exception (D'Agostino, 2006). Travel industry professionals would be unrealistic to believe that most consumers and customers seek or expect error-free services 100% percent of the time. Most consumers and customers conceivably will expect to experience some of what is known as service failure, as they would also expect airlines to always strive to boost service efficiency.

Service failure can be defined as any transaction resulting in a problem and service falling short of the customer's expectation of the level of service. Taking this argument one step further, some customers may have recovery expectations and some customers may have failure expectations. For instance, many customers recognize that consumption entails some potential for dissatisfaction (Murray & Schlacter, 1990). Therefore, to determine what will be done in the event of a failure, they inquire about warranties, exchange and refund policies (McCullough, Berry, & Yadav, 2000). Research has indicated that service failure and recovery is a critical issue for both service managers and researchers (McCollough, Berry, & Yadav, 2000). In research, service failure has been understood in terms of a "pushing determinate" that drives customer-switching behavior. Successful recovery from service failure can mean the difference between customer retention and defection (McCollough, Berry, & Yadav 2000). In turn, customer retention is critical to profitability (Stauss & Friege, 1999). Edvardsson and Strandvik (2000) emphasize that it is paramount that data on different perspectives of customer service incidents be collected for analysis purposes.

Factors which seem unrelated to the customer, such as adherence to ISO14001, the environmental quality standards can also impact the customer. One study links the potential benefits of ISO14001 to "improved customer satisfaction," improved image and reputation, and "increased

domestic market share" among other benefits (Korul, 2005, p. 54). While this study does not address or propose any direct linkages between air rage and airport and the airline environmental quality, it does suggest an area for further inquiry. In an airline industry study on managing service quality, conducted by Edvardsson and Strandvik (2000), some emphasis was placed on airport environment or serviscape. "Interpersonal interactions are key in triggering customer dissatisfaction but likewise is the significance of the place or environment where the service is delivered, the serviscape" (p. 89).

CAN THE PERCEPTION OF POOR CUSTOMER SERVICE BE REVERSED?

Little evidence exists to support the idea that lowered expectations of services impact the incidence of air rage. Southwest Airlines' record is no different from that of other carriers who tout high levels of service and strive to meet these criteria (Zellner, 2001). However, further research may reveal that Southwest Airlines' customers are willing to put up with lower levels of service. Customers constantly complain about the quality of service provided by the airlines, and their perceptions are that it is deteriorating at a significant rate (McCollough, Berry, & Yadav, 2000). The perception is that the increase in air rage incidents arises from the increase in poor service (Brady & Cronin, 2001).

DO AIRLINE EMPLOYEES' POOR ATTITUDES CONTRIBUTE TO AIR RAGE?

Hartland and Ferrell (1996) defined front-line airline employees (FLEs) as "typically underpaid, under-trained, overworked, and highly stressed" due to factors such as customer abuse and unreasonableness, and not being able to meet company performance standards and deadlines. FLEs report that working under extreme pressures and living behind a mask of pleasantry while having to take insults and verbal abuse on a daily basis is very stressful. FLEs stated that they have to deal with external factors, like disgruntled customers, and must also learn to deal with internal factors, such as management, and work within the company's guidelines. The FLEs complain of being expected to express positive emotions as they are interacting with customers and act in such a way as to build trust, demonstrate promptness and reliability, and give a sense of personal attention to each passenger (Hochschild, 1983). The FLEs state that this is hard to do when moments earlier they were verbally abused by a customer. Even after being verbally or physically abused by a customer, these FLEs said that their airline managers discouraged them from pressing charges or reporting the incident. "International aviation organizations, deeply anxious about maintaining the integrity of their industry, become understandably

upset when they hear how air rage negatively influences the public's perception of air travel" (Anonymous & Thomas, 2001, p. 102). In turn, a high-quality performance is shown to enhance customer satisfaction and loyalty (Singh, 2000).

Very little has changed since Bateson's (1985) analysis of the frontline jobs as a "three-cornered fight" in which the customer and the organization are each at one end of the spectrum and the frontline employee is "caught in the middle" (Singh, 2000). The negative job performance exhibited by FLEs could definitely affect the ways these employees respond to airline customers. One of the biggest problems that exists today within the airline industry is the constant complaint from customers regarding the deterioration of service (McCollough, Berry, & Yadav, 2000). An employee's behavior is critical and can be directly correlated to shaping the perception of the organization's image, the customer's expectations of service, and possibly a reaction to perceived lack of service.

Sheth, Sisodia, and Sharma (2000) propose that the confluence of demographic and technological factors will lead to the widespread adoption of customer-centric marketing in place of product and segment-centric marketing as a way to effectively and efficiently serve customers and consumers in this century. The focus, according to these researchers, is now shifting from merely selling to customers, to servicing customers effectively. Being customer-oriented allows firms to acquire and assimilate the information necessary to design and execute marketing strategies that result in more favorable customer outcomes. Even if consumers may not have the expectation of 100% error-free service all of the time, customers do expect the airlines to implement procedures to keep them abreast of various current irregularities and to minimize service failure. In an industry plagued by bad press regarding declining customer service, the implementation recommendations presented here would greatly influence one's overall customer satisfaction outcomes and requirements.

Airline customers resent the ways in which FLEs respond to questions, give information, and express negative attitudes. These behaviors probably reflect the employees' unhappiness with work conditions. New research points to rudeness and bad behavior as major sources of stress and aggravation for both the passengers and transportation workers (Public Agenda, 2003). This customer perception of the airline employees sends customers into an air rage episode (Singh, 2000).

1. Sixty-five percent of passengers say rudeness is a serious problem in travel these days, and 52% of travelers say rudeness is a major cause of stress. Fifty-four percent of travel employees say passenger rudeness is a top cause of their on-the-job stress and tension.

2. Nearly half (49%) of travel workers say they have personally seen a situation where disrespectful behavior threatened to escalate into

physical confrontation. An additional 19% say disrespect has led to a situation actually getting physical.

3. Sixty-two percent of travel personnel say they sometimes or often see their fellow workers being rude, and another 50% admit that they have lost patience and been impolite to passengers themselves. But when this happens, 56% say it is typically because employees were provoked and treated badly by passengers. While most passengers give travel personnel high marks for overall courtesy, 67% say that when they have a run-in with rude travel employees, they are likely to be rude in return.

4. Nevertheless, 62% of transportation employees say rude and disrespectful behavior is "mostly limited to a few people," and 45% say they are often treated with courtesy and respect. (Public Agenda, 2003, para. 4)

According to Public Agenda President Ruth Wooden:

Incivility is not just a minor daily irritant. . . . We found that 79% of Americans say lack of respect and courtesy is a serious problem. And where do we see some of the worst behavior in everyday life? Where do we see good people go bad? Too often—we see it or cause it ourselves—when we travel. Bad manners and rude behavior can make modern travel a trying and sometimes unpleasant experience. (Public Agenda, 2003, para. 8)

Numerous contemporaneous reports of actual incidents exist, with observers and those directly involved invariably recounting overall or episodic service failures as the precipitating cause of air rage. The role of customer expectations and the provision of good service in marketing success are unquestionable. The delivery of quality service is considered an essential strategy for success and survival in the industry (Dawkins & Reicheld, 1990; Zeithaml, Berry, & Parasuraman, 1985, 1988, 1996; Reicheld & Sasser, 1990). Zeithaml, Berry, & Parasuraman (1996) state without exception that poor service in the airline industry results in a customer's change in carriers, or in diminished use of the unsatisfactory line. Interestingly, a number of behaviors are listed as characteristic of customers who are dissatisfied to the point where service is minimized and often discontinued when perceived as unacceptable. Strenuous complaints are among the behaviors listed and one wonders if this behavioral characteristic might also sometimes approach the level of rage (Zeithaml, Berry, & Parasuraman, 1996).

The criticality of customer service to profitability has been analyzed and quantified by Zeithaml (2000), who refers to the monetary value of the single, average customer who is attracted to a carrier and who remains loyal

to the line (Shimp, 2000). He refers to this as the Customer Lifetime Value, using the new customer as a unit (which he calls the net present value or NPV) on which to project that potential lifetime value. Customer Lifetime Value is considerably diminished by the loss of the customer's loyalty, and the value of retention has been quantified in general by Reicheld and Sasser (1990), who say that a carrier boosts its profits by nearly 100%, with a mere 5% increase in customer retention. Customer retention is critical to profitability (Stauss & Friege, 1999).

How do airlines determine what customers want in service, and whether their expectations are being met? How do airlines improve customer service which has been deemed unsatisfactory by customers? Measurement criteria include customer feedback by way of complaints and compliments received by customer service personnel and via surveys (McCollough, Berry, & Yadav, 2000), records of compliance with industry and federal mandates such as on-time departure rates, and those developed by quality process consultants (Zeithaml, Berry, & Parasuraman, 1996). The criteria have been informative and helpful to the airlines.

WILL THE AIR RAGE PHENOMENON DECLINE?

In 1999, to prevent new regulations, most of the nation's airlines promised in a letter to Congress to improve customer service. However, additional federal standards may be forthcoming. Congressional passage of the Passenger Bill of Rights will set standards for service performance and impose penalties for non-compliance ("Congress Considers," 2000). Below are the major points of the bill (Airline Passenger's Bill of Rights, 2000):

> The Airline Passenger Fairness Act is not only designed to improve the customer service aspect of the airlines, but also to alleviate many small annoyances that the average air traveler may run into. Major points are: (a) inform a ticketed passenger whether or not his or her flight is overbooked; (b) permit a passenger holding a confirmed space on a flight to use only a portion of his or her ticket for any reason; (c) deliver a passenger's checked baggage within 24 hours of the flight the passenger was on, with minor exceptions; (d) provide the consumer with full access to all fares for that air carrier, regardless of the technology the consumer uses, based on the request of that consumer; (e) provide notice to each passenger holding a confirmed reserved space on a flight with reasonable prior notice when a scheduled flight will be delayed for any reason (other than reasons of national security); (f) inform passengers accurately and truthfully of the reason for the delay, cancellation, or diversion of a flight and refund the full purchase price of an unused ticket if the passenger requests a refund within 48 hours after the ticket is purchased; (g) disclose to consumers information that would

enable them to make informed decisions about the comparative value of frequent flyer programs among airlines. (para. 3)

The institution of incentives, such as frequent-flyer miles and deluxe accommodations for frequent flyers, is one method used by carriers to improve at least the perception of service (Shimp, 2000). "It is not the absolute benefits [of frequent flyer program] but the relative gains compared to that of the other carriers that matter to individual travelers" (Chin, 2002, p. 56). However, ongoing excellence in service and service upgrades are more attractive to customers than such incentives, and the managerial goal of a carrier must be to establish an organization that fosters employee behavior that improves customer service (Brady & Cronin, 2001). These relationships are borne out by a Northwest Airlines study that tracked specific service improvements with its "preference index," (i.e., the consumer's expression that Northwest was his or her first choice among carriers). The correlation, they found, was direct (Zeithaml, Berry, & Parasuraman, 1996). "A carrier's complete commitment to gauging, evaluating and meeting customer expectations, and the extent to which that commitment permeates every personnel layer in the organization, is universally seen as key in customer service maintenance and improvement" (Reilly, 1996, p. 39).

The paradigm for total commitment to service quality, and the belief that profit and growth will follow and not drive that commitment, is the conviction of the head executives at Nordstrom Department Stores. The executives contend that the Nordstrom philosophy is its commitment 100% to customer service. They say they are not committed to financial markets, real estate markets, or to a certain amount of profit. Rather they are only committed to customer service (Spector & McCarthy, 1995).

Application of this principle to the airline industry was seen by Sheth, Sisodia and Sharma (2000). The entire focus of efforts toward profitability needs to shift from sales to service. How does an organization ensure that this attitude pervades its entire structure? The reworking of job performance standards and job performance evaluation at every level of personnel is essential (Reilly, 1996). Reilly believes that since the relationship of service to marketing success is measured in customer attraction and retention, the service performance of every employee can be measured regarding the extent to which that employee contributes to a measurable element of customer satisfaction. Since that is the case, an essential element in each employee's performance evaluation (affecting raises, promotions, etc.) should be a rise or fall in profit (Reilly, 1996).

What if service expectations are unreasonably high and the reaction to its lack of provision is extreme? Much research shows that meeting a customer's reasonable expectations is better in the eyes of the consumers than responding to failure with superior recovery. In other words, the job

should be done right the first time. Education and training of airline and airport employees are required for improved customer service and, potentially, a reduction in air rage. Quilty (2003) addresses this issue as follows:

> Education and training are often viewed as one and the same. However, scholars will point out a distinction between the two. Training is a response to a need and should stem from gap in knowledge or performance. Training is performed as a short-term focused response to organizational and individual job needs. A training need will exist when an employee's performance differs from what the situation or task requires. More specifically, a training need exists when a current employee's knowledge, skills, or attitudes should be changed to help bring about desired performance. In general, training prepares individuals to do their current jobs.   In   contrast   to   training, education   provides   a   broader,   more   generalized   acquisition   of knowledge and development that prepares an individual for a future job or position. Education also enhances the ability of an individual to understand and appreciate the larger perspective of how things work in their organization and in the world. (pp. 4-5)

METHODOLOGY

The goal of this study was to examine the correlations between airline customers' expectations of service and attitudes toward and propensity toward air rage, as well as the correlations between airline customers' perception of airline customer service and attitudes toward and propensity toward air rage. In addition, regression analyses were performed. The Air Passenger Survey (APS; see Appendix), designed by this author, consisted of 55 questions and was distributed to 244 men and women at four major airports: Chicago, Atlanta, Washington, D.C., and New York. The four survey scales were representative of four domains of air rage and airline customer service that have been constructed based on the literature: Customer Expectation of Service, Consumer Perception of Service, Attitude Toward Air Rage and Feelings About (Propensity to Commit) Air Rage.

RESULTS

Demographic variables (gender, age, race, place of residence, level of educational completion, marital status, reason for flying, what airlines the passenger refuses to fly, type of airline flown and number of years flying) demonstrated that the range of customers surveyed was representative of the flying public. ANOVAs were performed to detect any significant correlations between categorical demographic variables and the two scales Attitude toward Air Rage and Feelings about Air Rage. One demographic

variable, ethnicity (Caucasian vs. all other ethnicities), was found to be significantly correlated with Customer Attitude toward Air Rage. Two demographic variables, frequency of flying (once a week or more often vs. less frequent flying) and whether the customer refuses to fly certain airlines (yes or no), were significantly correlated with Customer Feelings about Air Rage.

Hypothesis 1

Hypothesis 1 stated that as customers perceive service to be better (as Customer Perception of Service increases), their attitude toward air rage becomes more disapproving (Customer Attitude toward Air Rage decreases). In other words, as Customer Perception of Service increases, Customer Attitude toward Air Rage will decrease, that is, there exists a negative correlation between Customer Perception of Service and Customer Attitude toward Air Rage. As can be seen in Table 1, the test found a non-significant positive correlation between Customer Perception of Service and Customer Attitude toward Air Rage ($r = .030$, $p > .05$). Therefore, the null hypothesis was upheld. (A non-significant correlation can be considered as zero.)

Table 1. Correlation between Customer Perception of Services and Customer Attitude toward Air Rage

Expected Result According to Hypothesis	Direction of Correlation Expected	Actual Correlation	Null Hypothesis Rejected?
As customers perceive service to be better, their attitude toward air rage becomes more disapproving.	Negative	0.030 ($p > .05$)	No

Possible explanation of results

Customers could approve of air rage if even after they received good service, bad service is provided, which causes a change in thought. In other words, it is possible that bad service was provided to a customer and as a result, an air rage incident occurred, which caused those customers to become more approving of air rage. Furthermore, a customer could disapprove of air rage for other reasons besides good customer service. For instance, customers may believe that air rage is totally unacceptable regardless of how someone has been treated; a customer, regardless of the service they have received, should still not act out or cause disruptive behavior.

Another possible thought on the part of customers is that if a customer was to act out, he or she could cause thousands of people to be hurt or lose their lives. Therefore, it may be that regardless of how customers perceive

service, they still disapprove of air rage because of the notion that air rage is not tolerated and by acting out there are many consequences. This theory is in line with the results of this study, which suggest that customers disapprove of air rage.

Hypothesis 2

Hypothesis 2 stated that as customers perceive service to be better (as Customer Perception of Service increases), they have less of a propensity toward air rage (Customer Feeling about Air Rage increases). In other words, as Customer Perception of Service increases, Customer Feeling about Air Rage will increase, that is, there exists a positive correlation between Customer Perception of Service and Customer Feeling about Air Rage. As can be seen in Table 2, the test found a moderate, significant positive correlation between Customer Perception of Service and Customer Feeling about Air Rage ($r = .425$, $p < .01$). Therefore, the null hypothesis was rejected.

Table 2. Correlations between Customer Perception of Service and Customer Feeling about Air Rage

Expected Result According to Hypothesis	Direction of Correlation Expected	Actual Correlation	Null Hypothesis Rejected?
As customers perceive service to be better, they have less of a propensity toward air rage.	Positive	0.425 ($p < .01$)	Yes

Possible explanation of results

Customers who perceive service to be better were found to have less of a propensity toward air rage. This may be further supported by Dahlberg (2001), who suggests that when customer needs are not attended to, the result would be negative interactions between customers and staff. In addition, if the airlines eliminated delayed flights, cancelled flights, rude service by airline staff, lack of correct information given to customers, seat assignment mix-ups, and many other situations prior to boarding an aircraft, then air rage might be less likely to occur.

Hypothesis 3

Hypothesis 3 stated that as customers' expectations for bad service increase (as Customer Expectation of Service increases), their attitude toward air rage becomes more approving (Customer Attitude toward Air Rage increases). In other words, as Customer Expectation of Service increases, Customer Attitude toward Air Rage increases, that is, there exists

a positive correlation between Customer Expectation of Service and Customer Attitude toward Air Rage. As can be seen in Table 3, the test found a moderate, significant positive correlation between Customer Expectation of Service and Customer Attitude toward Air Rage ($r =. 279$, $p < .01$). Therefore, the null hypothesis was rejected.

Table 3. Correlation between Customer Expectation of Service and Customer Attitude toward Air Rage

Expected Result According to Hypothesis	Direction of Correlation Expected	Actual Correlation	Null Hypothesis Rejected?
As customers' expectations for bad service increase, their attitude toward air rage becomes more approving.	Positive	0.279 ($p < .01$)	Yes

Possible explanation of results

When the airlines do not provide good service, the customers may become more approving of air rage. With the lack until now of empirical research on attitudes on air rage and customer service, this is a significant finding for airlines and should be investigated further.

Hypothesis 4

Hypothesis 4 stated that as customers' expectations for bad service increase (as Customer Expectation of Service increases), they have greater propensity toward air rage (Customer Feeling about Air Rage decreases). In other words, as Customer Expectation of Service increases, Customer Feeling about Air Rage decreases, that is, there exists a negative correlation between Customer Expectation of Service and Customer Feeling about Air Rage. As can be seen in Table 4, the test found a non-significant, positive correlation between Customer Expectation of Service and Customer Feeling about Air Rage ($r = .074$, $p > .05$). Therefore, the null hypothesis was upheld.

Table 4. Correlation between Customers' Expectation of Service and Customer Feeling about Air Rage

Expected Result According to Hypothesis	Direction of Correlation Expected	Actual Correlation	Null Hypothesis Rejected?
As customers' expectations for bad service increase, their feeling about air rage becomes for disapproving.	Negative	0.074 ($p > .05$)	No

Possible explanation of results

Just because customers expect bad service does not mean they will have a greater propensity toward air rage. Other factors such as physiological (e.g., psychiatric disorders) or physical (e.g., diseases, substance abuse), could provide reasons as to why individuals who expect bad service do not have a greater propensity toward air rage. As stated earlier, airlines have no control over such physiological and physical factors, and thus an individual could perceive service as bad and still not have a greater propensity to air rage. Also, even if individuals do not expect bad service, their propensity to air rage could result from underlying factors such as the fact that they are always the type to engage in aggressive behaviors, show signs of anger, frustration, irritability, hostility, rudeness, etc.

Another reason the null hypothesis was upheld could be that customers' expectations for high levels of service have decreased. Many people may realize that flight delays, overbooking, and lost baggage are more likely to occur than ever these days. If this is true, then customers go about their travel experience with these expectations in mind. Therefore, the chance of air rage occurring is suppressed.

Two regressions were performed, one with Customer Attitude Toward Air Rage as the dependent variable and one with Customer Feeling About Air Rage as the dependent variable. In both regressions, Customer Expectation of Service and Customer Perception of Service were the independent variables, and demographic variables significantly correlated with the dependent variable were treated as covariates. Thus, in the regression on Customer Attitude Toward Air Rage, ethnicity (Caucasian vs. all other ethnicities) was treated as a covariate, and in the regression on Customer Feeling About Air Rage, frequency of flying (once a week or more often vs. less frequent flying) and whether the customer refuses to fly certain airlines were treated as covariates.

Correlations among the independent and dependent variables are presented in Table 5. In the regression on Customer Feeling About Air Rage (see Table 6), Customer Perception of Service was found to have a

significant positive effect on Customer Feeling About Air Rage ($\beta = .47$; $p <$ .001), and Customer Expectation of Service was not found to affect Customer Feeling About Air Rage ($\beta = -.05$, *Ns.*). In other words, as customers perceive service to be better, they have less of a propensity toward air rage, but their expectation of service does not affect their propensity toward air rage.

Table 5. Correlations among Customer Expectation and Perception of Service and Customer Attitude and Feeling about Air Rage (N = 232)

	Customer Expectation of Service	Customer Perception of Service	Customer Attitude Toward Air Rage	Customer Feeling About Air Rage	Mean ± *SD*
Customer Expectation of Service	---				1.93 ± .53
Customer Perception of Service	.27***	---			2.60 ± .56
Customer Attitude Toward Air Rage	.28**	.03	---		2.10 ± .54
Customer Feeling About Air Rage	.07	.43**	-.07	---	3.52 ± .71

*Note. *$p < .05$. **$p < .01$. ***$p < .001$, two-tailed

In the regression on Customer Attitude toward Air Rage (see Table 7), Customer Expectation of Service was found to have a significant positive effect on Customer Attitude Toward Air Rage ($\beta = .32$; $p < .001$). In other words, as customers' expectations of poor service increase, their attitude toward air rage becomes more approving. Customer Perception of Service was not found to have a significant main effect on Customer Attitude toward Air Rage ($\beta = -.01$ *Ns.*). In addition, an interaction effect was found ($\beta = .03$; $p < .05$; see Figure 1). The interaction can be interpreted as follows: When customers expect good service, their perception of service does not affect their attitude toward air rage. When customers both expect and perceive poor service, they are more approving toward air rage than when they expect poor service and perceive that they are being served well.

Table 6. Regression Analysis of Customer Feeling about Air Rage

Independent Variables	R	R^2	ΔR^2	Overall F	F Change	df	T	Standardized β
Step 1	.16	.02		2.60		2		
Frequency of flying							.21	.01, *Ns.*
Refusal to fly certain airlines							1.67	.10, *Ns.*
Step 2	.48	.23	.20	12.07***	17.96***	3		
Customer expectation of service							-.74	-.05, *Ns.*
Customer perception of service							7.32	.47***
Customer expectation of service × Customer perception of service							.51	.03, *Ns.*

Note. *p < .05. **p < .01. ***p < .001, two-tailed

Table 7. Regression Analysis of Customer Attitude toward Air Rage

Independent Variables	R	R^2	ΔR^2	Overall F	F Change	df	T	Standardized β
Step 1	.26	.06		14.4***	14.4***	1		
Ethnicity (Caucasian vs. other ethnicities)							-4.40	-.27***
Step 2	.42	.18	.12	12.0***	10.6***	3		
Customer expectation of service							5.13	.32***
Customer perception of service							-.13	-.01, *Ns.*
Customer expectation of service × Customer perception of service							2.06	.13*

Note. *p < .05. **p < .01. ***p < .001, two-tailed

Figure 1. The Relationship between High and Low Levels of Customer Perception of Service and Customer Attitude toward Air Rage and High and Low Levels of Customer Expectation of Service

Estimated Marginal Means of A (Z-score)
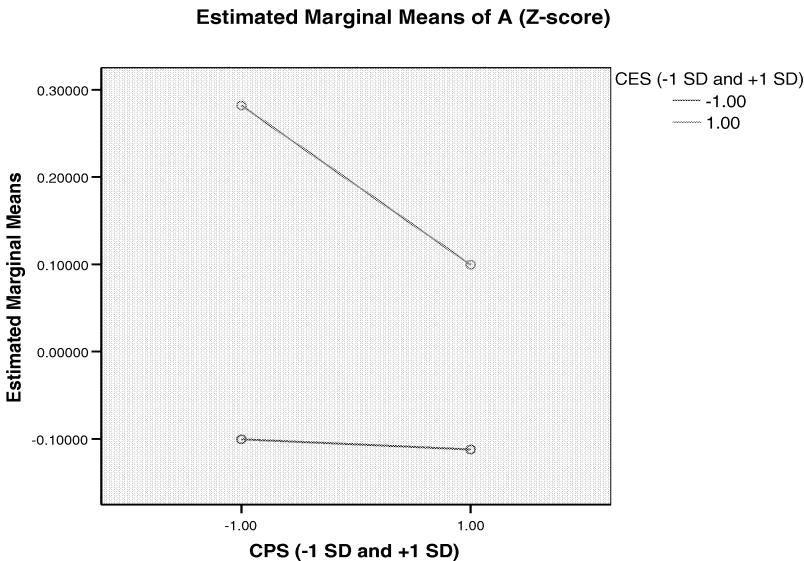
Note. CES = Customer Expectation of Service; CPS = Customer Perception of Service
A = Customer Attitude toward Air Rage; -1 SD = high levels; 1 SD = low levels

DISCUSSION

Survey results showed that the null hypothesis was accepted for Hypothesis 1. In other words, customers who perceive service to be better may not necessarily disapprove of air rage. As a matter of fact, air rage behavior may be favored. One reason the null hypothesis was upheld could be that many airline customers often feel they are entitled to certain privileges. If these privileges are not granted, they engage in disruptive behavior to get their way. People want things—information, gratification—now (Harkey, 2003). Having to wait one or two minutes is sometimes considered an inconvenience.

A second reason the null hypothesis was upheld could be society's attitude toward accepting the increased level of violence in our society today. Violence in society is increasing (Harkey, 2003). Because airline passengers mirror society, they may be more aggressive in their responses to delays or problems encountered when traveling (Harkey, 2003). Hence, air rage behavior becomes the norm and not the exception.

A third reason the null hypothesis was upheld for Hypothesis 1 could be that, as the literature suggests, people may be less inhibited or perhaps fear retaliation or consequences less when the target of their aggression is someone they do not know and who does not know them (Harkey, 2003). People now feel free to get into other people's faces in a way that they did not 20 years ago (Harkey, 2003). This supports the theory that customers still exist that are simply looking for a fight even if they perceive service to be better.

Survey results rejected the null hypothesis for Hypothesis 2. As customers perceive service to be better, they have less of a propensity toward air rage. Dahlberg (2001) suggested that service failures experienced prior to boarding the aircraft can be antecedents to overt conflict in the passenger cabin, where cabin crews cannot meet passenger needs immediately because of safety tasks having priority over service tasks during critical phases of the operation. This is a prime example of the idea that if good service was provided from the beginning, then the incidence of air rage might be lessened. It would be interesting to put this theory into practice by examining whether advance notification to customers regarding delays or cancelled flights would decrease customers' propensity toward air rage. The caveat to this theory is that air rage incidents might have a number of antecedents and might occur not because the airline triggered a response in the passenger, but rather because the customer is acting out due to some other internal or external factor.

Survey results rejected the null hypothesis for Hypothesis 3. As customers expect worse service, their attitude toward air rage becomes more approving. This finding could have resulted from the fact that the customers have a good understanding of when an airline provides bad service that customers are more approving of air rage. Moreover, there are valid circumstances, caused by the airline, for customers to act out. However, careful consideration should be given to this finding. Just because as customers' expectations for bad service increase and their attitude toward air rage becomes more approving, this does not mean that they will have a greater propensity toward air rage as was the finding in Hypothesis 4. Moreover, the statistical finding for Hypothesis 3 yielded a weak correlation, meaning that not all customers with expectations for bad service will have more approving attitudes toward air rage. This could be because customers believe that one should do what is right despite what the airline does wrong. This is more important than reacting to bad service.

Over the years, customers have become less tolerant of the bad service provided by the airlines. In a recent poll, 57% of travelers said they think the experience of flying has gotten worse over the past five years (Bryant, 2001). Given this, many airlines can expect an increase in customers' attitudes towards air rage. Furthermore, given the perception that the increase in air

rage incidents arises from the increase in poor service, we as researchers can expect customers to be more approving of air rage in the future, unless the airlines provide strategies to help alleviate customers' perceptions of bad service.

One way to alleviate customers' perceptions of poor service and attitude toward air rage is by following the poor service with a positive act. If this is done, then the customers' perception of poor service could be moderated because the airline essentially made up for the bad service provided. A simple positive act by the airline can help a customer become less approving of air rage. Customers who experience positive acts by the airline following bad service may begin to change their attitude and think differently about air rage. For instance, customers could say to themselves that air rage should not be acceptable when the airline does everything possible to make up for the bad service.

Survey results showed that the null hypothesis was accepted for Hypothesis 4. As customers expect worse service, they have a greater propensity toward air rage. This finding might have resulted because customers who have experienced bad service do not necessarily have a greater propensity toward air rage. With all the hype about acting out on airplanes and the remnants of 9/11, many people today would not think about acting out simply because they have experienced bad service. People today might realize that acting out will not get anything accomplished and that doing so could lead to imprisonment, restraint from flying, or other sanctions the airline wishes to impose.

Moreover, the traits and characteristics of most people responding to the study might not be conducive to a great propensity toward air rage. For instance, even if a person who is elderly has an experience with bad service, they may not have the desire or strength to display air rage. Their propensity toward air rage is lessened because of their status. This may also be true for teens, people with cognitive impairment, introverts, and others with easy going temperaments. Some people are more passive and will not respond no matter how bad the service is that is experienced. In addition, people may also realize that bad service comes with the territory. Flight delays due to weather could be perceived as bad service, but in actuality, a flight delay is an issue outside of the airlines' control. A flight delay is very different than lost baggage, mixed-up seating, and personnel attitudes, to name a few. Therefore, it is imperative that future research looks at what defines bad service and the traits and characteristics of people with expectations for bad service. This paper did not evaluate cultural risk perceptions and service quality expectations. A recent paper provides an excellent perspective on the potential differences in customer risk perceptions across cultures (Cunningham, Young, & Lee, 2002). Airline Quality Rating 2006 is an objective method that assessed multiple monthly performance criteria during

2005, with scores based on four major areas: on time, denied boarding, mishandled baggage, and customer complaints. These kinds of reports are paramount to the improvement of airline customer services if utilized by members of the industry (Bowen & Headley, 2006).

CONCLUSIONS AND IMPLICATIONS FOR THE AIRLINE INDUSTRY

The study has significant implications for the airline industry, the transportation industry, and society in general, as well as for marketing and transportation scholars. One of the challenges presented herein was for airlines to find ways to assist personnel in dealing with customers and delivering impeccable customer service in an effort to deter air rage incidents. As the airline industry continues to make major changes to its operations, several items must be taken into consideration when trying to improve processes and lessen the number of air rage incidents. First, airlines must learn to recognize customers' behaviors that can lead to air rage before the customers are allowed to board the plane. If such behaviors are suppressed in the terminal, the likelihood that an incident will occur in the air is diminished. Airlines should train customer service agents regarding such behaviors and look for ways to eliminate negative behaviors or acts. For instance, they can develop profiles of individuals who have acted out in the past and use these profiles to train customer service agents what to look for. The current problem is that customer service agents are reactive to customer needs rather than being proactive, which causes poor customer satisfaction and possibly increases the number of air rage incidents.

Second, airlines must recognize that simply providing a response the customer wants to hear is not enough. Airlines must establish ground rules for customer behavior and adhere to those rules. Customers must be made aware of new regulations and policies regarding disruptive behavior. Customers must be warned as to the consequences for committing an air rage incident in the terminal or on board an aircraft. The warnings regarding disruptive behavior should differ from the standard regulations and policies provided to customers at the beginning of a flight, which mention that federal law prevents passengers from tampering with smoke detectors, carrying a gun onboard, etc. Rather, what is needed is information that makes clear that certain types of behaviors will not be tolerated on airplanes, and specifies the consequences for disruptive behaviors. A change in federal law may be necessary for the airlines to enact such new policy.

Third, in order for airlines to reduce air rage, airline personnel must rededicate efforts to creating customer satisfaction and lessening the negative attitudes toward airlines by reinforcing the marketing concept that an organization should make every effort to satisfy customer needs. In other

words, give customers exactly what they want. The one-size-fits-all solution to maintaining customer satisfaction is not the recommended approach.

Finally, airlines must recognize that communication is one of the major problems contributing to air rage. Quite often, airlines do not communicate the exact nature of the problem to customers in a timely manner. Many customers become totally frustrated with long lines, delayed flights, etc. When no information is given in a crisis, the problem is exacerbated. Airlines must be sensitive to the fact that customers are motivated to comply with polices for different reasons and that, in order for customers not to become irate, solutions must be provided based on individual customers needs and desires.

Airlines must recognize that many of the negative behaviors exhibited in a terminal or during a flight are not necessarily a direct result of something the airlines has done. Disruptive behavior on the part of customers might be due to reasons other than poor customer service delivered by the airlines and will decline or reverse itself with improved services. Airlines must ensure some method of suppressing any negative behavior and satisfying or pacifying the traveler. "People and processes, not peanuts and pillows make the difference," Powers wrote (2006). Therefore, airlines of all different classes and sizes should develop a uniform method of addressing air rage. Airlines must develop plans in collaboration and provide similar service. Customers perceiving consistency from one airline to another will become more satisfied with traveling. In turn, customers will be more likely to comply with rules, regulations, and policies. Hopefully, airline customers will become more receptive to flying and less likely to exhibit disruptive behavior.

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APPENDIX

Air Passenger Survey
Demographics

1.   Gender: Male _____ Female _____

2.   Age: _____

3.   Race/Ethnicity:

   a.   White/Caucasian _____
   b.   African-American/Black/Negro _____
   c.   Latino/Hispanic _____
   d.   Asian/Pacific Islander _____
   e.   Native American _____
   f.   Other _____

4.   Where do you currently reside (U.S. state or country)?

   a.   State: _____
   b.   Country: _____

5.   Highest level of education completed:

   a.   Some High School _____
   b.   High School Diploma /GED _____
   c.   Some College _____
   d.   Associate Degree _____
   e.   Bachelor's Degree _____
   f.   Master's Degree _____
   g.   Professional Doctorate (M.D., J.D., Ed.D., D.B.A., Psy.D.) _____
   h.   Ph.D. _____

6.   Marital Status:

   a.   Married _____   c.   Divorced _____
   b.   Single _____   d.   Widowed _____

7.   What airline do you fly most often? _____

8. Do you refuse to fly any airline?

    a. Yes _____   No _____

    If Yes, which airline(s)?
    _____

9. Do you fly for:
    a. Business _____   b. Pleasure/Personal _____   c. Both _____

10. How often do you fly? _____

11. Do you usually fly:

    a. First Class _____ b. Business Class _____   c. Coach Class _____

12. How many years have you been flying? _____

Questionnaire

Please circle the response that represents your view.

13. **Airline customer service should be:**

    a. Poor   b. Average   c. High   d. Very High

14. **As an airline customer, I expect to feel important in the eyes of the airline.**

    Strongly   Agree   No Opinion   Disagree   Strongly
    Agree   Disagree

15. **I expect to receive efficient service from airline personnel.**

    Strongly   Agree   No Opinion   Disagree   Strongly
    Agree   Disagree

16. **I expect the airline to provide me with comfort.**

    Strongly   Agree   No Opinion   Disagree   Strongly
    Agree   Disagree

17. **The airline believes that the passenger is always right.**

    Strongly   Agree   No Opinion   Disagree   Strongly
    Agree   Disagree

18. **I expect airline personnel to behave toward me in a friendly manner.**

    Strongly   Agree   No Opinion   Disagree   Strongly
    Agree   Disagree

19. **I feel the airlines are unconcerned about my ability to successfully make connecting flights.**

    Strongly   Agree   No Opinion   Disagree   Strongly
    Agree   Disagree

20. **Decreased service in the airport terminal is a significant cause of disruptive behavior on the airplane.**

    Strongly   Agree   No Opinion   Disagree   Strongly
    Agree   Disagree

21. **The service provided by the airlines is terrible.**

    Strongly   Agree   No Opinion   Disagree   Strongly
    Agree   Disagree

22. **Poor customer services cause passengers to be dissatisfied.**

    Strongly   Agree   No Opinion   Disagree   Strongly
    Agree   Disagree

23. **Poor customer service frustrates passengers.**

    Strongly   Agree   No Opinion   Disagree   Strongly
    Agree   Disagree

24. **What is your status as it relates to smoking?**

    a. Smoker   b. Never Smoked   c. Former Smoker

25. **My in-flight stress increases because I am not able to smoke during a flight.**

Strongly   Agree   No Opinion   Disagree   Strongly
Agree   Disagree

I Don't Smoke _____

26. **I get frustrated during a flight because I feel less than adequately attended to by the flight crew.**

Strongly   Agree   No Opinion   Disagree   Strongly
Agree   Disagree

27. **I feel that cabin crews are inadequately trained in providing quality service.**

Strongly   Agree   No Opinion   Disagree   Strongly
Agree   Disagree

28. **When I feel that the ticket agent has treated me rudely, I feel:**

Angry   Disappointed   Frustrated   Demeaned   Upset

29. **Airline personnel in the airport terminal are less responsive than personnel in other industries.**

Strongly   Agree   No Opinion   Disagree   Strongly
Agree   Disagree

30. **When I feel crowded on an airplane I become:**

Angry   Frustrated   Stressed   Uncomfortable

31. **Have you ever witnessed an act of disruptive behavior on a flight?**

a. Yes   b. No

32. **Was it started by:**

a. Airline Staff   b. Passenger

33. **If so, were you personally affected by this act?**

a. Yes   b. No

34. Do you know someone whose flight behavior has been disruptive?

a. Yes   b. No

35. Have you ever been involved other than as a witness in flight disruptive behavior?

a. Yes   b. No

36. I feel that flight disruptive behavior with physical contact should be treated as a criminal matter.

| Strongly | Agree | No Opinion | Disagree | Strongly |
| Agree | | | | Disagree |

37. Passengers have the right to act to prevent flight disruptive behavior.

| Strongly | Agree | No Opinion | Disagree | Strongly |
| Agree | | | | Disagree |

38. Airline employees have the right to act to prevent flight disruptive behavior.

| Strongly | Agree | No Opinion | Disagree | Strongly |
| Agree | | | | Disagree |

39. I think that airport personnel can help prevent flight disruptive behavior.

| Strongly | Agree | No Opinion | Disagree | Strongly |
| Agree | | | | Disagree |

40. I think that some acts of flight disruptive behavior are justifiable.

| Strongly | Agree | No Opinion | Disagree | Strongly |
| Agree | | | | Disagree |

41. **No passenger should be allowed to get away with flight disruptive behavior.**

Strongly   Agree   No Opinion   Disagree   Strongly
Agree   Disagree

42. **I think that flight disruptive passenger behavior has increased since September 11, 2001.**

Strongly   Agree   No Opinion   Disagree   Strongly
Agree   Disagree

No Experience With This _____

43. **When the food on the airplane is bad, I get upset.**

Strongly   Agree   No Opinion   Disagree   Strongly
Agree   Disagree

No Experience With This _____

44. **When no food service is offered on the airplane and I did not know this in advance, I get upset during the flight.**

Strongly   Agree   No Opinion   Disagree   Strongly
Agree   Disagree

No Experience With This _____

45. **When no food service is offered on the airplane, even though I knew in advance that no food would be offered, I get upset during the flight.**

Strongly   Agree   No Opinion   Disagree   Strongly
Agree   Disagree

No Experience With This _____

46. **When a mix-up occurs about my seat on the plane, I get upset.**

Strongly   Agree   No Opinion   Disagree   Strongly
Agree   Disagree

No Experience With This _____

47. **When I cannot find room to put away my carry-on bag on the plane, I get upset.**

Strongly   Agree   No Opinion   Disagree   Strongly
Agree   Disagree

No Experience With This _____

48. **I find the security screening at airports upsetting because it invades my privacy.**

Strongly   Agree   No Opinion   Disagree   Strongly
Agree   Disagree

No Experience With This _____

49. **I find the security screening at the airports upsetting because it takes too much time.**

Strongly   Agree   No Opinion   Disagree   Strongly
Agree   Disagree

No Experience With This _____

50. **When airline personnel refuse to serve me an alcoholic drink, I get upset.**

Strongly   Agree   No Opinion   Disagree   Strongly
Agree   Disagree

I Don't Drink On Planes _____

I Am Always Served Drinks _____

51. **Decreased service on the airplane is a significant cause of disruptive passenger behavior on the airplane.**

Strongly   Agree   No Opinion   Disagree   Strongly
Agree   Disagree

52. **I get frustrated during a flight because I felt less than adequately attended to by airline personnel in the airport terminal.**

Strongly   Agree   No Opinion   Disagree   Strongly
Agree   Disagree

53. **I feel that airline personnel in the airport terminal are inadequately trained in providing quality service.**

Strongly   Agree   No Opinion   Disagree   Strongly
Agree   Disagree

54. **Flight crews are less responsive than personnel in other industries.**

Strongly   Agree   No Opinion   Disagree   Strongly
Agree   Disagree

55. **Please rank each of the following as to how annoying it is to you, with 1 representing not annoying at all and 5 representing extremely annoying.**

    a. A flight delay   1   2   3   4   5

    b. A cancelled flight   1   2   3   4   5

    c. Rude personnel   1   2   3   4   5

    d. Poor service   1   2   3   4   5

    e. No food service   1   2   3   4   5

    f. High fares   1   2   3   4   5

    g. Lack of baggage space   1   2   3   4   5

    h. Security check   1   2   3   4   5

EMERGENCY PREPAREDNESS FOR CATASTROPHIC EVENTS AT SMALL AND MEDIUM SIZED AIRPORTS: LACKING OR NOT?

Kathleen M. Sweet
Purdue University
West Lafayette, Indiana

ABSTRACT

The implementation of security methods and processes in general has had a decisive impact on the aviation industry. However, efforts to effectively coordinate varied aspects of security protocols between agencies and general aviation components have not been adequately addressed. Whether or not overall security issues, especially with regard to planning for catastrophic terrorist events, have been neglected at the nation's smaller airports is the main topic of this paper. For perspective, the term general aviation is generally accepted to include all flying except for military and scheduled airline operations. General aviation makes up more than 1 percent of the U.S. Gross Domestic Product and supports almost 1.3 million high-skilled jobs in professional services and manufacturing and hence is an important component of the aviation industry (AOPA, n.d.). In both conceptual and practical terms, this paper argues for the proactive management of security planning and repeated security awareness training from both an individual and an organizational perspective within the general aviation venue. The results of a research project incorporating survey data from general aviation and small commercial airport managers as well as Transportation Security Administration (TSA) employees are reported. Survey findings suggest that miscommunication does take place on different organizational levels and that between TSA employees and airport management interaction can be contentious and cooperation diminished. The importance of organizational training for decreasing conflict and increasing security and preparedness is discussed as a primary implication.

Kathleen M. Sweet is an Associate Professor at Purdue University's Department of Aviation Technology and the University of Connecticut's Department of Continuing Studies. She teaches courses in Aviation Security, Terrorism and Strategic Intelligence. She is CEO and President of Risk Management Security Group. Dr. Sweet received degrees from Franklin and Marshall College and Temple University. After law school, Dr. Sweet joined Wyeth International Pharmaceuticals as a legal specialist. She later joined the US Air Force and was a member of the Judge Advocate General's Department. After 15 years as a JAG, she transferred to the 353rd Special Operations Wing as a military political affairs officer. She was later an intelligence officer assigned to HQ AMC as an executive officer and briefer. In 1995, she became an Assistant Air Attaché to the Russian Federation. She also instructed at the Air War College International Security Studies division. She is the author of four books, *Terrorism and Airport Security*; *Aviation and Airport Security: Terrorism and Safety Concerns*; *The Transportation Security Directory*; and *Transportation and Cargo Security: Threats and Solutions*.

METHODOLOGY

Eighteen graduate and undergraduate students from the disciplines of aviation technology, aviation flight, aviation administration, and aviation security were recruited for this study. The research team coordinated with different types of aviation organizations, including regional, general, and corporate aviation, to both develop and implement the survey. The specific goal of the research team was to work on the development of a survey to solicit the opinions of knowledgeable individuals within the general aviation system concerning the degree of emergency catastrophe planning currently in place, basic knowledge of forensic protocols and the successful interaction of individual responsible parties within the overall system. Names and addresses were randomly selected from the *Transportation Security Directory* (Sweet, 2005b). The questions themselves were comprised of elements from proposed questions obtained from industry representatives when asked what information would be of interest to them concerning emergency disaster planning and the effectiveness of interaction with the TSA.

More specifically, development of the industry survey of catastrophe planning policies and practices occurred in four phases. First, each research team developed potential survey questions and queried industry professionals across the United States as to their interest in the subject matter. Second, collaboration occurred across the graduate and undergraduate students to construct a preliminary survey that integrated the ideas of each research team and incorporated relevant questions obtained from the industry professionals contacted. Third, industry and government representatives from each type of aviation organization again were contacted to comment on the final survey and make any additional recommendations as to content. After these discussions, some questions were deleted or modified. Fourth, the entire research team met to integrate the findings from the organizational interviews and finalize the survey. In that so many of the queried industry professionals recommended the same questions, a reasonable amount of validity was acquired.

Two versions of the survey were developed; one for airport managers and one for TSA personnel. Virtually the same questions appeared on both surveys with only slight variations. The survey contained 40 questions, measured on a 7-point Likert scale, with a *not applicable/don't know* option. For example, one question posed the statement "current planning procedures need improvement" and asked respondents to indicate a response to this statement with *strongly disagree* (1), *somewhat agree* (4), and *strongly agree* (6). In addition, open-ended and closed-ended questions were asked to gather general demographics and information about security awareness

training and knowledge of forensic aspects of catastrophe protocols. For example, a close-ended, yes or no question asked whether "a training class, including both airport management and TSA personnel, based on forensic aspects of post-catastrophe planning, would be beneficial to the airports operational status." Respondents were then asked in an open-ended fashion why or why not and blank lines were provided to write in personal rationales for their responses. A comprehensive list of airports was generated including regional/feeder airports, general aviation, and corporate operations. This sample of responses was considered representative because the individuals who completed this survey were randomly chosen and reflected similarity in response. A total of 505 surveys were distributed to a representative sample of airport professionals and TSA personnel from the list of organizations either by mail or personal delivery. Specifically, a survey was sent to 250 airport managers and 255 TSA employees across the United States. The sample size was small but it is believed a high degree of validity was obtained from interviewees. In addition, even though the respondent rate was also low, it is considered acceptable because no statistical analysis was conducted, only basic comparisons based on percentile statistics. Completion of the survey was purely voluntary. Out of the returned surveys, 64 contained usable data from airport managers and 28 from TSA employees. Several responses were not included in the analysis due to incompleteness. The response rate of usable surveys was therefore 27% for airport managers and 13% for TSA employees.

The survey concentrated on small to medium sized operations and not major airports. As background, the Federal Aviation Administration requires a full scale disaster drill every three years to test the emergency plan at airports certified for air carrier operations, but no such requirement exists for the type of airports included in this analysis. For example, at commercial airports, each certificate holder must coordinate an emergency plan with local law enforcement agencies, rescue and firefighting agencies, medical personnel and hospital organizations, principal airport tenants, and all other entities that have responsibility under the plan (Federal Aviation Regulations Part 139.325, n.d.). Again, by regulation, no such requirement exists for non-commercial airports. Therefore, the results of the survey reflect the lack of equivalent plans for the smaller aviation operations throughout the nation. After careful analysis of the collected surveys, it was determined there are six major areas of concern in regard to the knowledge, training, and planning of catastrophe response among the responding personnel. Those areas have been designated: intra-departmental communication, inter-departmental communication, planning, education/training, forensics, and attitude.

INTRODUCTION/ LITERATURE SEARCH

The managers of the new Department of Homeland Security have been struggling to combine 22 constituent programs and agencies to provide proper planning on a national level (U.S. General Accounting Office, 2003). Planning for a catastrophic event can seem like an exercise in futility and can lead planners to believe that whatever is prepared might be inadequate or possibly ineffective. Managers consequently tend to rely too heavily on government response in the event of a disaster. Since 9/11, state and local governments have established offices of homeland security or attempted to enhance the functions of existing emergency management departments (U.S. General Accounting Office, 2003). At the local and municipal level, however, disaster planning has lagged behind efforts seen at the national level (Federal Emergency Management Agency, 2002). Additionally, opinion polls have generally found that managers believe terrorist attacks are definitely going to take place, but simultaneously downplay whether it is going to happen to their organizations (Mankin, & Perry, 2003). To ensure the viability of the aviation system in general, it is imperative that disbelief regarding terrorism not be translated into a lack of action on the part of aviation managers and planners. Not planning can lead to increased injury, or even death, to passengers and personnel, while also contributing to the destruction of evidence. This results in a decreased ability to respond to a disaster appropriately and to apprehend the culprits involved in any deliberately contrived terrorist attack.

Additionally, airport officials need to at least be aware of appropriate emergency management and forensic techniques in order to safely react to the inevitable human toll and not to hinder any follow-on investigation. Having a decision plan can be useful in many respects. A plan to deal with a terrorist bomb, nerve gas or anthrax attacks is also useful in response to a workplace violence incident, earthquake impact, hazardous spill, large scale electrical failure, hurricane or flood (Mankin, & Perry, 2005).

Piecing together evidence is the job of qualified forensic experts brought to the scene, but team arrival may not be immediate; especially in the case of international or remote locations. Airport managers can therefore take advantage of basic plans which are readily available and public upon which they can tailor individual plans. For example, the National Fire Protection Association (NFPA) preparedness standard is already well known and used in the business community. The NFPA document provides preparedness basics and is applicable to many transportation sectors. (NFPA 1600, 2004). It includes hazard identification, assessment of the organization's resources, development of procedures for responding to a disaster and resuming

operations, development of communication systems and employee training (Cadrain, 2004). Airport managers and the TSA would do well to utilize its contents and template. In conjunction, airport operators, supporting airlines and the TSA must take care not to destroy crucial evidence in the event of a catastrophe, no matter how overwhelming that task may first appear. The majority of terrorist attacks against aviation have used either explosives or incendiary devices, the outcome of which has resulted in both human and structural damage.

There is of course a plethora of information and studies which have been done relating to the effects of a major commercial aircraft crash. However, there has been little work done on the threat awareness of small to medium sized airport managers, the effectiveness of their interaction with the TSA, their preparedness for major catastrophic events or their knowledge in the field of forensic investigation as it relates to aviation disasters. The responsibility of emergency preparedness and response in the event of a terrorist incident shifted from state and local governments to the federal government after 9/11. The concern raised by the event exposed the need to prepare and mitigate acts of terrorism and resulted in the federal government's financial support of approximately $11 billion from fiscal years 2002-2005 for state and local first responders (GAO Report, 2005). Section 2 of the Homeland Security Act (6 U.S.C.S 101) defines emergency response providers as including, "Federal, State, and local emergency public safety, law enforcement, emergency response, emergency medical (including hospital emergency facilities), and related personnel, agencies, and authorities" (6). Homeland Security Presidential Directive 8 further defined the term first responder as:

> Individuals who in the early stages of an incident are responsible for the protection and preservation of life, property, evidence, and the environment, including emergency response providers as defined in section 2 of the Homeland Security Act of 2002 (6 U.S.C. 101), as well as emergency management, public health, clinical care, public works, and other skilled support personnel (such as equipment operators) that provide immediate support services during prevention, response, and recovery operations. (PDD 8, 2003)

Airport managers clearly fit into these new definitions and will be held to the duty of reasonable care in protecting their facilities and acting appropriately in a disaster.

DATA ANALYSIS

Intra-departmental communication

It has often been said in management circles that plans are only good intentions unless they immediately translate into effective action. In addition, quality planning is critical to actual success (Farell, 2005). In conjunction with that perspective, respondents were specifically asked the question "what percentage of the time do you think miscommunication between personnel result in poor planning." Analysis of data indicates that both airport managers and TSA personnel believe that miscommunication results in poor planning about 50% of the time. These findings have several possible implications. The first may be that respondents have a sober view of communication issues in that they realize miscommunication does happen in organizations of all sizes from international airports down to the local grass strip. A second implication may be that as employees become aware that mistakes were made throughout the planning process, they correct them accordingly; factoring in the realization that miscommunication can result in poor planning.

Results vary between specific geographical regions as seen in the chart below, but generally speaking, all agreed some miscommunication took place. However, it cannot be assumed that, at present, airport managers and TSA personnel have dysfunctional communication networks within organizations and areas of influence. The data collected speaks only to the frequency of poor planning that is generated from previous miscommunication. It is reasonable to say that at least half of the airport managers and TSA employees who responded recognize that improvement might be needed.

Figure 1. Estimate of Percentage of the Time Miscommunication between Airport Personnel Result in Poor Planning, for Airport Managers and TSA Personnel, by Location of Airport
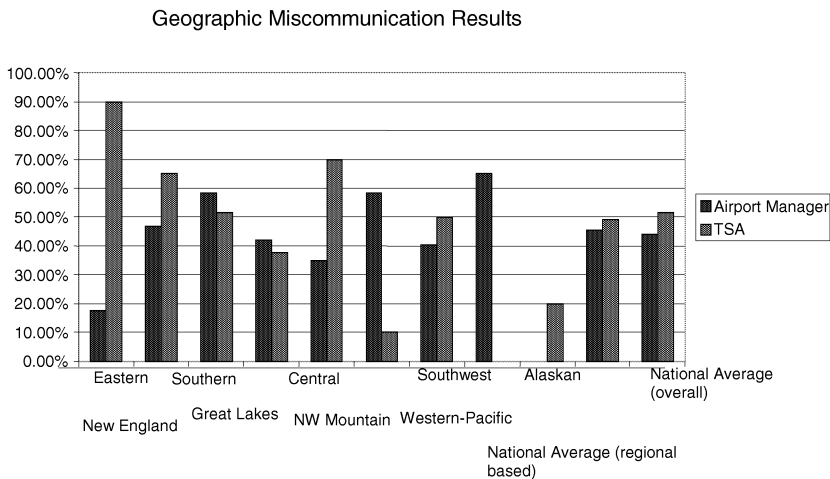
Even though managers might concede that poor planning may result about half of the time, they still clung to the belief that current planning was adequate. In light of recent events, both natural and terrorist, this premise is suspect at best. A revealing survey question asked "current methods of post-catastrophe readiness planning and training need improvement at this organization." The results indicate that personnel generally felt that current plans were adequate, as shown in the Figure 2. However, planning often seems not to be as effective in time of tragedy as expected and improved planning based on inter- and intra-organization cooperation can provide more successful results. Because planning should encompass the entire organization, assembling a disaster recovery team that represents all areas of the organization is the best way to approach the effort. That translates to complete cooperation between local authorities, the TSA and internal personnel. In the best of circumstances, the team should perform a business-impact analysis, help to develop and implement a recovery plan, test the validity of the plan, and execute the plan if and when a disaster strikes (Udelso, 2005).

Figure 2. Level of Agreement that Current Methods of Post-catastrophe Readiness Planning and Training Need Improvement at Their Organization, for Airport Managers and TSA Personnel

Current Plans Need Improvement
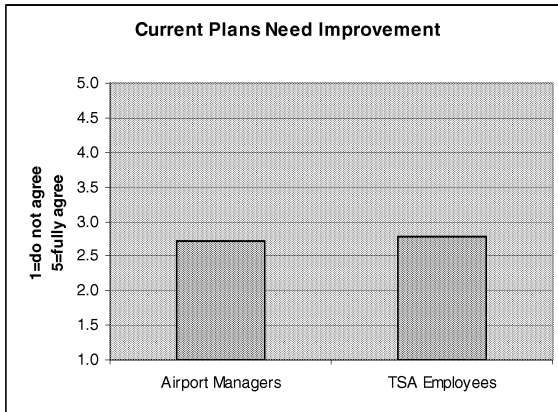
Consequently, organizations should always identify and address miscommunication issues with active feedback, training, and self-reporting systems for all employees. As in any organization, the human element creates the possibility for misunderstanding, error, or loss due to the actions of specific individuals. Human factors play a role in the design of any effective management and security plan within any environment. Therefore, because some miscommunication is inevitable, it is important for organizations, like airports, to have several layers of redundant planning built into the response capability (Sweet, 2005a). The results of the survey reflect that managers of small and medium sized airports and the TSA do not currently recognize this need.

Inter-departmental communication
Many different types of people, equipment, and governing organizations comprise civil aviation and all integrate into a complex system. If just one point in this divergent system is vulnerable, the entire system is equally exposed to that vulnerability. Potential miscommunication between primary government agencies responsible for security and the implementers is therefore deserving of critical analysis. Of note is the fact that both airport managers and TSA personnel feel they communicate best with a person who has an aviation background. Unfortunately, many TSA employees have little to no aviation education or experience. Additionally, the only group to list TSA personnel as easy to communicate with was TSA personnel. This reflects the likely existence of a communication barrier between airport management and the TSA. One airport manager went so far as to write he

communicated well with "all except TSA." The graph below portrays a visual representation of the perceived effectiveness of communication within an organization during a crisis.

Figure 3. Level of Effectiveness of Community within My Organization in Times of Crisis, for Airport Managers and TSA Personnel, by Location of Airport
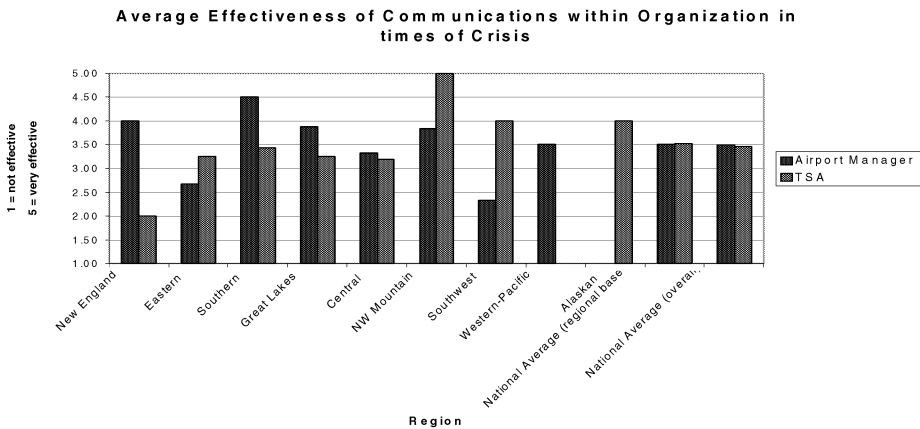
Data further indicates that only airport managers felt at ease talking with pilots, whereas TSA personnel indicated an indifference to them and their associated skills. This lack of focus regarding an essential element of the aviation hierarchy also evidences a distinct communication boundary between the TSA and the industry. Communication problems in this specific arena is disconcerting considering the importance of the link between TSA, the pilot and passenger security. In general, the data point toward the conclusion that the industry, in all aspects, lacks the ability to exchange information on a well-managed basis. Concurrently, the more experienced the operator, the less likely they believed in the effectiveness of the total communication chain, even though they did often express trust within their own organization.

As regards preparation, TSA personnel replied they had post-catastrophe/terrorism plans for general aviation airports and that coordination between agencies responsible for them was in place. Airport managers on the other hand did not support this conclusion. The divergent responses either indicate a distrust of the TSA's plans, not having plans, or poor communication between the airport manager and the TSA that such plans do exist. The disaster management process is driven by the understanding that nothing happens without a plan and that no plan is ever finished. When the smoke clears, the organizations that survive are the ones that constantly build, test and constantly improve disaster management plans

(Bean, 2002). Unfortunately, the surveyed airport managers appear to be comfortable with the current information gap that seems to exist between the TSA and general aviation airport management. The lack of direct contact, or oversight, was seen as a plus and not a negative by airport managers. One airport manager surprisingly returned the questionnaire asking "what is the TSA?" Training, and the continuing need for it, was a different matter. Further training, as regards security planning, was supported by TSA personnel but not airport managers in the field. TSA personnel rate security training as more effective than airport managers do but both organizations indicated current training is effective even when there was a lack of it. Only airport managers in the Northwest Mountain region considered training not to be effective at all.

More importantly, the data show that airport managers do not feel, on average, that they would work effectively with the TSA in times of a crisis or tragedy. Meanwhile, TSA personnel, on average, believe the opposite. This gap again highlights the communication problems between these organizations. Unsurprisingly, and as already stated, TSA personnel indicated they consider themselves easier to work with more frequently than airport managers do. The averages, both overall and regionally-based, show a wide discrepancy. For example, TSA personnel in the Alaskan region overwhelmingly noted that an it-won't-happen-here attitude permeates the environment. These data further support the contention that communication between the TSA and airport management is poor, and is even poorer when it specifically comes to security of the facility.

In light of the expressed attitudes, it is noteworthy that both groups feel miscommunication results in poor planning due to faulty communication. This assessment calls into question the validity of post-catastrophe plans. There is obviously miscommunication between airport managers and the TSA and therefore the plans might not be as effective or of as high quality as they could. More specifically, airport managers have more communication problems stemming from the use of acronyms and accessibility. TSA personnel indicate internal communication problems are rooted more in technology and personalities. Overall both groups indicated all four of the listed items—acronyms, accessibility, personalities, and technology—interfered with effectiveness. However, not any one item was noted more so than the others.

In analyzing the communications mode data, the order of perceived effectiveness between participants and modes of communication highlights some differences. It appears that TSA personnel are more comfortable with face-to-face, phone, electronic communications, written communications, and radio communications, in that order. Airport managers preferred electronic communications most, followed by written, phone, face-to-face, and, finally, radio. The differences in the preferred forms of communication

likely contribute to the gap in communications between airport managers and the TSA. Several TSA personnel also referred to the use of Blackberry devices and weekly meetings as most useful. Although the differences may appear minor, they do occur and are a contributing factor to overall lack of optimal communication. Experts recommend that a manager choose a system. They agree that each manager needs to designate one primary method to communicate. The method chosen must work with available technology, the group's preferred style, and the staff's skill level (Neil, 2005).

Training and planning as a combined function

The fundamentals of basic security are based upon proper planning, training and eventually executing the two seamlessly. However, planning, even if properly drafted, will only be successful if management wholly supports the concept. All too often, management does not support the needs of proper security until after tragedy and great loss occurs. Even then, the mindset is frequently lost when the immediate demand for increased security has rescinded. Therefore, it is imperative that upper-management always keep the issue in the forefront.

> By arming themselves with the knowledge they need to understand and manage catastrophic risk, *airports* can more accurately gauge the full spectrum of potential catastrophic risk they face, the financial impact those risks pose and their own abilities to handle that impact. Such knowledge does not have to be imported, however. In most cases, it already exists within the organization and needs only to be identified, captured and harnessed. Once done, it can drive an ongoing internal education process that will boost the ability to better manage catastrophic risk. (Otterson, 2005, p. 46)

The survey showed some interesting perceptions about planning: specifically, comfort levels of upper management, openness to making suggestions, and sense of readiness to respond to a catastrophic event.

As previously discussed, despite the relatively recent tragedies of 9/11, train bombings in Madrid and London, and hurricane Katrina in New Orleans, a significant portion of surveyed TSA personnel still felt that current methods of post-catastrophe readiness planning are sufficient and do not need improvement. Arguably, this is a function of a lack of proper training. As a regulative body of transportation security and a coordinating branch of public safety, it is of concern that any transportation component or regulatory agency retains that perception of preparedness. And when multiple city and government response plans have been exposed as weak— exhibiting multiple degrees of failure resulting in loss of life as well as critical infrastructure—the perception verges on dangerous. Training and planning are two tasks that should be routinely supplemented with

technological advancements, process improvements, and personnel refinements as well as enhanced practice efforts to ensure proper execution. Confidence—even if it does not rise to the level of overconfidence—conjures a scenario that has never proven to be very effective. There needs to be constant momentum for improvement, especially since recent events have proved that the minimally-required planning has not been adequate to handle the needs. The survey has exposed responses of complacency which could prove to have catastrophic results if not addressed.

Airport manager respondents were content with current training. It may be prudent to mention that when terrorists were selecting viable airports to carry out 9/11 they evaluated airports at many different cities. Assessments calculated likelihood of resistance and preparedness. Arguably, many airports evaded looming tragedy simply by being better prepared than another facility. Airport security is critical not only for the well being of a facility, but also of the public. Proximity to power plants, critical infrastructures, and national democratic symbols all are added reasons to be more prepared. It was not evident that airport managers accepted this perspective but it is critical that an organization be comfortable accepting new ideas for post-disaster readiness and awareness training.

> Action is frequently most effective when implemented locally so that local conditions are understood, and objections or concerns can be dealt with more immediately and directly, assuming that appropriate mechanisms exist to effect the desired action. Individuals can then be motivated to change their behavior, to spread the message and unofficially monitor, evaluate and enforce desired policies and actions. Disaster-risk reduction, sustainability and development cannot be forced on or "done" for others; people must accept those processes and undertake them themselves. (The 9/11 Commission Report, 2004)

While both TSA personnel and airport manager respondents feel current methods of catastrophe readiness planning are sufficient and do not need improvement, they did indicate an openness to suggestions about new training regarding post-catastrophe readiness and response. The graphic below indicates the high degree of agreeability to accept new ideas. Security is often one of the least funded budgetary items and frequently many suggestions, though acceptable, are never realized due to cost considerations. Ultimately, however, it should be stressed that it is cheaper to prevent than it is to repair. This is counter intuitive to the finding that many respondents feel their facility has an it-won't-happen-here attitude. If a facility believes it is not prone to attack, it has no reason to adequately prepare and learn how to adequately respond.

Figure 3. Level of Comfort in Suggesting New Ideas, for Airport Managers and TSA Personnel, by Location of Airport

Average comfort in suggesting new ideas
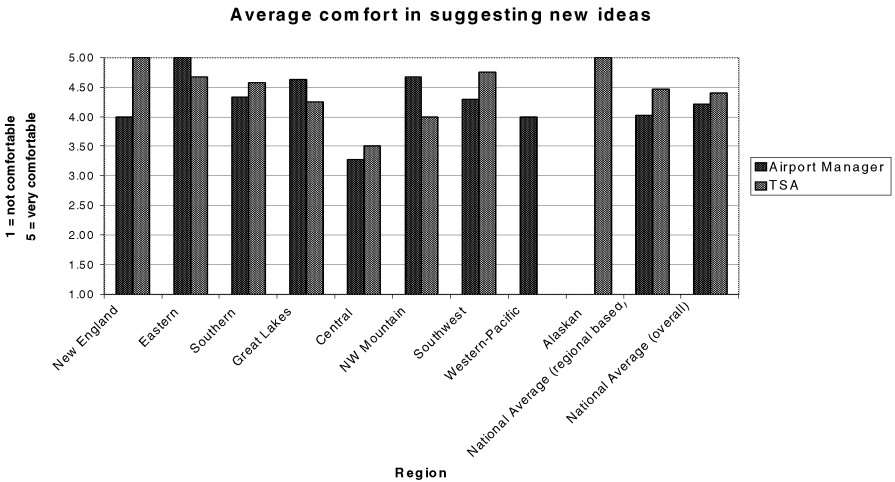
In summary, while TSA personnel and airport managers are open to suggestions, they seem overly confident that they will be able to respond and that they will not need to respond since their facility is not at risk. The only way to minimize physical costs of damage to a facility, disruption of the economy and loss of life is to have effective plans. Planning will enable faster response times, proper response by employees and allocation of resources by management. Clearly, adequate preparation is not likely when management believes it will not happen there. The Emergency Management Accreditation Program (EMAP) defines an emergency management program as "a jurisdiction-wide system that provides for management and coordination of prevention, mitigation, preparedness, and response and recovery activities for all hazards. The system encompasses all organizations, agencies and individuals responsible for emergency management and homeland security" (Bently, 2004). In other words, EMAP looks at coordination of a multi-agency, multi-disciplinary system for all activities that are needed to prevent, mitigate against, prepare for, respond to, and recover from a disaster. The program would provide yet another tool useful within the aviation venue.

Education/training
    This survey contained several inquiries to determine the level of experience, education, and training of TSA employees and airport managers. It was determined that airport managers have held positions about three times longer than TSA employees, and total years of experience in the

aviation field is about seven years longer. Certainly one reason that airport managers have held positions longer than TSA employees is because the TSA was not established until passage of the Aviation Security and Transportation Act in November 2001. Unfortunately, it is obvious that the TSA has not sought to hire individuals with extensive aviation experience. It is important to also note that the average total years of aviation experience for airport managers was about 27 years while the total for TSA employees was far less. Admittedly, experience measured in years does not necessarily equate to quality experience and increased knowledge in the field, but it is still worthy of recognition. An airport environment is unique and complex and experience in the industry can only add to disaster preparedness. Regardless, even with more experience in the aviation industry, airport managers feel less urgency as it relates to security training. When asked, "What is the frequency of your organization's recurrent security training" almost all of the TSA employees indicated they have some frequent training, with two responding that they did not know.

Figure 4. Number of Years in Their Current Position, for Airport Managers and TSA Personnel

Figure 5. Total Years of Aviation Experience, for Airport Managers and TSA Personnel

Airport managers, on the other hand, vary widely on frequency of training, and 30% responded they never had recurrent security training. These results show the need for standardized training among TSA employees and mandated requirements for airport manager training. When asked to rate how consistently the training policy was followed on a scale of one to five with one being never followed and five being always followed, airport managers responded with an average of 3.5 indicating that their training policy is followed for the most part. TSA employees averaged 4.4 indicating that their policy is followed more frequently than airport managers. It is also worth mentioning that no TSA employees answered 1 or 2 while there were many airport managers that responded their training policy was never followed. Therefore, while the TSA needs to work out standardization of training, airport managers need to create, implement, and continue security training. Of note is the fact that airport managers also need to include the agencies they will depend on in the event of an emergency in their training. For example, the police are clearly interested in training programs that entail an understanding of the complexity of airport policing and an attempt to professionalize it. It is important that they recognize an airport is a demanding, people-oriented environment, which requires some unique understanding from law enforcement officers, as well as knowledge of all aspects of airport and air carrier operations. "Due to extensive airport regulations and the demands placed upon airport police officers, the aviation security community should fully address the challenges of full-spectrum training and oversight" (Raffel, 2001).
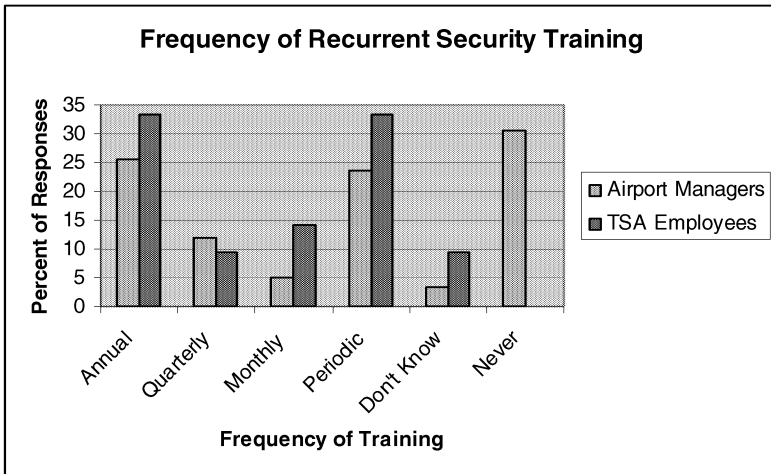
This survey also documents that TSA personnel rate the effectiveness of awareness training higher than airport managers do. Airport managers and TSA employees were asked to rank the effectiveness of the organization's current method of security awareness training, on a scale from one to five with one being not effective to five being highly effective. Airport managers averaged a 3.3, indicating they feel the method is somewhat effective. TSA employees averaged 3.9, indicating they feel the method of security awareness training is quite effective. Again, it is worth mentioning that no TSA employees answered 1 or 2 while there were many airport managers that responded training is not effective. So, not only must there be a training program in place, but it must also be effective; and that apparently is not occurring among airport managers to the extent it is for TSA employees.

Another important training topic is post-catastrophe training. Since 9/11 less than half of the airport managers have provided or received additional catastrophe training in contrast to almost three-quarters of TSA employees. Overall, it is apparent that training is an area that needs to receive more attention. It is also important to understand that the responses to this survey are solely what the airport managers and TSA employees think and feel, not necessarily what is actually occurring. For example, they may think that the training is effective but perceptions are often notoriously wrong.

Forensics

The success of the United States law enforcement community is derived from many applications and techniques but none more essential than the utilization of forensic science. Forensic protocols are varied and include the use of entomology, odontology, taphonomy, and similar forensic methodologies. However, the importance of these protocols and others seem to be misunderstood by the respondents. There is an apparent disconnect in comprehending the importance of forensic science as it pertains to aviation catastrophes. In the event of an aviation industry terrorist incursion timely access and undisturbed evidence is critical to the forensic investigator. The investigator must be given unfettered access to the incident scene and know that only essential emergency response activities have taken place in regard to event scene alteration. The alteration of human remains or physical evidence, in any form, greatly restricts the ability of the investigator to successfully complete his task. With this identified, it is critical that all aviation industry personnel understand the importance of forensic protocols and how they contribute to the apprehending of perpetrators in a catastrophic event.

Figure 7. Percent of Respondents who have Received Training in the Field of Criminal Forensics, for Airport Managers and TSA Personnel
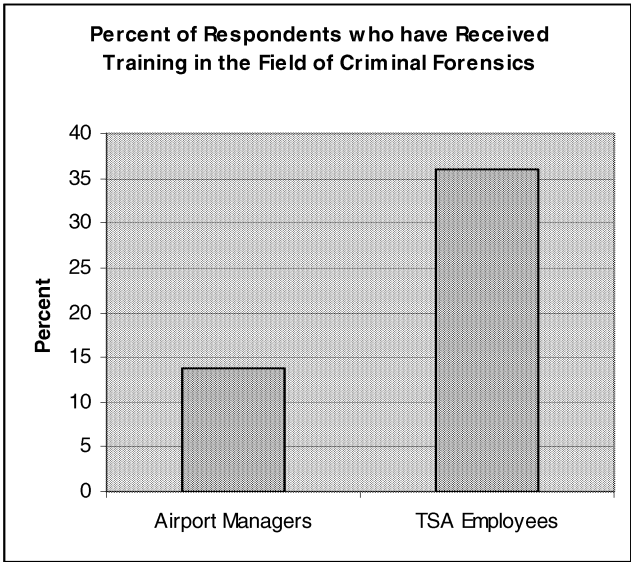
When questioned if they felt that a minimal knowledge of forensic protocols was important both TSA personnel and airport managers indicated

that it was of little concern to them. They both continued by describing the importance of individual areas of forensic science as it would benefit them in their creation of a post-catastrophe plan. Unfortunately, they both concluded that this knowledge, as it applied to all forensic areas noted within the survey, was of little value to them. Finally, they were asked to indicate if they had ever received any training within the field of criminal forensics. Of those responding from the TSA, 36 percent indicated that they had received this type of training. Of those responding as an airport manager, only 13.6 percent indicated that they had received such training. This lack of understanding of the importance of forensics can be contributed to the minimal education provided.

When asked if they were interested in the topic of forensic investigation both TSA personnel and airport managers were mildly interested. Again, these results would demonstrate the lack of understanding to the benefits this field of study brings to the aviation security. When surveyed in regard to whether the organization was more reactive than proactive both survey groups indicated an overwhelming response to the reactive. This reactive nature seems to be validated by all previously mentioned replies. Additionally, both survey groups felt strongly that their organization would not react to a catastrophic event in such a manner as to result in the loss of critical information. However, when questioned on the effectiveness of the organization's current method of security training they both leaned toward the not effective response. Together, these responses seem to contradict each other and lead to the questioning of each organization's ability to truly perform in a manner that will not result in the loss of critical information. The frequency of training within each organization did not clearly demonstrate any pattern; therefore no implied conclusion can be drawn from this question as it applies to forensic protocols.

Survey results indicated that airport managers have held their positions approximately four times longer than TSA personnel respondents. Additionally, airport managers have approximately 2.5 times the experience within the aviation industry. These data combined with the aforementioned questions and results related to forensic science do not allow us to form any clear conclusion based upon years in position or experience. Indicators show that the area of forensic science, as it is applied to catastrophic events within the airline industry, is grossly misunderstood and under emphasized.

Attitude

Personal attitudes play a key role in day-to-day interaction among individuals and small and large organizations. This element of human behavior is both complex and unavoidable. The attitude of individuals and organizations directly responsible for aviation security obviously should receive a great deal of attention due to the tremendous impact it has on the

American people and national security. The safety and security of communities throughout the nation are a responsibility that is shared by all residents, by government, and by the private sector. Their attitudes will reflect their success (Kelman, 2005). Specifically, this study examined how security personnel prepare to respond to catastrophic events. The attitudes and perceptions of the security personnel surveyed in our study are the same that are being portrayed as the acceptable model to subordinates. There is no simple way to determine one source of attitudes from the respondents; however some general conclusions can be made based upon information given.

Airport managers that responded have been in their positions longer than the TSA employees. The first question asked was "how many years have you been an airport manager?" Although the question was worded identically for both airport managers and TSA employees, the period of time in which airport managers have been in an airport management role was significantly greater than the responses of the TSA employees. Most airport managers have at least 10 years of experience.

The second question asked "how many years have you been at your current position?" The responses for airport managers showed little job re-positioning; in fact many of them have not changed jobs since they originally took their current position. The respondents from the TSA indicated more shift in job responsibilities. This should come as no surprise due to the changes which occurred related to the governing of airport security by the formation of the Department of Homeland Security. It is believed airport mangers feel a greater sense of comfort with current operations because of time spent in the aviation industry. This sense of comfort is believed to be the reason why airport mangers are not highly concerned with security planning and training. Most indicated they feel current measures are adequate. Another rational for this belief is the fact airport managers have other duties beside security in their job descriptions.

Another question asked to rate—on a scale from one to five, with one being the least vulnerable, and five being the most vulnerable—"due to your geographic location, how vulnerable do you believe your organization is to a terrorist attack?" The first unsettling part of the responses is that neither group expressed great concern that their facility is vulnerable. This could be due to the fact that there is no clear distinction of baseline understood vulnerability for all aviation facilities. Nonetheless, airport managers more predominately indicated they feel their facility is at the lowest possible level of vulnerability based upon the wording of the question. When responding to the question "I believe that there is an 'it won't happen here' attitude at this facility," a higher level of airport mangers—compared to TSA employees—felt this type of attitude does exist. Noting that most TSA employees have only held their current positions since soon after 9/11 security preparedness

and planning seem to be a more pressing issue. With a lower level of job experience in their current positions, 9/11 is also fresher in the minds of TSA employees. Another reason why security is a higher priority for TSA personnel may be because they are government employees who feel direct pressure from federal agencies to insure proper security measures are in place.

Figure 8. Perceived level of Vulnerability to a Terrorist Attack for their Organization, Due to Geographic Location, for Airport Managers and TSA Personnel, by Location of Airport
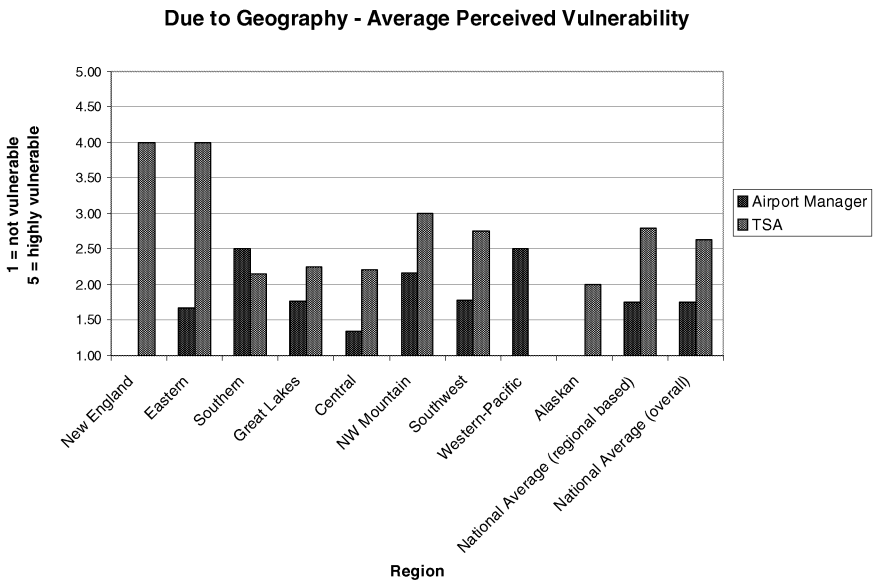
Figure 9. Belief of the Existence of an "It Won't Happen Here" Attitude at their Organization, for Airport Managers and TSA Personnel, by Location of Airport

"It won't happen here" attitude exists (average)
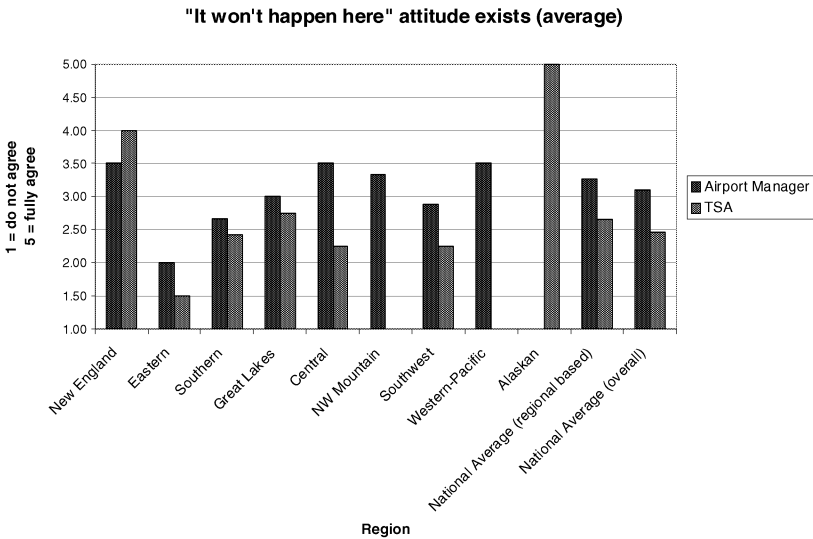
Overall, the attitudes and perceptions of the current state and future needs of security differ greatly between airport mangers and TSA employees. Certainly this group of researchers believes this is an area which needs reevaluation and more consideration. The first step in taking action is realizing change is needed. It is no easy task to convince personnel this change is in fact needed; however, this group of researchers believes this threat is real and this report will reflect the need to change. Convincing the general aviation component of the industry that the threat is indeed real poses a significant challenge and is worthy of further study.

CONCLUSIONS

The data collected support what is already widely suspected; namely that catastrophe planning within the aviation community needs to be improved. More specifically, more attention needs to be given to the current threat to the general aviation community in general. It is simply too easy to access the facilities and to engage in nefarious conduct without raising too much suspicion. Common sense dictates that the criminal or terrorist is more comfortable accessing the least secure facility and the one presenting the least risk. Admittedly, the terrorist, unlike the criminal, is rarely concerned with escape but they still need to gain entrance to the transportation network

to disrupt it. To ignore the desire of terrorists to possibly use the general aviation community to attack a larger target suggests the old head-in-the-sand cliché may be a reality. The results of the survey minimally support the conclusion that miscommunication between agencies takes place internally and externally which could result in less effective response to a catastrophic event.

Additionally, it seems apparent that miscommunication between the TSA and airport managers is contributing to the lack of improvement in this area. The TSA has focused on larger commercial airports which service the nation's transportation requirements but has neglected smaller and more vulnerable facilities. This is of particular significance if the small to medium sized airport is near a dangerous critical infrastructure such as a nuclear power plant, chemical weapons storage facility or large dam. The survey seems to support the conclusion that a general complacency does indeed exist to varying degrees depending on the facility. Attitudes may have turned complacent over time since 9/11 or never existed in the minds of the operators at any time previously. It seems prudent that attention to planning and training should be revitalized before another catastrophe occurs. Efforts based on both the adequacy of existing plans and the potential current threat is a function of education. No one—especially a facility manager—wants to seriously believe that a disaster will take place under their watch on their facility. Such contentment can unfortunately be fatal.

The general aviation industry basically portrayed only a mild interest in the field of forensics. This lack of understanding regarding the significant contribution that such basic knowledge can provide in capturing those that have engaged in a terrorist act is disappointing. The democratic system prides itself on bringing those who commit crimes to justice. The forensic teams at work after catastrophic events take place can be greatly hindered by acts committed by well-intentioned but ill-informed individuals with access to a scene prior to the arrival of the forensics team. The damage such personnel can inflict on a crime scene can be substantial and hinder later prosecutorial efforts. This is another topic worthy of further research.

It is not within the parameters of this paper to document the actual current threat but numerous government officials and security experts had repeatedly used the phrase "not if but when" in referring to the next attack. Unfortunately, many aviation professionals have lost sight of the potential for a massive catastrophic event—either natural or terroristic—and have not adequately planned to deal with the results.

It is critical that upper management—at a minimum—support efforts to improve communication, to place emphasis on planning and to continue to improve security awareness training as well as law enforcement and forensic training. Education should be standardized and mandatory in order to effectuate the best results. It is apparent that voluntary requests or

suggestions to improve security are seen by the aviation professional as an unnecessary cost to an industry already in need of improved profitability. The survey also reflects that the TSA does not necessarily speak the same language as the aviation professional, especially those of pilots. To ignore the advice and experience of such a critical component in the aviation chain does not bode well for future cooperation or success. The aviation industry is populated with highly trained professionals who function in a unique environment which includes airspace, airport facilities and supporting infrastructure. To have the government agency that regulates security at these facilities to not have the same competency level in such a unique environment should also be addressed.

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APPENDIX

Individual Survey Response Analysis

Airport Managers:
1. How many years have you been an airport manager?   12.99
   57 responses
2. How many years have you been at your current position? 12.21
   59 responses
3. What are the total years of your aviation experience?   27.61
   57 responses
   Overall, very experienced in aviation field in terms of years
4. To which geographic region are you assigned?
   [0] Alaskan [12] Central [6] Eastern [16] Great Lakes
   [4] New England [6] NW Mountain [6] Southern [9] Southwest
   [2] Western-Pacific
        2 blank   63 total responses
5. Due to your geographic location, how vulnerable do you believe your
   organization is to a terrorist attack? (1=not vulnerable, 5=highly
   vulnerable) 1.758   62 responses
   Average response indicates feeling of invulnerability
6. In your opinion, is it generally easier to communicate with a colleague
   who is:
   [ ] Military [ ] TSA [2] Law Enforcement [27] Has aviation
   background [5] A pilot [2] Management [17] No preference
   2 blank; 1 military, aviation background; 1 military, aviation, pilot; 2
   law enforcement, management; 1 aviation background, pilot, mgmt; 2
   aviation background, pilot; 1 all except TSA
   Easier to communicate with people with aviation background
7. In your organization, please rate how effective you believe the necessary
   communication chain would be in a catastrophic situation. (1=not
   effective, 5=very effective)   3.459   61 responses
   General feeling that communication would be effective
8. In general, you get better cooperation from:
   [ ] TSA [36] Local law enforcement [24] No preference
   1 neither; 2 blank
   Definitely not TSA; local law enforcement – this may because of the
   great number of response from small airports
9. Does your organization have a post-catastrophic or post-terrorism
   incident plan? [27] Yes [32] No   4 blank
   Need more to have plan

    a.   If so, does this plan include any other partnering organizations?   [ ] Yes [ ] No of yeses to 9a, only 1 no, 24 yes, 2 blank

    b.   Which ones?

Main ones included local & state police/authorities, FBI

Good to have other agencies involved, like to see more federal cooperation

10. Have you provided/received any additional post-catastrophe training since the September 11th terrorist attacks to your employees?

[27] Yes [33] No 3 blank

Required now for GA airport managers?? More need training, especially small airports; also why this number of 'no's is high, lots of small airports answered

11. A class including airport management, airline personnel, and the TSA, based on communication and/or resource management is needed in your work environment.

[16] Yes [41] No 6 blank

    a.   Why or why not?

Most of 'no's because small airport, yes good reasons

Still important for small airport managers to attend session so that they can help create a plan that includes cooperation and communication between several agencies

12. What is the frequency of your organization's recurrent security training?

[15] Annual [7] Quarterly [3] Monthly [14] Periodic [2] Don't know [18] Never   2 blank; 1 annual, quarterly

There are a lot of "nevers" for airport managers. Need more training

13. Please indicate how consistently the above training policy is followed. (1=never followed, 5=always followed)   3.5714 49 responses

Average indicates training policy generally followed

14. How would you rate the effectiveness of your organization's current method of security awareness training? (1=not effective, 5=highly effective)   3.3158 57 responses

Average indicates current security training is effective, but could be more effective

15. In your opinion, how effectively do airport management and the TSA work with each other, especially during times of crisis or tragedy? (1=not at all, 5=very well)   2.8222 45 responses

Average indicates airport management and TSA work together, but not very well

16. In your current position in your organization, how comfortable would you feel suggesting new ideas regarding post-disaster readiness/awareness training? (1=not comfortable, 5=very comfortable)

    4.1964 56 responses

Average indicates most would feel comfortable

17. Do you believe that your organization would take any action if an employee were to approach management and suggest new training regarding post-catastrophe readiness and response?
    [50] Yes [7] No
    Significant? Say yes

18. Current methods of post-catastrophic readiness planning and training need improvement at this organization. (1=do not agree, 5=fully agree)
    2.7143   56 responses
    Average is middle of the road, showing need for improvement, but leaning toward disagreement with statement

19. Information regarding post-disaster procedures is readily available in my organization to anyone who needs access. (1=do not agree, 5=fully agree)   3.0727   55 responses
    Average right down middle, access indeterminable

20. Generally speaking, TSA employees are easy to work with. (1=do not agree, 5=fully agree) 2.82979   47 responses
    Average middle of road

21. I am concerned that my organization would not be able to respond effectively to catastrophic event or terrorist attack. (1=do not agree, 5=fully agree)   2.193   57 responses
    Average indicates they do not agree with this statement; organizations could respond to catastrophic event "or so they think"

22. I am concerned that the quality of response from my organization could result in the loss of critical information to track down the perpetrators of a terrorist event at my facility. (1=do not agree, 5=fully agree)
    1.9821   56 responses
    Average indicates they do not agree with this statement

23. I believe that there is an "it won't happen here" attitude at this facility. (1=do not agree, 5=fully agree)   3.1356   59 responses
    Average middle of road

24. I believe that proper and repeated training would improve my organization's response to a terrorist attack. (1=do not agree, 5=fully agree)   3.069   58 responses
    Average middle of road; need for more training

25. It is easier to communicate with a TSA employee who is:
    [4] A pilot [25] Has an aviation background [21] No preference
    3 pilot, aviation background; 1 both ok
    easier to communicate with people with aviation background

26. My organization is more reactive than proactive. (1=strongly disagree, 5=fully agree)
    2.6034   58 responses

27. What percentage of the time do you think miscommunication between personnel result in poor planning? (circle one)
0% 1 10% 12   20% 5   30% 7   40% 4   50% 6   60% 1   70% 6
80% 6   90% 5   100% 2
   45.455 avg 55 responses
28. Have you ever received any training in the field of criminal forensics?
[8] Yes [50] No
Need training in forensics
29. How frequently do the following interfere with communication between airport managers and the TSA? (1=never, 5=always)

Acronyms (ex. TSA, DHS)	2.26	50 responses
Personalities	2.3	50 responses
Accessibility to one another	2.64	50 responses
Technology	2.08	50 responses

30. How often do airport managers and the TSA personnel use the following forms of communication? (1=never, 5=always)

Written	2.8462	52 responses
Face-to-face	2.4314	51 responses
Electronic communication (email)	2.76	50 responses
Phone	2.6275	51 responses
Radio	1.25	48 responses
Other: _____		

31. With regard to the creation of post-catastrophic planning, how effective are the following forms of communication? (1=not effective, 5=very effective)

Written	3.2364	55 responses
Face-to-face	4.00	56 responses
Electronic communication (email)	3.315	54 responses
Phone	3.481	54 responses
Radio	2.449	49 responses
Other: _____		

32. How helpful would the knowledge of the following basic forensic protocol be in the creation of a post-catastrophic plan for your organization? (1=not helpful, 5=very helpful)

Fingerprinting	2.1176	51 responses
Cadaver dogs	2.02	51 responses
Odontology	1.9796	49 responses
Entomology	1.959	49 responses
Mental Health/Grief Training	2.62	50 responses
Digital Photography	2.96	50 responses
Other: _____		

33. Minimal knowledge of forensic protocols is not important. (1=strongly disagree, 5=fully agree)   2.7679   56 responses
34. I am interested in the topic of forensic criminal investigation. (1=strongly disagree, 5=fully agree)   2.6491   57 responses
    Averages lean toward disinterest in forensics, but also lean toward forensics being important
35. To the best of your knowledge, how close is your facility to the nearest nuclear power plant?
    [15] 50 miles [5] 75 miles [15] 100 miles [12] 200 miles [8] Don't know 4 over 200

TSA Employees:
1. How many years have you been an airport manager?   10.2 9
    26 responses
2. How many years have you been at your current position? 3.339
    28 responses
3. What are the total years of your aviation experience?   19.75
    28 responses
    Less experience than airport managers, but still have many years
    experience in aviation
4. To which geographic region are you assigned?
    [1] Alaskan [5] Central [4] Eastern [4] Great Lakes [1] New
    England [1] NW Mountain [7] Southern [4] Southwest [ ]
    Western-Pacific 1 Southeast
5. Due to your geographic location, how vulnerable do you believe your
    organization is to a terrorist attack? (1=not vulnerable, 5=highly
    vulnerable)   2.63   27 responses
    Understand more so than airport managers that they are somewhat
    vulnerable to a terrorist attack
6. In your opinion, is it generally easier to communicate with a colleague
    who is:
    [1] Military [1] TSA [2] Law Enforcement [14] Has aviation
    background   [ ] A pilot [3] Management [6] No preference
    Like airport managers, easier to communicate with people with aviation
    background
7. In your organization, please rate how effective you believe the necessary
    communication chain would be in a catastrophic situation. (1=not
    effective, 5=very effective)   3.464   28 responses
    TSA feels their communication would be effective
8. In general, you get better cooperation from:
    [4] TSA [7] Local law enforcement [16] No preference
    No preference
9. Does your organization have a post-catastrophic or post-terrorism
    incident plan? [20] Yes [5] No
    Most have a plan
    a. If so, does this plan include any other partnering organizations?
        [19] Yes [ ] No
    b. Which ones?
    City fire, local police, etc
    Almost all of the plans include other organizations; good.
10. Have you provided/received any additional post-catastrophe training
    since the September 11th terrorist attacks to your employees?
    [18] Yes [7] No

Almost ¾ have had training; very good, much more than airport managers

11. A class including airport management, airline personnel, and the TSA, based on communication and/or resource management, is needed in your work environment.
    [13] Yes [11] No
    a.   Why or why not?
    TSA realizes more than airport managers that more training is needed, but still is about 50% yes

12. What is the frequency of your organization's recurrent security training?
    [7] Annual [2] Quarterly [3] Monthly [7] Periodic [2] Don't know [ ] Never   3 annual, quarter, monthly, periodic
    TSA adheres to recurrent security training more so than airport managers

13. Please indicate how consistently the above training policy is followed. (1=never followed, 5=always followed) 4.4783   23 responses
    Average indicates training policy almost always followed

14. How would you rate the effectiveness of your organization's current method of security awareness training? (1=not effective, 5=highly effective)   3.9167   24 responses
    Average indicates TSA employees feel their training is effective

15. In your opinion, how effectively do airport management and the TSA work with each other, especially during times of crisis or tragedy? (1=not at all, 5=very well)   3.5833   24 responses
    TSA feels that airport management and TSA work well together

16. In your current position in your organization, how comfortable would you feel suggesting new ideas regarding post-disaster readiness/awareness training? (1=not comfortable, 5=very comfortable)
         4.4   25 responses
    Average indicates most would feel comfortable, even more so than airport managers

17. Do you believe that your organization would take any action if an employee were to approach management and suggest new training regarding post-catastrophe readiness and response?
    [20] Yes [4] No
    Significant? number of responses say yes

18. Current methods of post-catastrophic readiness planning and training need improvement at this organization. (1=do not agree, 5=fully agree)
         2.7826   23 responses
    Average is middle of the road, showing need for improvement, but leaning toward disagreement with statement

19. Information regarding post-disaster procedures is readily available in my organization to anyone who needs access. (1=do not agree, 5=fully agree)   3.24   25 responses
Average right down middle, access indeterminable
20. Generally speaking, TSA employees are easy to work with. (1=do not agree, 5=fully agree)
3.8425 responses
TSA feels that TSA employees are easy to work with; more so than how the airport managers feel
21. I am concerned that my organization would not be able to respond effectively to catastrophic event or terrorist attack. (1=do not agree, 5=fully agree)   1.833   24 responses
Average indicates they do not agree with this statement; organizations could respond to catastrophic event "or so they think"; TSA disagrees with this statement even stronger than airport managers
22. I am concerned that the quality of response from my organization could result in the loss of critical information to track down the perpetrators of a terrorist event at my facility. (1=do not agree, 5=fully agree)
        1.9583   24 responses
Average indicates they do not agree with this statement
23. I believe that there is an "it won't happen here" attitude at this facility. (1=do not agree, 5=fully agree)   2.4583   24 responses
TSA feels that that attitude does not exist at their facilities, for the most part
24. I believe that proper and repeated training would improve my organization's response to a terrorist attack. (1=do not agree, 5=fully agree)   4.00   24 responses
TSA understands that more training would be beneficial to the organization's response to an attack
25. It is easier to communicate with a TSA employee who is:
[1] A pilot [11] Has an aviation background [13] No preference
No preference if they have an aviation background or not about 50% of time
26. My organization is more reactive than proactive. (1=strongly disagree, 5=fully agree)   2.7917   24 responses
Average indicates slight disagreement with this statement. They may not want to answer that they are reactive so they answer proactive, but don't want to disagree strongly with the statement
27. What percentage of the time do you think miscommunication between personnel result in poor planning? (circle one)
10% 4   20% 1 30% 3 40% 6 50%   60%   70% 1 80% 4
90% 4   100% 1
51.667

TSA feels that miscommunication results in poor planning about 50% of the time.

28. Have you ever received any training in the field of criminal forensics?
    [9] Yes [16] No
    More TSA employees have received training in criminal forensics, but more training is needed
29. How frequently do the following interfere with communication between airport managers and the TSA? (1=never, 5=always)

Acronyms (ex. TSA, DHS)	2.12	25 responses
Personalities	2.88	25 responses
Accessibility to one another	2.36	25 responses
Technology	2.2	25 responses

30. How often do airport managers and the TSA personnel use the following forms of communication? (1=never, 5=always)

Written	3.44	25 responses
Face-to-face	4.16	25 responses
Electronic communication (email)	3.92	25 responses
Phone	4.08	25 responses
Radio	1.4	25 responses
Other: _____		

31. With regard to the creation of post-catastrophic planning, how effective are the following forms of communication? (1=not effective, 5=very effective)

Written	3.8261	
Face-to-face	4.09	23 responses
Electronic communication (email)	3.8696	23 responses
Phone	3.522	23 responses
Radio	2.182	22 responses
Other: _____		

32. How helpful would the knowledge of the following basic forensic protocol be in the creation of a post-catastrophic plan for your organization? (1=not helpful, 5=very helpful)

Fingerprinting	2.333	24 responses
Cadaver dogs	2.75	24 responses
Odontology	2.435	23 responses
Entomology	2.3636	22 responses
Mental Health/Grief Training	3.5	24 responses
Digital Photography	3.542	24 responses
Other: _____		

    Data is inconclusive; however, TSA results for 32 are all higher than airport manager's results, indicating that TSA employees see the need for knowledge more so than airport managers.

33. Minimal knowledge of forensic protocols is not important. (1=strongly disagree, 5=fully agree)
    2.6522   23 responses
34. I am interested in the topic of forensic criminal investigation. (1=strongly disagree, 5=fully agree)
    2.6087   23 responses
    Averages lean toward disinterest in forensics, but also lean toward forensics being important
35. To the best of your knowledge, how close is your facility to the nearest nuclear power plant?
    [5] 50 miles [1] 75 miles [8] 100 miles [4] 200 miles [6] Don't know
    Some TSA employees don't know distance.

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PRODUCTIVITY ANALYSIS OF PUBLIC AND PRIVATE AIRPORTS: A CAUSAL INVESTIGATION

Bijan Vasigh
Embry-Riddle Aeronautical University
Daytona Beach, Florida

Javad Gorjidooz
Embry-Riddle Aeronautical University
Prescott, Arizona

ABSTRACT

Around the world, airports are being viewed as enterprises, rather than public services, which are expected to be managed efficiently and provide passengers with courteous customer services. Governments are, increasingly, turning to the private sectors for their efficiency in managing the operation, financing, and development, as well as providing security for airports. Operational and financial performance evaluation has become increasingly important to airport operators due to recent trends in airport privatization. Assessing performance allows the airport operators to plan for human resources and capital investment as efficiently as possible. Productivity measurements may be used as comparisons and guidelines in strategic planning, in the internal analysis of operational efficiency and effectiveness, and in assessing the competitive position of an airport in transportation industry. The primary purpose of this paper is to investigate the operational and financial efficiencies of 22 major airports in the United States and Europe. These airports are divided into three groups based on private ownership (7 British Airport Authority airports), public ownership (8 major United States airports), and a mix of private and public ownership (7 major European Union airports. The detail ownership structures of these airports are presented in Appendix A). Total factor productivity (TFP) model was utilized to measure airport performance in terms of financial and operational efficiencies and to develop a benchmarking tool to identify the areas of strength and weakness. A regression model was then employed to measure the relationship between TFP and ownership structure. Finally a Granger causality test was performed to determine whether ownership structure is a Granger cause of TFP. The results of the analysis presented in this paper demonstrate that there is not a significant relationship between airport TFP and ownership structure. Airport productivity and efficiency is, however, dependent upon the level of competition, choice of the market, and regulatory control.

Bijan Vasigh is professor of Economics and Finance in the College of Business at Embry-Riddle Aeronautical University, Daytona Beach Florida and a Managing Director at Aviation Consulting Group, LLC. Dr. Vasigh received a Ph.D. degree in Economics from the State University of New York in 1984, and he has written and published many articles concerning the

INTRODUCTION

Airport privatization was pioneered by Great Britain under the Thatcher Government as a result of its initial public offering of 100 percent of the shares in the former British Airports Authority (BAA) in 1987. Thus the prevailing model for airport privatization in Europe is outright sale as initiated by the British Government with its sale of BAA. BAA is now the largest airport operator in the world, with ownership of 7 airports in the United Kingdom (UK) and management of 11 airports outside of the UK, serving more than 230 million passengers a year (BAA, 2006).[1] Global airport privatization continues to be the predominant trend worldwide. Governments around the world are turning to private enterprises for airport management and development. More than 100 large and medium-size airports are being privatized in Europe, Asia, Australia, Africa, Latin America and the Caribbean, and North America.

Bijan Vasigh (cont'd.) aviation industry. The articles have been published in numerous academic journals such as the *Journal of Economics and Finance, Journal of Transportation Management, National Aeronautics and Space Administration (NASA) Scientific and Technical Aerospace Reports, Transportation Quarterly, Airport Business, Journal of Business and Economics*, and *Journal of Travel Research*, and quoted in major newspapers and magazines around the world. He was a consultant with the International Civil Aviation Organization (ICAO) and provided assistance on the evolution of aeronautical charge structure for the Brazilian Institute of Civil Aviation (IAC). He is currently a member of the international faculty at the International Air Transport Association (IATA) Learning Center and instructs Airline Finance and Accounting Management course at IATA training centers around the world. He is a member of the editorial board of Journal of Air Transport Management and Journal of Air Transportation World Wide. He worked on a NASA Research Grant on "Determination of Statewide Economic Benefits of the Small Aircraft Transportation System (SATS)." He is also a member of the Air Transport Research Society (ATRS) Global Airport Benchmarking Task Force.
Javad Gorjidooz is an associate professor of finance in Department of Business at Embry-Riddle Aeronautical University (ERAU) at Prescott campus in Arizona. He has MBA, MA, and Ph.D. degrees from Indiana University at Bloomington, Indiana with majors in accounting, economics and finance. He has 15 years of experience in teaching variety of courses in finance and economics at reputable institutions. Dr. Gorjidooz has written numerous articles which one of them was awarded the best paper presented at the 2002 Annual Meeting of the International Applied Business Research Conference in Puerto Vallarta, Mexico. He has presented workshops and given speeches at many institutions. Dr. Gorjidooz is a member of editorial board and reviewer of the *Scientific Journal International, Journal of Parametric*, reviewer of many books in finance, and has chaired many conferences across the globe. He has received many awards and recognitions for scholarly activities, intellectual contribution and professional services.

[1] On June 6, 2006, Spanish construction consortium, Grupo Ferrovial officially acquired the entire capital of the BAA for $19.30 billion. The Company manages airports in Australia (Sydney), the UK (Bristol and Belfast) and Chile; and more than 230,000 parking spaces, mainly in Spain.

Proponents of airport privatization believe the benefits of airport privatization include increases in operating efficiency through the transfer of ownership and management of public assets to private sectors, improvement of airport amenities, and increases in financial efficiencies in the form of increased revenues, increased profits, and reduced risks in undertaking unprofitable projects. Those who benefit from private management of airports are passengers, commercial airlines, private owners of airplanes, state and local government units through new revenue streams, and taxpayers.

Airport privatization can occur in many ways, including contract management, long-term lease, and sale. There are different objectives associated with each method of privatization. Contract management is often used for existing airports that are losing money, and the objective of contract management is usually to reduce costs and increase revenues to eliminate the deficit and potentially create a profitable airport operation. Long-term leases are often used for existing airports where a significant airport development is anticipated. The objective of a long-term lease is to shift a significant portion of the risk of new development from taxpayers to a private lessee. The term of the lease is primarily related to the length of time needed by the private lessee to recover its investment in new development and potentially make some profit.

The sale of an airport to the private sector is the most common method of global airport privatization. In full divestiture, the government generally sells entire airports as part of an overall program of divesting itself of a non-core business. This was the motivation for the British government in the 1987 sale of BAA. In some cases, governments only sell a majority or minority portion of the ownership and maintain the rest of the business interest for direct influence in airport management or for using the sale proceeds to finance airport expansion.

In an attempt to address the relative productivity and efficiency of commercial airports, both private and public, the authors utilize Total Factor Productivity (TFP) to develop a benchmarking tool to identify the areas of strength and weakness. The results shall enable airport managers to assess their competitive positions through operational and service comparisons.

AIRPORT OWNERSHIP, PRIVATIZATION, AND PERFORMANCE ANALYSIS

Airports are the backbone of the worldwide commercial transportation system. Air transportation of passengers and cargo is a dominant element of the transportation industry. Increasing passenger demand, escalating cargo expansion, increasing operating costs, and liability exposure have placed tremendous capital demands on government and state airport owners. As a

result, governments recognize that private investment capital is needed to meet airport expansion and commercialized management is needed to meet airports' operating efficiency and customer services, and therefore governments began to look into airport privatization.

While the trend of airport privatization is heating up around the world, in the United States (US) the airport privatization process is marching at a slower pace. Proponents argue that privatization would inject much needed capital into the aviation infrastructure. Opponents claim that local governments favor privatization as a way to divert airport revenue intended for developing aviation infrastructure to other municipal purposes, resulting in higher costs for airlines and passengers.

The privatization of the Stewart Airport in Newburgh, New York, is the very first airport privatization in the US under the 1996 Federal Aviation Administration (FAA) five-airport pilot program. Stewart Airport was leased for 99 years to National Express, a British company, in 2000. In five years, the airport managed to increase its passenger count by 33 percent and to attract new tenants who provided aviation services. The application for privatization of the New Orleans Lakefront Airport for a long-term lease to American Airport Corporation was submitted to the FAA in 2002 and as of June 27, 2005, the application required additional information for FAA final review (Bennett, 2005). In 2005, a new application was submitted to the FAA for approval of construction of a new airport, Abraham Lincoln National Airport, in Peotone about 40 miles south of downtown Chicago. The South Suburban Airport Commission held a competition and selected a team led by LVOR and SNC-Lavalin to finance, build, and operate the airport as a public-private partnership in which the government owns the land and the private contractor owns and operates the facilities (Sander 2004).

Other examples of successful airport privatization efforts in the US include the management contract awarded to BAA by the Indianapolis Airport Authority. In October of 1995, the BAA took over the management of Indianapolis International Airport promising to raise non-airline revenues by $32 million within the 10-year period of the contract. The contract was renegotiated in 1998 and extended until 2008. Between 1995 and 1999, costs per passenger were reduced from $6.70 to $3.70 and have increased very little since then. In spite of a moderate passenger annual growth rate of 3.5 percent, non-airline revenue per passenger more than doubled by 2003 (Vasigh & Haririan, 2003).

While over 100 airports around the world are either privatized or are in the process of being transferred to private enterprises, there are few studies that have been conducted to address the relative productivity of private versus public airports in terms of operational and financial efficiencies. With the privatization wave on the horizon, one surmises that privately owned

airports should outperform public airports in terms of TFP. However the latest research on this subject by Vasigh and Haririan (2003) could not document superiority of private airports over public airports. This study used 8 US airports as the only public airports and 7 British airports owned by BAA as the only private airports. Vasigh and Haririan observed that countries having privatized airports generally impose some form of price regulation or landing fees. In the UK, for example, landing fees are market-based pricing, indicating that landing fees are higher for peak travel times, and therefore private airports showed higher revenues from landing fees. They also concluded that privatization advocates point to labor productivity growth at airports in the UK as evidence of efficiency in private airports.

The results of other studies by Oum, Yu, and Fu (2003) and Oum, Zhang, and Zhang (2004) indicate that the airports owned by mixed enterprises with a private sector majority ownership are more efficient than airports owned by government branches or 100% public corporation.

Performance can be assessed based on financial efficiency or operational efficiency. Efficiency has several dimensions, two of which are economic efficiency and technological efficiency: economic efficiency means that the firm is using resources in such combinations that the cost per unit of output for that rate of output is the least; technological efficiency means that it must not be possible to produce the same rate of output with lesser amount of any resource.

In the airport industry, creation of a set of uniform performance measures has been essential not only to airport management but to airlines as well. Apart from measures of an airport's economic efficiency, managers need to be able to assess the input/output relationship in considering alternative investments or future developments.

The authors used 3 groups of airports consisting of 8 US public airports, 7 BAA private airports, and 7 European Union (EU) airports, both private and public.[2] They utilized financial and operational data such as landing fees, total assets, aircraft movements, number of airport gates, the annual number of enplaned passengers, and runway capacity. Initially, the authors adopted TFP to analyze the efficiency and performance measures of airports within each group by comparing and cross-referencing them with each other. They assessed and evaluated the performance of commercial airport(s) by developing a benchmarking tool to identify the areas of strength and weakness. This analysis led to identifying those airports that are not efficient and are thus dominated by other efficient airports.

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[2] These airports represent different sizes and ownership structure and located across EU and US. Availability of data was a major factor in our selection.

There are specific applications of this study. The report will allow the airport manager to:

1. Improve airport organizational quality;
2. Lower cost position;
3. Expose airport employees to new ideas;
4. Broaden the airport organization's operating perspective;
5. Create a culture open to new ideas; and
6. Raise the airport's level of maximum potential performance.

DATA AND METHODOLOGY

Data

The airport data reflected in this research are for five years from 2000 through 2004 and include a total of 22 airports in the following three groups:

1. US commercial airports (8 public airports),
2. BAA, (7 private airports), and
3. EU (the 7 busiest airports, both private and public).

The selected airports are shown in Table 1.

Table 1. Airports Selected for the Total Factor Productivity Analysis

BAA Airports[3] (Group 1)	US Airports[4] (Group 2)	EU Airports[5] (Group 3)
Aberdeen (ABZ)	Atlanta (ATL)	Amsterdam (AMS)
Edinburgh (EDI)	Chicago (ORD)	Frankfurt (FRA)
Glasgow (GLA)	Dallas-Fort Worth (DFW)	Munich (MUC)
London Gatwick (LGW)	Denver (DEN)	Paris Charles de Gaulle (CDG)
London Heathrow (LHR)	Detroit (DTW)	Paris Orly (ORY)
London Stansted (STN)	Los Angeles (LAX)	Rome Fiumicino (FCO)
Southampton (SOU)	Newark (EWR)	Zurich (ZRH)
	San Francisco (SFO)	

The authors selected 3 input factors and 5 output measures that are relevant in assessing airport productivity. Of the three input factors selected in this paper, two are financial and one is non-financial. The financial input factors are operation cost and net total assets. For European and British airports, operation cost was measured as total revenue minus earnings before interest and tax (EBIT). Appendix A shows ownership structure of non-UK

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[3] BAA owns and operates seven major airport facilities in England as well as other countries.

[4] The financial data for both input and output factors were obtained from the FAA and AirNav.com for all US airports.

[5] The financial data for both input and output factors were obtained from the respective annual reports for the non-US airports.

European airports. The non-financial factor, runway area, was measured as the sum of all active runways' area (length x width) given in square meters.

Of the 5 output measures selected, 2 are financial and 3 are non-financial. The financial output measures are operational and non-operational revenues.   Researchers must distinguish between operational and non-operational revenues, because an airport's primary purpose is getting passengers airborne, but many airports still earn a majority of their revenue on land-side operations, in areas ranging from parking and concession to direct retail. The non-financial measures are total terminal passengers, total airport movements, and aircraft landing fees. Total terminal passengers, measured on an annual basis, is indicative of an airport's ability to create demand and serve customers. Total airport movements measure the output of airside operations.

Input and output data are based on the total annual number of operations including air carriers, general aviation, air taxis, and military. These data are common among all the airports and contain financial and operational figures.

Methodology

A constant challenge in measuring productivity is deciding on precisely which measures to use. While not unique to airports, this problem requires using measures which can be applied to most airports and measures which can be obtained for airports under study. The primary objective of this study is to investigate the relationship between airport productivity and ownership and management structure.

There are a number of techniques that have been adopted and applied to measure airport efficiencies including ratio analysis, regression analysis, data envelopment analysis (Gillen & Lall, 1997), and TFP (Harrigan, 1997; Hooper & Hensher, 1997). This research utilizes TFP as it is proven to be the most accurate measure of productivity of all inputs involved in the production process, which allows for measuring cost efficiency and effectiveness and for distinguishing productivity differences in airport performance that arise from economies of scales and from managerial performance (Oum, Yu, and Fu, 2003; Oum, Zhang, and Zhang, 2004; Vasigh & Hamzaee, 1998; Vasigh & Harririan, 2003). This technique can also be used for investigating the impact of variations of input and output prices on an airport's performance (Gillen & Lall, 1997).

The following TFP index (model) was employed in this research which is similar to the framework introduced by Caves et al. (1982), which is also reviewed and analyzed by Hooper and Hensher (1997):

$$\ln\left(\frac{TFP_k}{TFP_b}\right) = \sum \left(R_{ki} + \overline{R_i}\right)\left(\ln Y_{ki} - \overline{\ln Y_i}\right) - \sum \left(R_{bi} + \overline{R_i}\right)\left(\ln Y_{bi} - \overline{\ln Y_i}\right)$$

$$- \sum \left(W_{kn} + \overline{W_n}\right)\left(\ln X_{kn} - \overline{\ln X_n}\right) + \sum \left(W_{bn} + \overline{W_n}\right)\left(\ln X_{bn} - \overline{\ln X_n}\right)$$

where :

$k =$ each individual observation, $k = 1,...,K$

$b =$ base observation (a particular or average observation)

$i =$ outputs, $i = 1,...,I$

$n =$ inputs, $n = 1,...,N$

$R_i =$ weights for each output

$\overline{R_i} =$ arithmetic mean of output weights over all airports

$W_n =$ weights for each input

$\overline{W_n} =$ arithmetic mean of input weights over all airports

$\ln Y_i =$ unit measure of output

$\overline{\ln Y_i} =$ geometric mean of unit measure over all airports

$lnX_n =$ unit measure of input

$\ln X_i =$ geometric mean of unit measure over all airports

EMPIRICAL RESULTS

Total factor productivity model

Based on TFP values as presented in Table 2 for the BAA group (private ownership structure), London Heathrow achieved the highest score throughout all 5 years under study. In the US group (public ownership structure), the highest score for 2004 is observed for Chicago O'Hare Airport, followed by Newark Airport for 2001 through 2003, and Atlanta Airport for 2000. In the third group (mixed private and public ownership), consisting of EU airports excluding the UK, Frankfurt has the highest scores for the years 2000 and 2001 and Paris Charles de Gaulle for the years 2002 and 2003; the airports share the highest score in 2004.

Table 2. Total Factor Productivity Scores for Selected Airports, 2000-2004

| | Year | | | | |
Airport	2000	2001	2002	2003	2004
Europe (excluding UK)					
Amsterdam	1.00	0.99	1.01	0.98	0.97
Frankfurt	1.08	1.06	1.04	1.04	1.06
Munich	0.94	0.96	0.96	0.96	0.97
Paris Charles de Gaulle	*	1.05	1.05	1.07	1.06
Paris Orly	*	0.98	0.98	0.98	0.98
Rome Fiumicino	1.01	0.92	0.93	0.94	0.94
Zurich	0.99	0.96	0.95	0.95	0.95
United Kingdom (BAA)					
Aberdeen	1.00	0.98	0.98	0.98	0.98
Edinburgh	0.97	0.97	0.98	0.98	0.98
Glasgow	0.96	0.98	0.98	0.98	0.98
London Gatwick	1.07	1.06	1.06	1.05	1.05
London Heathrow	1.21	1.21	1.20	1.17	1.11
London Stansted	0.95	0.96	0.96	0.97	0.97
Southampton	1.08	1.08	1.08	1.08	1.09
United States					
Atlanta	1.13	1.11	1.05	1.04	1.07
Chicago O'Hare	1.07	1.09	1.10	1.10	1.10
Dallas-Forth Worth	1.03	1.02	1.02	1.02	1.03
Denver	0.94	0.99	1.00	0.99	1.00
Detroit	1.01	1.00	1.00	1.00	1.00
Los Angeles	1.06	1.06	1.04	1.04	1.05
Newark	1.12	1.11	1.15	1.16	1.09
San Francisco	1.01	0.99	0.99	1.00	1.00

Note. For the year of 2000 no data could be obtained for Paris Charles de Gaulle and Paris Orly.

Based on average annual TFP for airport groups as presented in Table 3, the US airports group, representing public ownership structure, had the highest average annual TFP throughout the 5 years and outperformed the BAA airports group, representing private ownership structure, and the EU airports group, representing a mixture of private and public ownership structure.

Table 3. Average annual Total Factor Productivity for Airport Groups, 2000-2004

| | Year | | | | |
Airport	**2000**	**2001**	**2002**	**2003**	**2004**
Europe (excluding UK)	1.004	0.989	0.989	0.989	0.990
United Kingdom (BAA)	1.034	1.034	1.034	1.030	1.023
United States	1.046	1.046	1.044	1.044	1.043

Table 4 exhibits the 5-year average TFP for the third group (EU airports). Based on a 5- year average TFP, Paris Charles de Gaulle Airport scored the highest followed by Frankfort, Amsterdam, Paris Orly, Zurich, Munich, and Rome.

Table 4. Five-year Average Total Factor Productivity for European Union Airports Group, 2000-2004

EU Airport	Ownership Structure	Average TFP for 2000-2004
Amsterdam	Private Management	0.991
Frankfurt	Private Management	1.056
Munich	Public	0.958
Paris Charles de Gaulle	Public	1.058
Paris Orly	Public	0.978
Rome Fiumicino	97% Private	0.948
Zurich	51% Public	0.960

Table 5 presents the ranking of all 22 airports based on a 5-year average TFP score. The leading airport is London Heathrow from the first Group (airports with a private ownership structure) with a score of 1.18, followed by Newark (1.126) and Chicago O'Hare (1.093) from the second group (airports with a public ownership structure).

Table 5. Airport Ranking Based on Five-year Average Total Factor Productivity Scores, 2000-2004

Rank	Airport	Region	Score
1	London Heathrow	UK	1.180
2	Newark	US	1.126
3	Chicago O'Hare	US	1.093
4	Southampton	UK	1.084
5	Atlanta	US	1.080
6	London Gatwick	UK	1.059
7	Paris Charles de Gaulle	EU	1.058
8	Frankfurt	EU	1.056
9	Los Angeles	US	1.050
10	Dallas-Forth Worth	US	1.024
11	Detroit	US	1.002
12	San Francisco	US	0.997
13	Amsterdam	EU	0.991
14	Denver	US	0.985
15	Aberdeen	UK	0.984
16	Glasgow	UK	0.979
17	Paris Orly	EU	0.978
18	Edinburgh	UK	0.976
19	London Stansted	UK	0.962
20	Zurich	EU	0.960
21	Munich	EU	0.958
22	Rome Fiumicino	EU	0.948

Figures 1 through 3 compare TFP within all three groups for a period of five years from 2000 through 2004. In Figure 1, EU airports group, Paris Charles de Gaulle and Frankfort airports outperform the other airports. In Figure 2, UK airports group, London Heathrow outperforms the other airport listed over the five-year period. In Figure 3, US airports group, overall

Newark outperforms other airports listed although Chicago O'Hare extended its performance ahead of Newark in 2004.

Figure 1. Total Factor Productivity for European Union Airports, 2000-2004
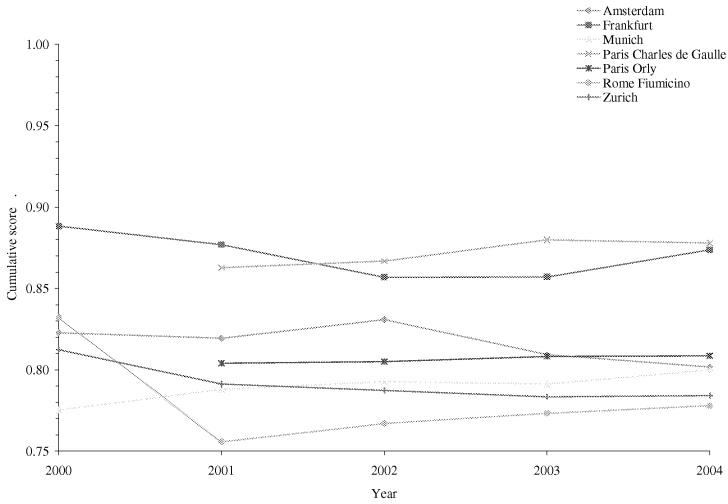
Figure 2. Total Factor Productivity for United Kingdom Airports, 2000-2004
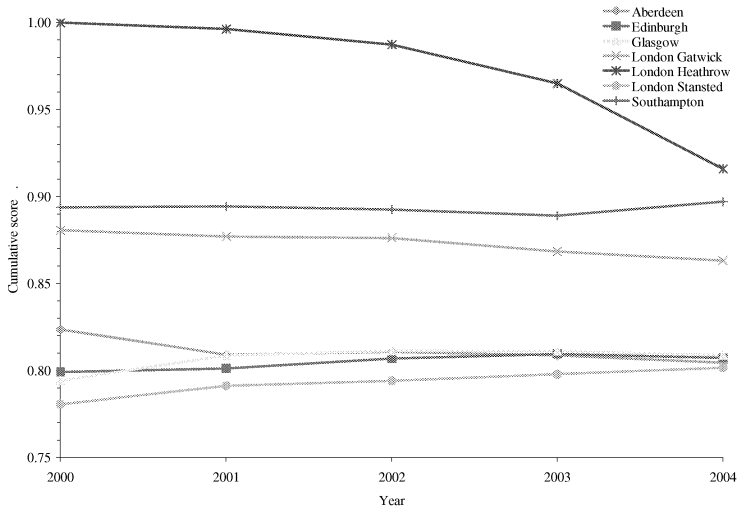
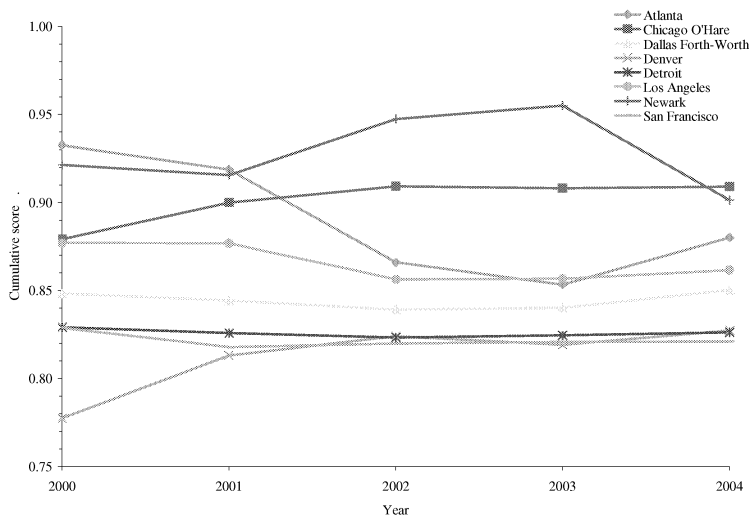**Figure 3. Total Factor Productivity for United States Airports, 2000-2004**

Figure 4 compares the annual average TFP for all three groups over five years (2000 – 2004). US airports consistently score higher than UK airports (BAA group), and EU airports always score lower than UK airports.

Figure 4. Total Factor Productivity for Selected Airports Grouped by Geographical Region, 2000-2004
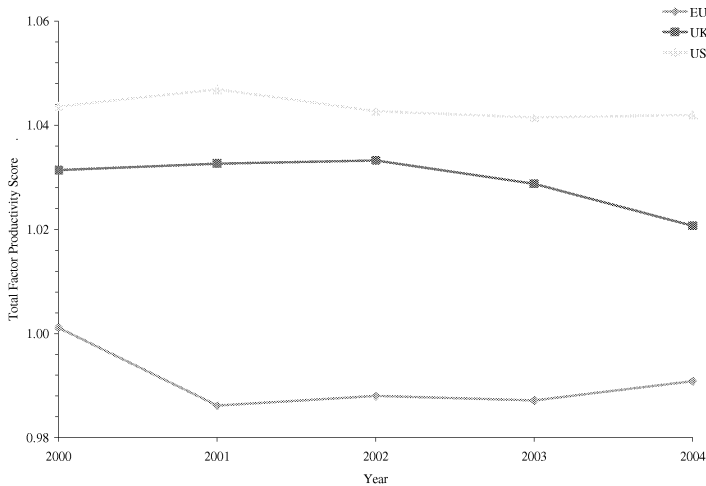
Stepwise-regression model

In order to evaluate and analyze the relationship between airport productivity and others factors such as airport ownership structure, management policy, and financial condition, the authors have developed the following functional relationship:[6]

TFP = f (RW, OC, NA, TP, MV, LF, OR, NR, D1, D2, D3, D4)

where:

RW = Airport runway area
OC = Airport operation cost
NA = Net total asset
MV = Aircraft movements
LF = Aircraft landing fee
OR = Operating revenue
NR = Non-operating revenue
D1 = Dummy variable, ownership structure
    D1 = 1 100% private
    D1 = 0 not 100% private
D2 = Dummy variable, airport location
    D2 = 1, all US airports
    D2 = 0, non-US airports
D3 = Dummy variable, multiple private entity
    D3 =1, multiple-airport operator
    D3 =0, single-airport operator
D4 = Dummy variable, multiple public entity
    D4 =1, multiple public entities owner or management
    D4 =0, single public entity owner

Stepwise-regression analysis was used to reveal whether productivity, defined as TFP, was related to runway size, airport operating cost, airport net assets, airport movements, landing fee, airport management, or ownership structure. This functional relationship was chosen because it selects the independent variable that is most predictive of the dependent variable (i.e., highest correlation with dependent variable "airport productivity") as indicated by the significance of t values.

---

[6] Variance Inflation Factors (VIFs) test was conducted among aircraft movements and operational revenue to uncover the possibility of multicollinearity. Since the calculated VIF value (6) was less than 10, therefore we reject multicollinearity between these two variables. This is a simple rule of thumb, since the VIF (like R^2) is a statistic without a distribution.

As Table 6 presents, the estimated coefficients for landing fees, runway area, aircraft movements, operational revenue, net assets, and dummy variable 3 (private multiple-airport multiple operator) are significant with at least 95 percent confidence. This result indicates that these independent variables contribute significantly to the TFP of the airport. On the other hand, the t-value for dummy variables 1, 2, and 4 are statistically insignificant, indicating that ownership structure, airport location (in group 1, 2, or 3), and public multiple entity are not contributors to airport productivity. As the results show, airport productivity was positively affected by landing fee, aircraft movements, and operational revenues and negatively affected by runway area and net assets. It also indicates that airports with higher TFP ratings may have used runways more intensively and used net assets more efficiently. In addition, the significance of dummy variable 3 indicates that if an airport operator manages more than one airport it will enjoy economies of scale in several areas, such as finance and marketing. Therefore, overall productivity increases and has a positive impact on the TFP score.

Table 6. Summary of Stepwise Regression Analysis for Variables Predicting the Total Factor Productive Score (N = 108)

Variable	Log-Linear			Linear function		
	B	SE B	B	B	SE B	β
Constant	0.326 (3.813)	0.086		0.892 (93.086)	0.010	
Landing Fee	0.052 (9.680)	0.005	0.550	0.015 (18.198)	0.001	0.670
Runway Area (m²)	-0.096 (-9.932)	0.010	-1.203	-0.000 (-10.466)	0.000	-0.570
Aircraft Movements	0.137 (13.170)	0.010	1.630	0.000 (17.810)	0.000	1.012
Dummy 3 (multiple airports)	0.037 (3.592)	0.010	0.289	0.015 (2.322)	0.007	0.123
Operational Revenues	0.027 (4.336)	0.006	0.464	0.000 (6.841)	0.000	0.335
Net Assets	-0.019 (-3.214)	0.006	-0.320	-0.000 (-0.146)	0.000	-0.007

Note. Log Values: Adjusted R^2 = .733; Durbin-Watson autocorrelation = 2.308. Non-Log Values: Adjusted R^2 = .874; Durbin-Watson autocorrelation = 2.020. Values in parentheses are t-values.

Granger causality test

The authors furthermore applied the Granger (1969) causality test between TFP and airport ownership, runway area, airport movement and operating revenue. The results of Granger causality tests are reported in Table 7. Generally, there is some evidence that TFP and runway area have Granger causality to each other.

Table 7. Granger Causality Test, for Airport Groups, 2000-2004

	US Airports		BAA Airports		EU Airports		Aggregate	
	No. Lags	FPE	No. Lags	FPE	No. Lags	FPE	No. Lags	FPE
RW -> TFP	2	0.00564	3	0.01023	3	0.10320	2	0.10747
MV -> TFP	3	0.00164	2	0.08322	1	0.12032	2	0.00591
NA -> TFP	1	0.10747	1	0.09210	2	0.07912	2	0.00792
OR -> TFP	2	0.01201	2	0.00003	2	0.06070	2	0.00000

-> Denotes Granger Causality

FPE is Final Prediction Error

In this section, the authors examined the causal relationship between airport landing fees, runway area, operating revenue, net assets, operating costs and airport total productivity. The relationship between airport operating cost and airport productivity is complex and the historical evidences are not clear. A large cut in airports operating expenses may reduce productivity because of diminishing returns due to more intensive use of variable resources; this is likely because large-scale and across-the-board cost cutting results in cutting productive and unproductive resources. Thus, it would seem that past values of airport operating costs may not help to predict TFP.

Furthermore, the Granger causality test indicated that there is no long-run relationship between the airport productivity and airport landing fees, operating revenue, and operating costs. However, the results for the BAA airports show that the runway area is Granger causes of airport productivity (but not for the other airport groups under the study).

CONCLUSION

The productivity and efficiency of any airport depends on the market power, regulatory control, choice of market to serve, and level of competition in the environment that it operates. In this research, the authors have assessed the performance of the 22 major international airports and utilized TFP model to measure airport performance.

This study concludes that airport operators managing more that one airport will enjoy a higher level of TFP than those that operate only one airport. Operators find this improvement through possible economies of scale in several areas that contribute to overall factor productivity of airports. This follows the reasoning of basic economics.

The study further found an inverse relationship between TFP and two of the input factors used in this model, total net assets and runway area. The negative coefficients imply that airports with higher TFP ratings may have used runways more intensively and used net assets more efficiently. It may also indicate that one airport operator may be able to produce greater outputs with the same net assets and runway area than another operator.

The positive relationships between TFP and landing fees, aircraft movements, and operational revenues, imply that these input factors contribute to increasing returns to scale. Therefore, increasing TFP may require additional units of these factors. Similarly, the increase in these input factors will result in a higher level of productivity.

The results of the analysis presented in this research paper demonstrate, among the airports under the study, that the ownership and management structure of an airport does not necessarily contribute to its productivity. These results support the prior findings of Vasigh and Harrian (2003), which found no link between ownership structure and productivity.

The quality of managerial performance, on one hand influenced by the distinct patterns of authority, responsibility, and economic incentives provided by the ownership arrangements and on the other hand depends on the market and competition conditions in which the airports operate. The US airports, although, marked as public ownership that owned by government departments or public authorities, majority of their operations are contracted to private enterprises. Since US airports operate in a competitive environment with significant private contractors of their operations, it is not unexpected to see that their performances are not significantly different as compared to the airports owned by the private enterprises under this study.

Further tests of the link between ownership structure and productivity might be most easily seen in time-series test on airports that adjusted their ownership structures. As airports worldwide privatize, there will be opportunities to measure the value of shifts in ownership structure. This could provide important observations in this critical time. With changing airports structures, one can compare the resulting change in productivity of the same airport with respect to changes in organizational structure, organizational direction, and strategic decision making. These comparisons may produce the most fruitful results.

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ACKNOWLEDGMENT

APPENDIX

OWNERSHIP STRUCTURE OF EUROPEAN AIRPORTS (EXCL. UK)

Airport	Ownership Structure
Amsterdam	Managed and operated by Schiphol Group: 75.8% State of Netherlands 21.8% City of Amsterdam 2.4% City of Rotterdam
Frankfurt	Managed and operated by Fraport: 31.7% State of Hesse 20.3% Stadtwerke Frankfurt am main Holding GmbH 6.6% Federal Republic of Germany (exchangeable bond) 5.4% Julius Baer Investment Management LLC 5.0% Deutsche Lufthansa 31.0% free float
Munich	Managed and operated by Flughafen Muenchen GmbH: 51.0% Free State of Bavaria 26.0% Federal Republic of Germany 23.0% City of Munich
Paris Charles de Gaulle Paris Orly	Managed and operated by Aéroports de Paris S.A., a state-owned company.
Rome Fiumicino	Managed and operated by Aeroporti di Roma (ADR S.p.A.): 44.68% Macquarie Airports Group 51.08% Leonardo S.r.l. 3.00% Local Authorities (1.33% Regione Lazio, 1.33% Comune de Roma, 0.25% Provincia, 0.1% Comune de FCO) 1.24% Others
Zurich	Managed and operated by Unique AG: 51.00% Public sector 13.51% Financial Institution 3.78% Private individuals 2.78% Companies 1.10% Pension Funds 27.83% Free float

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