SEPTEMBER–OCTOBER 2011
NUMBER 276

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

TR NEWS

Positioning Aviation for Skies Unlimited

- Air Traffic Control's Next Generation
- Implementing Sustainability Measures
- Testing Ecologically Friendly Fuels
- Addressing Flaws in Security
- Efficient and Affordable Economics

TR NEWS

NUMBER 276 SEPTEMBER–OCTOBER 2011

POSITIONING AVIATION FOR SKIES UNLIMITED

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Expanding the Benefits of Aviation: Answering Key Challenges
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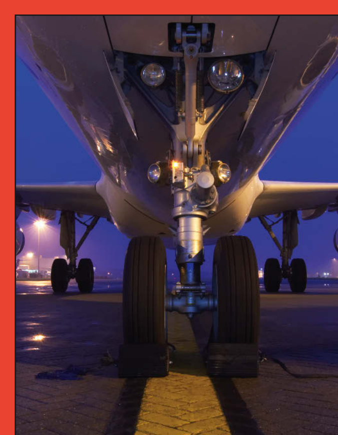

COVER: The aviation industry is facing challenges and transitions and is applying research findings to ensure success. (Photo: iStockphoto)

TR NEWS

features articles on innovative and timely research and development activities in all modes of transportation. Brief news items of interest to the transportation community are also included, along with profiles of transportation professionals, meeting announcements, summaries of new publications, and news of Transportation Research Board activities.

TR News (ISSN 0738-6826) is issued bimonthly by the Transportation Research Board, National Research Council, 500 Fifth Street, NW, Washington, DC 20001. Internet address: www.TRB.org.

Editorial Correspondence: By mail to the Publications Office, Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001, by telephone 202-334-2972, by fax 202-334-3495, or by e-mail jawan@nas.edu.

Subscriptions: North America: 1 year $55; single issue $10. Overseas: 1 year $80; single issue $14. Inquiries or communications concerning new subscriptions, subscription problems, or single-copy sales should be addressed to the Business Office at the address below, or telephone 202-334-3216, fax 202-334-2519. Periodicals postage paid at Washington, D.C.

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PHOTO: ROGER W. WINSTEAD, NORTH CAROLINA STATE UNIVERSITY

The Pulstar reactor, developed under the sponsorship of the National Science Foundation, characterizes the porosity of materials at nanoscale.

Feature articles in the next *TR News* explore the applications of nanotechnology in transportation, examine asset management for low-volume road systems, review the metamorphosis of traffic data from the Long-Term Pavement Performance studies, and more.

INTRODUCTION

Expanding the Benefits of Aviation

ANSWERING KEY CHALLENGES

SETH YOUNG AND PETER MANDLE

Young is Director of the Center for Aviation Studies and Associate Professor, Department of Aviation, Ohio State University, Columbus, and Chair of the TRB Aviation System Planning Committee. Mandle is Director, LeighFisher, Inc., Burlingame, California, and Chair of the TRB Aviation Group.

Aviation with fixed-wing aircraft—a technology proved more than 100 years ago—amazingly remains the newest and most revolutionary mode of transportation in the 21st century world of digital communications, satellite navigation, and economic globalization. Civil aviation has grown to connect the world in ways that automobiles, trains, or ships never have, and has served as the mode of transportation that most has enabled the world to develop technologically and economically.

Although aviation is new as a mode, more than 150 papers, publications, symposia, and other products of aviation-related research emanate annually from Transportation Research Board (TRB) activities. This special issue of *TR News* highlights several of the most important issues facing the aviation industry.

A Complex System

Civil aviation is a complex system of aircraft, airports, and air traffic infrastructure. Aircraft range in shape, size, and purpose—from 700-passenger commercial superjumbo jets to general aviation aircraft seating one or two persons. Similarly, nearly 20,000 public- and private-use airports, heliports, and other landing areas of varying sizes and purposes operate in the United States, including nearly 500 commercial service airports, more than 5,000 public-use general aviation airports, and thousands more privately owned facilities.

All of the airports and aircraft in the aviation system are supported by publicly operated air traffic management infrastructure, including command centers, control towers, radar facilities, navigational aids, communications systems, and a defined network of federal airways not unlike the Interstate

PHOTO: KOOLHOVEN AEROPLANES FOUNDATION, WWW.KOOLHOVEN.COM

The world's first airliner specifically designed for commercial aviation was the F.K. 26, produced by British Aerial Transport in 1919. Although modern aircraft accommodate significantly more passengers and often use new technologies such as satellite navigation or biofuel power, the fixed-wing design remains constant.

Photo: Air New Zealand

The Boeing 747-400 jet airliner combines a four-engine wide-body layout with an efficient airframe. First introduced in the late 1980s, a 747-400 can hold more than 500 passengers.

Highway System. Unlike vehicles on the roads, however, aircraft are under constant management—for routes, speeds, and altitudes—from the departure gate or parking position until arrival at the destination gate or parking position. Airports function as true multimodal centers in the nation's transportation infrastructure—all are served by automobiles, and most commercial airports are served by taxis and buses; many are served by rail—or soon will be; and some are integrated with marine terminals.

For each pilot flying an aircraft, no fewer than 10 full-time professional staff are working behind the scenes to make the flight successful, including airline flight planners and dispatchers, aircraft maintenance and repair personnel, airport operations and management professionals, and air traffic controllers. In addition, dozens of ancillary positions contribute to the success of the system, including aircraft and parts manufacturers, caterers, customer service personnel, emergency services, policy makers, and—of course—researchers.

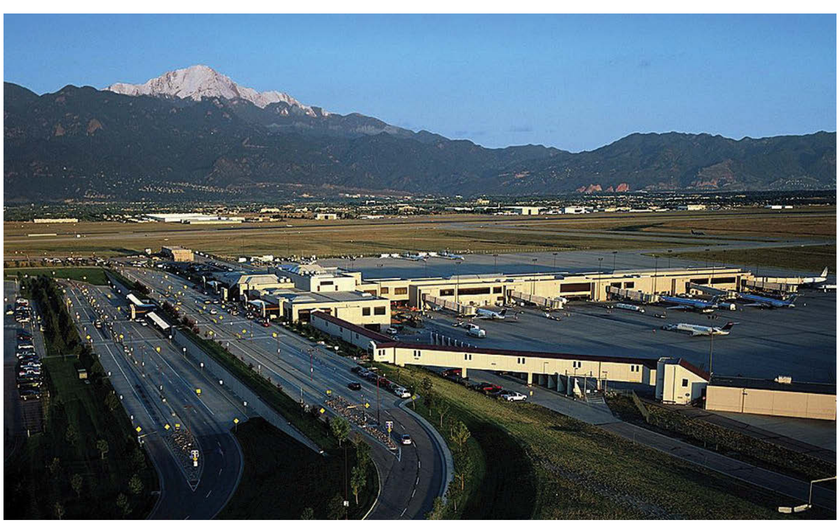


Photo: Colorado Springs Airport

The complex infrastructure system supporting commercial aviation includes public- and private-use airports, heliports, landing areas, air traffic management, and multimodal transportation to and from airports.

Meeting Mobility Needs

The U.S. civil aviation sector—including air transportation, aircraft manufacturing, and air-based travel and tourism—collectively generated more than $1.3 trillion in economic activity in 2007, accounting for 11.5 million jobs and $396 billion in payroll expenditures.[1] U.S. civil aviation provides an enormous contribution to the national and global economies. A recent study by the Federal Aviation Administration (FAA) reported that

- The revenue ton-miles for freight transported through U.S. airspace exceed 67 billion[1];
- Regularly scheduled nonstop air service connects the United States to more than 140 international cities[2]; and
- More than 700 million passengers board a commercial aircraft in the United States annually,[1] and more than 4 billion passengers board flights worldwide.

Aviation is key to meeting the world's mobility needs. The timely movement of people and goods around the world depends on a smoothly functioning aviation system. In the United States, people assume that shipments will arrive overnight and that they can travel anywhere in the world in less than 24 hours. A reliable air transportation system is vital to many industries—such as the manufacturers of personal electronics, computers, and computer parts and the wholesalers of flowers and fresh foods.

Key Challenges

Authors of articles in this special edition of *TR News* examine several key challenges facing civil aviation, including the implementation of the Next Generation Air Transportation System (NextGen); the sustainability of the aviation system; developing and testing alternative fuels; effective approaches to aviation security; and meeting the economic needs of the industry.

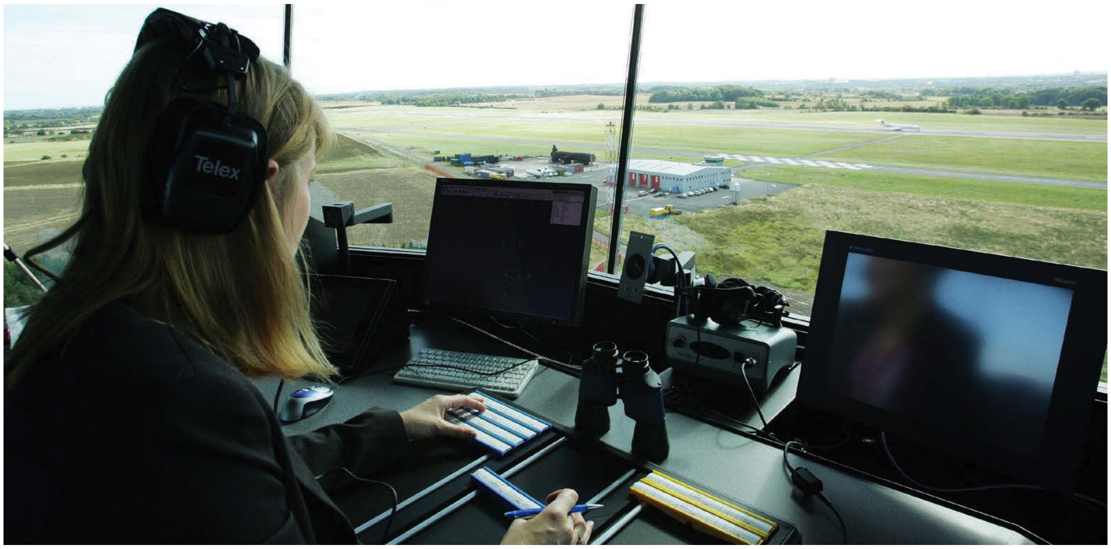
NextGen

NextGen represents one of the greatest challenges to the long-term future of the aviation system, requiring the accommodation of a major technological upgrade for managing air traffic. NextGen is expected to improve national airspace capacity, as

[1] www.faa.gov/air_traffic/publications/media/FAA_Economic_Impact_Rpt_2009.pdf.

[2] www.bts.gov/xml/air_traffic/src/index.xml#TwelveMonthsSystem.

Photo: Newcastle International Airport



Successful aircraft flights depend not just on the pilot but also on communications and navigation professionals such as flight planners and dispatchers and air traffic controllers.

well as contribute to safety and efficiency and reduce impacts on the environment. The successful transition of a mature system built on a more than 100-year foundation will require a vast amount of dedicated resources for years to come.

Sustainability and Alternative Fuels

In delivering many positive economic benefits, the aviation industry and system consume increasingly scarce resources. To manage the available resources—particularly fossil fuels—in a sustainable way while providing for the movement of people and goods, the aviation industry is reviewing opportunities across the entire system to ensure that future needs can be met.

The development of commercially viable alternative fuels offers an important opportunity. Research is under way and is starting to yield promising results that will determine if alternative fuels can be used safely, can reduce U.S. dependence on foreign imports significantly, can provide an economically viable alternative to increasingly expensive fossil fuels, and can reduce the environmental impacts from the use of fossil fuels.

Maintaining a Secure System

Perhaps the most significant changes affecting the aviation industry and those it serves have occurred in the past 10 years as a result of terrorist attacks involving aircraft and airports. These changes address the design and operation of airports, aircraft, and supporting services. Although a necessity, the changes to enhance aviation security have increased the time required to travel through U.S. airport terminals and have decreased somewhat the level of comfort and convenience aviation offers.

Preserving the efficacy of the aviation system while ensuring its security continues to challenge all

Photo courtesy of LeighFisher, Inc.

An airplane fuels up at Seattle–Tacoma International Airport. Research into environmentally friendly, commercially viable alternative jet fuels has gained traction as oil prices rise.

Photo: David Benbennick

The scope and intensity of airport security measures have grown significantly since the September 11, 2001, terrorist attacks, posing a challenge to the aviation industry in balancing efficiency and thoroughness.

who are working at the task, including government officials, aircraft and airport operators, first responders, university and research organizations, security consultants, and technology providers.

Meeting Economic Needs

A key difference between the U.S. aviation system and its road and transit system is that aviation is virtually self-supporting. The civil aviation system relies principally on user charges—for example, surcharges on the costs of tickets and of aviation fuel—to fund operations and capital development.

In the United States, federal laws and regulations require major commercial service airports to be financially self-sustaining. U.S. airports rely on grants from these federally imposed user charges, as well as on revenues from fees collected directly from aircraft operations—such as landing fees, fuel fees, gate leases, and hangar rentals—and from passengers and visitors who purchase such services as food, retail goods, and public parking at the airport.

Assuring an adequate and continuing source of funding is a key challenge for the entire aviation industry. The radar and communication technologies supporting the U.S. air traffic control system are quickly becoming obsolete and are to be replaced with satellite-based navigation and digital communication systems. The new systems require the concurrent replacement of ground-based technologies and the installation of compatible technologies in commercial aircraft. Funding these replacement technologies will be difficult.

TRB's Involvement

The nine standing committees in TRB's Aviation Group promote and share the results of research addressing each of the operational, environmental, economic, and security challenges presented in this issue, along with issues associated with intergovernmental relations, system planning, airport terminals and ground access, aircraft–airport compatibility, and light commercial and general aviation aircraft. In 2011, the Aviation Group sponsored and cosponsored more than 150 presentations and posters in more than 50 sessions, workshops, and events on these topics at the TRB Annual Meeting; the committees peer-reviewed 18 papers published in August in *Transportation Research Record: Journal of the Transportation Research Board, No. 2214*. In addition, the Aviation Group and its committees routinely sponsor meetings, webinars, and symposia around the country.[3]

Members of the Aviation Group committees actively participate in TRB's Airport Cooperative Research Program (ACRP) as researchers, as members of panels overseeing the research, or by identifying research needs. Established in 2005 in the FAA's Vision 100 Reauthorization Act, ACRP has initiated more than 200 research projects benefiting the aviation industry and has released more than 70 publications.[4]

The articles in this issue should provide readers with a greater appreciation of the aviation industry and the challenges it faces. Readers are welcome to become involved in one or more of TRB's Aviation Group committees and in the ever-promising future of the world's newest mode of transportation.

Acknowledgment

Special thanks and appreciation are expressed to TRB Senior Program Officer Christine L. Gerencher for her contributions in developing this issue of *TR News*.

The Oversight Committee for the Airport Cooperative Research Program meets at the National Academies' Keck Center in Washington, D.C., January 2011. Since 2005, ACRP has initiated more than 200 research projects and released more than 70 practice-oriented publications.

[3] For more information about the activities of the Aviation Group committees, see www.TRB.org/Aviation1/TRBCommittees.aspx.

[4] For more information about ACRP publications and research, see www.TRB.org/ACRP.

NextGen, the Next Generation Air Transportation System

Transforming Air Traffic Control from Ground-Based and Human-Centric to Satellite-Based and Airplane-Centric

WILLIAM J. DUNLAY, JR., AND JASENKA RAKAS

Dunlay is Director, LeighFisher, Inc., Burlingame, California. Rakas is Deputy Director, National Center of Excellence for Aviation Operations Research II, University of California, Berkeley.

Since the dawn of the Jet Age more than 50 years ago, aircraft technology has undergone many major advances. Today's aircraft are equipped with on-board flight management system computers that optimize routes and automatically guide landings in virtually any weather condition. Technologies use signals from the Global Positioning System (GPS) to enable aircraft to fly paths of approach or departure with an accuracy that some have likened to "flying on rails."

Major advances in air traffic control (ATC) technologies include radar displays that are much more accurate and that provide more useful information to air traffic controllers than earlier radar systems did. In addition, major recent improvements in airport sur-

Photo: Federal Aviation Administration

Although many technological changes have advanced the practice of air traffic control, the process still involves radar vectors and voice communications. NextGen will replace the ground-based system with a satellite-based system.

NextGen and Its Key Capabilities

The Next Generation Air Transportation System (NextGen) is the latest generation of national aviation improvement plans. The first generation began after a 1956 midair collision over the Grand Canyon and established the en route and terminal airspace systems; another aviation plan emerged after the 1981 air traffic controller strike and led to the National Airspace System, which has modernized the nation's air traffic control (ATC). The latest generation, NextGen, looks to transform the U.S. and global air transportation systems to meet ever-expanding transportation and economic needs.

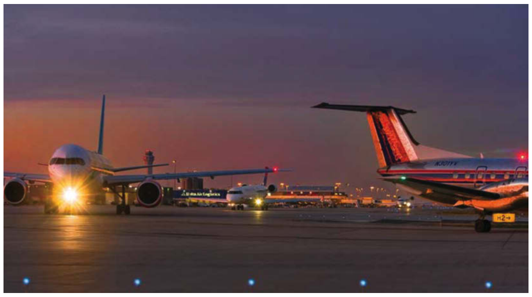
Following are some of the capabilities of NextGen technologies:

◆ **Broad-area precision navigation services—positioning, navigation, and timing:** The satellite-based navigation and surveillance system will enable FAA to meet the predicted growth in air traffic in coming decades with a set of scalable technologies.

◆ **Aircraft trajectory-based operations:** Focused primarily on high-altitude cruise operations in en route airspace, this capability represents a shift from traditional clearance-based to optimized trajectory-based ATC that will enable aircraft to fly negotiated four-dimensional (4-D) flight paths.

◆ **Equivalent visual operations:** State-of-the-art cockpit instrumentation technologies would permit a level of operation equivalent to or better than visual operations and would provide safer and more efficient flight operations.

◆ **Superdensity arrival and departure operations:** Primarily for terminal airspace around the busiest airports, this capability would safely reduce the separation between aircraft in surface and terminal operations and would maximize performance.



Airplanes line up for takeoff at Salt Lake City International Airport in Utah. When fully implemented, NextGen will allow planes on direct routes to fly closer together.

PHOTO: MICHAEL SCHOENFELD, SALT LAKE CITY DEPARTMENT OF AIRPORTS

face radar have benefited Federal Aviation Administration (FAA) tower controllers, airlines, and airports.

Despite these advances, however, the ATC process has remained virtually unchanged. Aircraft are still served on a first-come, first-served basis, and—for the most part—controllers still issue radar vectors to pilots via voice communication channels. The rules specifying the separations between aircraft and flight paths also have not changed significantly.

To modernize the nation's ATC technologies and procedures, FAA is developing the Next Generation Air Transportation System (NextGen) in cooperation with major stakeholders in the aviation industry.

Deconstructing NextGen

NextGen is a congressionally mandated multiagency initiative to modernize the ATC system. The Vision 100—Century of Aviation Reauthorization Act (PL 108-176), passed by the U.S. Congress in December 2003, established the Joint Planning and Development Office (JPDO) in the U.S. Department of Transportation to manage the partnerships designed to bring NextGen online (see list at left). These partnerships involve private-sector organizations, academia, and government departments and agencies.

The evolving ATC and aircraft technologies of NextGen are designed to transform the U.S. ATC system from ground-based to satellite-based. The transformation will enable the ATC system to accommodate air traffic demand by increasing capacity, reducing aircraft delays, and reducing fuel burn and emissions. When fully implemented, NextGen will allow more aircraft to fly safely yet closer together on more direct routes, reducing delays, saving money, and providing benefits for the environment by reducing carbon emissions, fuel consumption, and noise exposure.

NextGen is part of a global initiative outlined in the Global Air Traffic Management Operational Concept advanced by the International Civil Aviation Organization (ICAO), a United Nations agency. Europe has undertaken a program parallel to NextGen, called Single European Sky ATM Research, or SESAR, which also aims to realize the ICAO concept (see sidebar, above).

Government Departments and Agencies in the Joint Planning and Development Office

- U.S. Department of Transportation
- U.S. Department of Commerce
- U.S. Department of Defense
- U.S. Department of Homeland Security
- Federal Aviation Administration
- National Aeronautics and Space Administration
- White House Office of Science and Technology Policy
- Office of the Director of National Intelligence (ex officio)

SESAR and NextGen

The European Commission launched the Single European Sky (SES) initiative in 1999 to reorganize and integrate the fragmented European airspace, to modernize the system, and to increase system capacity. The Single European Sky ATM Research (SESAR) program represents the technological and operational dimension of the initiative.

SESAR and NextGen have many similarities. The SESAR approach enables aircraft to fly collaboratively using four-dimensional trajectories, called business trajectories (BTs), which are negotiated between airlines, air traffic control providers, airports, and the military. The goal is to bring the BT as close as possible to the optimal trajectory from a business perspective.

Advantages and Upgrades

FAA and the airlines often describe NextGen in terms of its effects on communications, navigation, and surveillance capabilities. NextGen would take advantage of satellite-based technologies that can dramatically increase the precision of aircraft flight paths, radar displays, and aircraft operating times.

Radar-based displays of air traffic, for example,

How NextGen Will Transform the Air Transportation System

Current System	NextGen
Ground-based navigation and surveillance	Satellite-based navigation and surveillance
Air traffic control	Air traffic management
Voice communications	Datacom
First come, first served	Best equipped, best served

would be replaced by more accurate displays of GPS-based aircraft positions that would be viewable by air traffic controllers and pilots. The goal of these upgrades is to sever aircraft flight paths from radio signals on the ground. Instead, aircraft could fly virtually any desired path through an airspace defined by waypoints that enable more fuel-efficient, four-dimensional (4-D) flight trajectories from origin to destination.

NextGen offers other procedural advantages and effects. Aircraft could follow shorter, more fuel-efficient, conflict-free, all-weather flight paths to and from the runways, because of the greatly improved navigational accuracy of cockpit-based GPS receivers. Neighborhoods surrounding airports could benefit from the environmental and noise advantages of optimal profile descents—the landing aircraft can descend at idle thrust from cruise altitude to the runway without having to level off, and departing aircraft can use unrestricted climbs. Noise exposure levels, however, also could increase for residents under the more concentrated flight paths; this could pose problems if the paths cannot be moved to less noise-sensitive areas.

The physical effects of NextGen at airports would include reduced spacing between parallel runways for independent operations, reduced dependence between airports that share limited airspace, and reduced congestion on the airport surface with improved management of departure queues and optimized taxiing paths.

Changing Controller–Pilot Interactions

NextGen will change fundamentally the interactions between air traffic controllers and pilots, who now communicate through radio voice channels. These communications relay many types of information, including tactical commands to alter flight paths, strategic messages to maximize longer-term flight and airspace efficiency, and routine information that often may be repetitive or advisory but nonetheless is required by ATC rules.

Providing the tools to controllers and pilots to reduce the workload associated with their communications is a key prerequisite for enhancing the capacity and efficiency of the National Airspace System. Nearly all future automation and operational

PHOTO: CHRISTINE GERENCHER

Air traffic control technology always has adapted to the needs of the region served. Developed in the 1920s and 1930s, the lighted airway beacon system has been phased out in most of the United States, but "OriginalGen" remains in service in the remote, mountainous regions of Montana.

Core NextGen Technologies

◆ **RNAV and RNP:** Area navigation (RNAV) technology enables aircraft to fly on any desired flight path instead of flying between ground navigation aids. RNAV-equipped aircraft have better access and flexibility for point-to-point operations. Required navigation performance (RNP) is RNAV combined with onboard capability for performance monitoring and alerting.

◆ **4-D trajectories:** Four-dimensional (4-D) trajectories are based on three dimensions plus required times of arrival at waypoints along the flight path; this allows pilots and controllers to negotiate a flight path to optimize efficiency through precise timing and highly accurate position data.

◆ **Datalink communications:** The datalink communication system, or datacom, enables controllers and pilots to exchange in digital format routine information such as altitude, altimeter settings, taxiing data, clearances, and other precomposed text messages.

◆ **ADS-B and CDTI:** Automatic dependent surveillance-broadcast (ADS-B) is a Geographic Positioning System (GPS)–based surveillance technology that allows GPS-equipped aircraft to broadcast information about their position, which can be picked up and displayed by any airborne or ground-based ADS-B–capable receiver. Cockpit display of traffic information (CDTI) provides proximate information about other traffic by displaying the ADS-B information broadcast by other aircraft.

◆ **ASDE-X:** Airport surface detection equipment–Model X (ASDE-X) collects data from a variety of sources and tracks vehicles and taxiing aircraft in the airport movement area—that is, the runways and taxiways. The detailed coverage allows air traffic controllers to detect potential runway conflicts. ASDE-X can determine the position and identify aircraft and transponder-equipped vehicles in the airport movement area, as well as aircraft flying within 5 miles of the airport.

◆ **Multilateration:** Multilateration is a ground-based surveillance technology. Radio stations in strategic ground locations use replies from transponder-equipped aircraft—including legacy radar and ADS-B avionics—to determine an aircraft's position based on the time difference in the arrival of the replies. Multilateration surveillance is independent of the airborne navigation system and of associated aircraft equipage requirements and can be used to support surface or wider-area surveillance systems and to supplement radar surveillance in mountainous regions without coverage.

◆ **4-D weather cube:** The Improved Weather Information and Dissemination System is planned to be a network-enabled, continuously updated, 4-D weather data cube that will serve as a repository of weather data and information. The data will present a common picture of the weather for aviation system decision makers, including forecasters, traffic controllers, and air traffic management personnel.

NextGen would allow controllers to focus less on routine air traffic control tasks, such as communicating navigation instructions or radar vectors, and more on value-added tasks, such as negotiating 4-D flight plans.

Photo courtesy of FAA

concepts that address these issues depend on digital data communications, or datacom.

NextGen datacom and automation enhancements will enable evolution from the workload-intensive, voice-based, and short-term-focused ATC system to a collaborative, planned management-by-exception system. Ground and airborne computers will exchange repetitive and advisory information, allowing controllers and pilots to focus their time and energy on more value-added tasks. Instead of controllers instructing aircrews to turn, climb, or slow down, pilots and air traffic managers will negotiate detailed 4-D flight plans to ensure orderly and efficient air traffic flow. Advanced datacom between ground and airborne systems will convey more complete data on wind and weather, along with revised 4-D routings, in real time.

These changes also will affect the roles of pilots and controllers. Pilots would have more information about surrounding aircraft and greater responsibility for their own navigation and separation. Controllers would spend less time giving navigation instructions or radar vectors to pilots, reducing the voice communications between pilots and controllers and allowing controllers to focus on the less routine tasks of air traffic management.

Expected Benefits

NextGen is expected to improve the performance of the National Airspace System by providing benefits in the following areas:

- *Capacity*—Improved navigational accuracy and reduced controller and pilot workload will enable more simultaneous movements and greater all-weather throughput in the airspace and on the runways.
- *Efficiency*—Increased capacity and more direct routing will reduce aircraft operating times and delays.
- *Predictability*—4-D trajectories and greater navigational accuracy will reduce the variability in aircraft operating times.
- *Flexibility*—Users will be able to request desired 4-D flight paths.
- *Environment*—Optimal flight profiles and increased efficiency will reduce the fuel consumption and carbon emissions of aircraft operations, both in the air and on the airport surface.
- *Safety*—More precise tracking and information sharing should improve the shared situational awareness of controllers and pilots and make runway incursions less likely. Datacom should reduce the opportunities for operational errors.

FAA estimates that failure to implement NextGen by 2022 could cost the United States $22 billion annually in lost economic activity, with the losses exceeding $40 billion by 2033 (*1*).

The most visible benefits of NextGen would be an increase in the capacity of the air transportation system and a reduction in aircraft delays. FAA's latest estimates of potential NextGen benefits show that by 2018,

> NextGen will reduce total flight delays by about 21 percent while providing $22 billion in cumulative benefits to the traveling public, aircraft operators, and the FAA. In the process, more than 1.4 billion gallons of fuel will be saved during this period, cutting carbon dioxide emissions by nearly 14 million tons. These estimates assume that flight operations will increase 19 percent at the 35 major U.S. airports between 2009 and 2018, as projected in the FAA's 2009 traffic forecast. (2)

These estimates are probably understated,

Head-up displays and other technological advances in airplane navigation are becoming more common in commercial airplanes.

Photo: Brett B. Despain

because the model for the benefits calculations did not include all of the NextGen capabilities.

Research Areas

Many private-sector organizations, academic institutions, and government departments and agencies are supporting FAA's NextGen research, development, and implementation, exploring new technologies, processes, procedures, and policies. Research areas include aviation safety, regulatory processes, innovative technologies, human factors, concept modeling, weather prediction, airline maintenance, ramp operations, wake turbulence, datacom, airport environment, and sustainable alternative fuels.

Major Challenges

Achieving the benefits of NextGen requires that aircraft be properly equipped, but airlines are reluctant to invest in avionics upgrades without assurances that the program will deliver all that is promised. Possible solutions include third-party funding for aircraft equipage. For example, leading U.S. aerospace companies have established a NextGen Fund to lease aircraft equipage, with payments deferred until the program is implemented and benefits are realized.

Another proposal is for government-guaranteed loans based on the delivery of NextGen benefits. If FAA does not achieve an established benefit within a specified time, the government would pay the interest on the loan or even the loan itself. Innovative funding solutions may be critical for overcoming the stalemate on the financing of equipage.

A second hurdle to realizing NextGen's benefits involves local and regional environmental concerns—particularly community concerns about exposure to aircraft noise. Because NextGen airspace improvements change the way that airspace routes are structured and the nation's airspace is used, patterns of noise exposure can change, especially near congested airports. The National Environmental Policy Act (NEPA) states that these kinds of changes can require expensive and time-consuming environ-

PHOTO: NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Airport surface detection equipment display, part of research for a new wireless communications technology for shared situational awareness and air traffic applications in development at the NextGen communications, navigation, and surveillance test bed in Ohio and New York.

The Airport Perspective on NextGen

Airports have key roles to play in the development of NextGen, representing their communities in prioritizing the improvements, providing local knowledge and support to FAA about NextGen airspace and procedure enhancements, and implementing important NextGen capabilities—such as surface management systems—among other tasks. As Rick Busch, City and County of Denver, Colorado, has noted, "The airport is the face of NextGen to the community."

Data collected by FAA consistently show that airports—especially in congested metroplex areas—are the sources of the majority of delays. The impacts of congestion delays, however, extend far beyond—smaller airports with air service to metroplexes are frequently affected by ground delay programs and other traffic management initiatives that delay departing flights. Regardless of where they occur, airport delays leave passengers frustrated and disappointed. Delays hurt airport efforts to serve the traveling public and to maintain high levels of customer service; they also hurt productivity and economic competitiveness.

NextGen promises to reduce these delays by reducing the impact of adverse weather conditions on airport capacity, reducing delay-causing interactions among nearby airports, and enabling airports to use their infrastructure more effectively. These benefits will result from enhanced airport surface surveillance and traffic management, improved flight procedures, and reduced separations, all of which are enabled through implementation of NextGen communications, navigation, and surveillance technologies.

How are airports getting involved? Several airport representatives are actively participating in NextGen development efforts, either through FAA's NextGen Advisory Committee, the Joint Planning and Development Office, or as part of regionally focused Metroplex Study Teams.

An airplane passes over a residential neighborhood near London's Heathrow Airport. In the United States, changes in patterns of noise exposure near airports require expensive and time-consuming National Environmental Policy Act studies—this may affect the implementation of NextGen, which will change flight paths and facilitate increases in air traffic.

Photo: Adrian Pingstone

mental studies and noise mitigation efforts. Completing NEPA reports in a timely, cost-effective manner without delaying NextGen capabilities will be a major challenge to implementation.

A third challenge for NextGen is maintaining funding and commitment by FAA, Congress, and stakeholders during the long time frame for implementation, particularly in an era of reduced federal and state resources.

Progress to Implementation

FAA already has achieved several critical NextGen milestones. Pilot projects for satellite-based surveillance, satellite-based navigation, and performance-based navigation procedures have been completed successfully at various airports.

In December 2009, FAA began controlling air traffic over the Gulf of Mexico with satellite-based surveillance technology. This active airspace previ-

Weatherproofing the National Airspace System

Few air travelers have had the luxury of never experiencing the impacts of adverse weather on their trip. Aviation system performance data attribute approximately 70 percent of all delays in the U.S. air transport system to weather. Because the system operates best in good weather, when pilots and controllers can see runways and surrounding aircraft, many of the NextGen initiatives have focused on workable solutions during reduced visibility, to minimize the uncertainty associated with poor to severe weather conditions and to reduce the associated delays.

In the terminal area, air traffic controllers applying NextGen procedures will be able to allow aircraft to fly closer to one another during takeoffs and landings and will be able to use closely spaced parallel runways to increase the runway capacity when visibility has decreased. A variety of arrival and departure procedures will ensure safe separation from collision and wake turbulence while increasing throughput—sometimes taking advantage of particular wind and weather conditions. Innovative technology solutions such as head-up displays and aircraft-to-aircraft data communications will improve pilots' situational awareness, increasing their ability to perform as in visual conditions.

In the en route environment, severe weather events can disrupt planned air routes. Instead of reacting tactically to severe weather events, air traffic managers—with the assistance of automated decision-support tools—will be able to plan and maximize traffic flows by assigning precise flight paths around weather systems.

ously had no radar coverage. Satellite-based surveillance also has been successful at airports in Louisville and Juneau. FAA has implemented performance-based navigation procedures as overlays to current procedures at most major U.S. airports. NextGen technologies and procedures, along with airspace redesign, have enabled more direct routes and more efficient operations in several major metropolitan areas, reducing fuel consumption and emissions.

FAA also has deployed advanced airport surface radar at most major airports, providing controllers with a color display of aircraft and vehicle movements overlaid on a map of the airport's runways, taxiways, and approach corridors. This continuously updated map allows controllers to spot potential traffic conflicts and runway incursions more easily, especially at night and during adverse weather conditions.

Priorities and Funding

The necessarily long time frame for the implementation of NextGen is proving a difficult hurdle. As noted, some of the technologies must mature and gain FAA certification, and the airlines need time to equip their aircraft to take advantage of NextGen's operational improvements and associated benefits.

In 2009, FAA asked RTCA, Inc., a not-for-profit organization that acts as a federal advisory committee on air traffic management issues, to establish a task force to forge consensus recommendations on near-term operational capabilities for NextGen. The 300-member Task Force 5 has delivered a series of recommendations, adopted by FAA (3).

RTCA also has formed a NextGen Advisory Committee (NAC), with a membership of senior executives of FAA, JPDO, airlines, aircraft operator organizations, aerospace manufacturers, air traffic controllers, airports, and other stakeholders. NAC is working toward a common understanding of NextGen priorities, with an emphasis on the near term and midterm—that is, through 2018—implementations of NextGen technologies and procedures.

Although some technological hurdles remain, continued progress toward implementing NextGen will depend more on making the business case to the users and on gaining the funding. FAA has made major progress in implementing the automatic dependent surveillance-broadcast program, which is on budget and ahead of schedule. Progress has yet to be demonstrated, however, in developing the business case for the airlines to equip their airplanes; this requires the timely delivery of the promised NextGen benefits.

Details on NextGen goals and objectives, program elements, and schedules can be found online at the links below.

Related Websites

Next Generation Air Transportation System (NextGen)
www.faa.gov/nextgen/

NextGen Implementation Plan
www.faa.gov/nextgen/media/ng2011_implementation_plan.pdf

Joint Planning and Development Office, U.S. Department of Transportation
www.jpdo.gov/

JPDO's December 2004 NextGen Integrated Work Plan
www.jpdo.gov/library/PartnerAgency/IWP_ED.pdf

RTCA, Inc.
www.rtca.org/

References

1. *NextGen Q and A*. Federal Aviation Administration. www.faa.gov/nextgen/qanda/.
2. *NextGen Benefits*. Federal Aviation Administration. www.faa.gov/nextgen/benefits/.
3. *NextGen Mid-Term Implementation Task Force Report*. RTCA, Inc., Washington, D.C., September 9, 2009. www.rtca.org.

Photo: Southwest Airlines

As NextGen implementation progresses, aircraft navigation technologies will transition to satellite-based navigation systems.

Aviation Sustainability

A Movement Evolves

BURR STEWART, CAROL LURIE, AND CHERYL KOSHUTA

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Aviation is vital to the U.S. and global economies—efficient air service is widely available in developed countries and highly sought after by developing countries. Concerns are growing, however, about the environmental impact of air travel, the disparity of service availability, the impacts on the communities surrounding airports, and the economic costs associated with the growth of the aviation sector.

The scarcity of global resources has directed attention to sustainability—that is, to using resources more efficiently and enhancing the economic and social equity of communities around the world. The integration of sustainability into the aviation industry has sparked heated debate about topics ranging from carbon footprints to noise to engine design. Progress toward sustainability is under way in North America, raising many topics for future research.

Photo courtesy of LeighFisher, Inc.

Among aviation's many impacts on the environment is stormwater management at airports, including the flow of chemical deicing compounds into the watershed.

Sustainability's Context

The aviation industry is a complex web of equipment and services and of the laws and regulations that govern its activities. A myriad of market pressures influence air travel and cargo demand, including the needs or preferences of individual travelers and shippers and the fluctuating cost of fuel. The environmental, social, and economic impacts of aviation add to the complexity, from the raw materials consumed in the manufacture of aircraft, to noise exposure, to carbon emissions and other air quality impacts, to stormwater management at an airport. Every day, millions of passengers and tons of valuable cargoes and mail are shipped by air all over the world, providing invaluable benefits to individuals and the global economy, while consuming large quantities of materials, energy, and natural resources.

The sustainability movement has evolved in the past 20 years to address the growing understanding that human civilization is at risk of exceeding the planet's capability to sustain it, and its own ability to sustain itself, now and into the future. The unprecedented population growth of the past 100 years has contributed significantly to global environmental degradation and dwindling resources, which directly affect the global economy and social communities, threatening to limit growth and development.

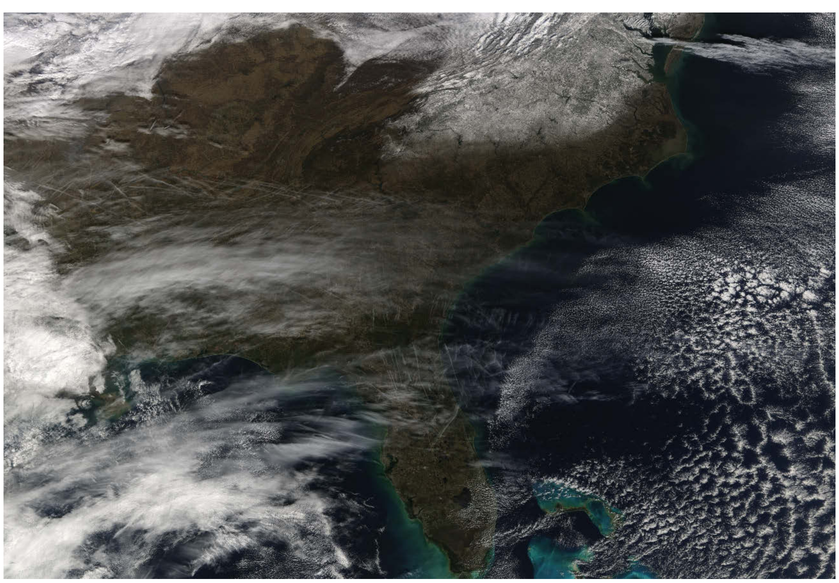

Image: NASA Langley Research Center

According to NASA scientists, the cirrus clouds formed by aircraft vapor emissions (*lower left*) are capable of contributing to global warming. The aviation industry is examining and debating sustainable approaches to emissions, noise, engine design, and other factors.

Sustainability principles are becoming important in resource allocation and decision making. Sustainability frameworks generally seek to balance economic, social, and environmental objectives and implications in the decision-making process. A healthy and functioning society ensures economic opportunities; these in turn depend on the continued health and availability of natural resources and the environment.

Aviation is a major tool in the development of a healthy and functioning society and economy, but it is also a major consumer of fossil fuels and natural resources. The aviation industry is participating in the sustainability movement in a variety of ways. Although most of the efforts address the environmental impacts of aviation, clarifying the benefits of aviation to the global society and understanding the impact on economic factors also are key efforts.

Definitions and Frameworks

Sustainability generally comprises three components: the environmental, the social, and the economic, often referred to as the triple bottom line. The environmental component includes protection of the environment and the conservation of natural resources. The social component refers to community and stakeholder needs, with an awareness of social equity. The economic component includes the economic viability of aviation industry businesses and the maintenance of strong and stable economies globally and locally.

Several approaches, or frameworks, have evolved to help organizations and individuals make decisions and start initiatives to move toward sustainability. The aviation industry has used available frameworks as applicable and has developed its own as necessary.

Airport Initiatives

The Airports Council International–North America (ACI-NA), an organization representing the local, regional, and state governing bodies that own and operate commercial airports in the United States and Canada, has developed an aviation-specific framework for sustainability.[1] The EONS framework includes the traditional three components of sustainability with a fourth added for operations: economic sustainability (E), operational efficiency (O), natural resource conservation (N), and social improvement (S).

In 2008, TRB published Airport Cooperative Research Program (ACRP) Synthesis 10, *Airport Sustainability Practices*, presenting analysis and findings from survey data collected on environmental, social, and economic practices implemented at 31 U.S. and 21 foreign airports.[2]

[1] www.aci-na.org/sustainability.

[2] http://onlinepubs.trb.org/onlinepubs/acrp/acrp_syn_010.pdf.

Photo courtesy of LeighFisher, Inc.

Albuquerque International Sunport in New Mexico received a $2.4 million FAA Voluntary Airport Low Emissions (VALE) grant to install solar panels atop a multilevel parking facility.

Also in 2008, a group of airports, airport industry associations, and aviation consultants formed the Sustainable Airport Guidance Alliance (SAGA) to produce an online compendium of airport sustainability practices and guidelines for developing awareness and action programs. Members of SAGA surveyed U.S. and foreign airports, identifying nearly 1,000 sustainability practices. The data were published in an online database that allows users to sort the actions by the EONS categories or by functional area of the airport.

The guidelines provide definitions of sustainability, present the drivers for sustainability, and trace the process of planning and implementing sustainability.[3] ACRP has started a new research project to update and enhance the SAGA database.[4]

Sustainability Benchmarking

The Global Reporting Initiative (GRI) is an international effort to establish voluntary guidelines for organizations to develop effective and consistent measures for reporting progress toward sustainability.[5] The framework draws on six elements: economics, environment, labor practices, human rights, society, and product responsibility. Each element includes suggested performance metrics and instructions for consistent measurements.

In 2008, a group of international airport industry stakeholders began meeting to develop an airport sector supplement, a document that customizes the GRI metrics for specific airport issues and applications. The final version of this document is expected for release this year and will be useful to airports in preparing and evaluating sustainability programs.

[3] www.airportsustainability.org.

[4] ACRP Project 02-30, Enhancing the Airport Industry SAGA Website. For more information, go to www.TRB.org/ACRP/FindaProject.aspx and type in the project number.

[5] www.globalreporting.org.

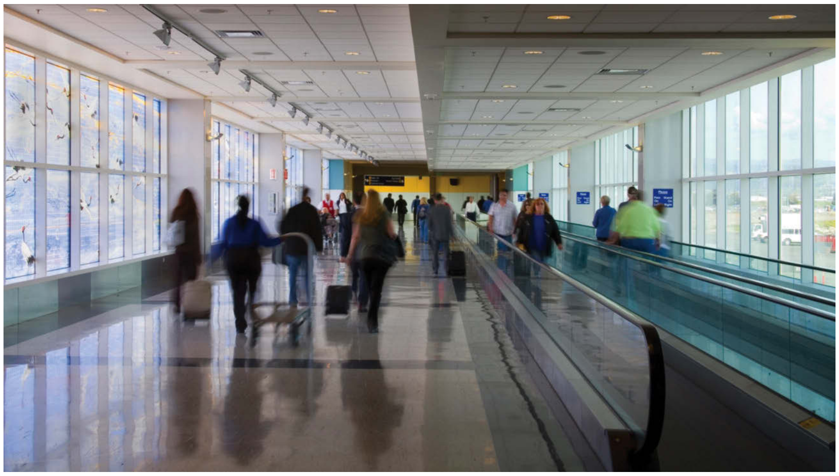

Photo: Port of Oakland

In early 2011, Oakland International Airport's Terminal 2 concourse received LEED Silver certification for new construction. The terminal was the first in the United States to receive the rating.

Green Building Certification

Several organizations and jurisdictions have developed methods for certifying sustainable facility design and construction, and many aviation entities have adopted the approaches. Generating the most interest is the U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) certification.

Originally developed for new commercial office buildings, LEED certification standards have expanded to include remodeling, operations and maintenance, retail construction, neighborhood development, and several other categories. Airports and other aviation-related buildings often have unique requirements, however, because of the nature of the activities and locations, and do not yet have a specific standard. Nevertheless, some jurisdictions across the country have adopted LEED certification as a requirement for public construction projects, as have federal agencies that carry out construction at airports.

Other approaches taken by airports have included California Green Solutions, the Architecture 2030 Challenge, and airport-specific design and construction standards such as the Chicago Department of Aviation *Sustainable Airport Manual*. An ACRP project is under way to examine the potential need and options for an airport-specific sustainability standard or a certification framework and process.[6]

Other Frameworks

Other organizations and frameworks can inform aviation organizations that are addressing sustainability, although some approaches may not specifically address aviation issues.

- The International Standards Organization (ISO), which developed standards for quality assurance (ISO 9000) and standards for environmental management systems (ISO 14000), has developed a draft Framework for Social Responsibility Reporting (ISO 26000),[7] similar to the GRI.
- The Natural Step is a nonprofit organization

[6] ACRP Project 02-28, Airport Sustainability Practices: Tools for Evaluating, Measuring, and Implementing. For more information, go to www.TRB.org/ACRP/FindaProject.aspx and type in the project number.

[7] www.iso.org.

Photo: C&S Companies

Ithaca Regional Airport developed a sustainability-minded master plan update and was presented as a case study in the Chicago Department of Aviation *Sustainable Airport Manual*. The airport performed baseline assessments of 12 sustainability categories and based goals for improvement on those categories. Team members sought to maximize existing infrastructure instead of constructing new buildings for the airport's facility needs.

that helps create a sustainable strategy for initiatives in companies and communities.[8]

◆ The Business Alliance for Local Living Economies offers training and networking in sustainability frameworks for small businesses and local communities.[9]

◆ The Community Indicators Consortium is a network of local governments and foundations dedicated to advancing the effective use of performance indicators.[10] Some members have advanced comprehensive frameworks for community health and well-being that can be helpful to aviation organizations.

Initiatives Taking Off

Environmental Standards

The International Civil Aviation Organization (ICAO), a United Nations agency, has established the Committee on Aviation Environmental Protection (CAEP) to deal specifically with environmental issues.[11] CAEP analyzes and recommends environmental standards for aircraft design performance and is involved in several sustainability initiatives, including the Global Framework for Alternative Aviation Fuels and research on climate change adaptation for aviation stakeholders.

Of particular interest in the development of aviation sustainability are the extensive global aviation modeling systems that CAEP applies to develop recommendations for international environmental standards governing the performance of aircraft designs. The modeling has allowed complex policy analyses that evaluate the trade-offs between increasing engine efficiency and decreasing aircraft noise.

Alternative Fuels

In 2006, a consortium of aviation industry stakeholders developed a joint initiative to explore and facilitate the sustainable use of alternative jet fuels in commercial aviation. The Commercial Aviation Alternative Fuels Initiative (CAAFI)[12] has been working to address four key topic areas:

◆ Fuel certification and qualification, to establish safety certification for alternative fuels in aviation;

◆ Research and development, to identify and coordinate needed research on alternative fuel options;

◆ Environment, to measure and assess the range of life-cycle environmental considerations for alternative fuels; and

◆ Business and economics, to develop markets, industry collaborations, business cases, and deployment opportunities for alternative fuels.

The consortium maintains research and development road maps on its website.

NextGen

The Federal Aviation Administration (FAA) operates the U.S. air traffic control system and regulates many other aspects of the aviation system. The agency has consolidated much of its advanced planning into the NextGen initiative, described in another article in this issue (see page 7). The plan is for NextGen system components to modernize the operation and management of aircraft, creating

Photo: C&S Companies

Students from two classes at Ithaca College in New York present reports to faculty, the airport and consultant team, and members of the public, as part of the Ithaca Regional Airport's master plan update. Community members, such as local sustainability nonprofits and nearby colleges, were involved in the update process.

Photo: Pratt & Whitney

The PurePower PW1524G high-efficiency jet engine, developed by Pratt & Whitney, undergoes ground testing in West Palm Beach, Florida.

[8] www.naturalstep.org.

[9] www.livingeconomies.org.

[10] www.communityindicators.net.

[11] www.icao.int/env/.

[12] www.caafi.org.

Nashville International Airport in Tennessee is a member of the FAA's Sustainable Master Plan Pilot Program, which funds long-range planning. The lessons learned from these plans will be used to develop national program guidance on airport sustainability.

Photo: John Guder, Nashville International Airport

opportunities to increase system efficiency, lower operating costs, and reduce environmental impacts and the consumption of resources.

Sustainability Plans

Starting in the 1990s, several individual airports in the United States and around the world began to develop sustainability reports and programs—for example,

- Boston's Logan Airport launched an annual report on its environmental performance across a variety of metrics;
- Los Angeles World Airports developed a comprehensive, organizationwide sustainability management system, tracking environmental and operational performance metrics;
- Chicago's Department of Aviation developed a sustainable design manual for its airport capital programs; and
- The British Airports Authority developed an extensive verification process for its sustainability performance metrics, involving community stakeholders.

Airport industry associations have publicized these efforts within the airport community, and a growing number of airports are considering or imple-

Massport Tests Green Light at Boston Logan International Airport

In rehabilitating the Terminal B parking garage at Boston Logan International Airport, the Massachusetts Port Authority (Massport) has installed photovoltaic solar panels on the garage roof and is replacing the lighting for the garage, roadways, and walkways with light-emitting diode (LED) illumination.

The 16 solar panel trees have a single-structure design, a stem-and-steel frame that uses the solar panels as a roof. The installation is expected to produce 83,980 kilowatt-hours (kW-h) of electricity, or 2.5 percent of the garage's total annual consumption. This eliminates an equivalent of 50 metric tons of CO_2 emissions and avoids using 115 barrels of oil or 5,637 gallons of gasoline annually.

The tree design also collects rainwater for landscaping and cleaning. Each solar array is mounted on an air ventilation unit on the garage roof and will not affect parking or the lot's capacity. Total cost for the photovoltaic solar panels is approximately $1.4 million.

Massport estimates that the LED fixtures will consume 49 percent less electricity—about 2,261,218 kW-h per year. Along with energy conservation measures, this will reduce CO_2 emissions by 1,307 metric tons, or the equivalent of not using 3,040 barrels of oil or 148,385 gallons of gasoline annually. The LED lights will cost approximately $2 million, about twice the amount of standard lighting, but the airport will recoup its investment in 5.5 years. The airport expects a savings of $3.8 million in electricity use in the next 20 years, based on costs of $0.12/kW-h.

Massport evaluates renewable energy options to meet Gov. Deval Patrick's "Lead by Example" executive order to procure 15 percent of all energy from renewable resources and to reduce greenhouse gas emissions. In 2010, Massport installed 20 building-integrated wind turbines on the roof of the Logan Office Center, which houses Massport's administrative offices at the airport. Massport also developed the first airport, container terminal, and bridge in the United States that meet voluntary international standards for environmental management systems (ISO 14001). Airport Terminal A is the world's first to be certified by the Green Building Council for meeting the Leadership in Energy and Environmental Design, or LEED, standards. The Signature Flight Support facility at Logan received LEED certification in 2009.

Source: Massport News Room, http://www.massport.com/news-room/News/EfficientLightingTerBGarage.aspx.

menting sustainability programs and developing sustainability reports.

FAA initiated the Airport Sustainable Master Plan Pilot Program in 2010 to assist a representative group of airports across the country in developing sustainable master plans or sustainability programs.[13] The program will assess ways for airports to achieve forecasted levels of demand while reducing the environmental impacts; the results will help FAA develop guidance and funding criteria for addressing sustainability for the entire U.S. airport system.

Ten airports of various sizes, types, and locations were selected to participate in the program and will be preparing either a sustainable master plan that incorporates sustainability into a master planning process or a sustainable management plan, a standalone effort focusing on sustainability, during 2011 and 2012. The studies will incorporate input from airport tenants, airlines, and community interests, and will help FAA incorporate airport sustainability issues into national sustainability programs, guidelines, data structures, and regulations.

Low Emissions Program

In 2004, FAA established special funding through the Voluntary Airport Low Emissions (VALE) program to help commercial service airports in areas of the United States with poor air quality develop innovative clean technology solutions and—in some cases—to capture emissions credits with regulatory agencies.[14] Examples of funded projects include cleaner vehicles, electric ground support equipment and gates, natural gas refueling stations, and alternative power sources, such as geothermal and solar. In addition, FAA assists the VALE projects in partnering with air quality regulatory agencies and in expediting environmental reviews.

ACRP Projects and Reports

ACRP has undertaken research projects and has prepared several synthesis reports addressing sustainability issues. These reports are available via the ACRP website.[15] In addition, several sustainability-related projects are under way (see box, page 20, for a list of ACRP's published titles and current research projects related to sustainability).

Research Directions

Many key areas in aviation sustainability require further research and development. The field has been developing from the bottom up, starting with local-level efforts, as individual cities, airports, states, and regions draw up sustainability policies, collect data, and implement projects. Yet top-down systems are needed to integrate these efforts—systems management tools require large-scale collaboration and cannot be developed and implemented at the local level only.

Photo courtesy of LeighFisher, Inc.

Electric ground support equipment, cleaner vehicles, natural gas refueling stations, and alternative power sources are among the improvements supported by funds from FAA's VALE program.

Areas for further research include the following:

- *Standard methods for life-cycle analysis*. Understanding the benefits and impacts of an activity throughout the supply chain that supports it and throughout its life is a key to sustainability. Integrated and shared data sets and standard methodologies that can assure consistent results are necessary for this level of analysis. These can be developed at a local level, but would be more effective on a larger scale.
- *Third-party verification*. USGBC LEED certification requires an independent review of sustainability claims related to construction. Other areas of sustainability will need mechanisms for the auditing and third-party verification of claims.
- *National and global data structures*. Local plans and actions generate most of the information about sustainability; however, many of the supporting policies should be based on analyses of systemwide data at the national and global levels. Funding and managing sustainability data sets is a growing need.
- *Understanding social and economic implications of decisions*. Sustainability plans have emphasized environmental issues over social and economic issues. Research is needed to clarify ways to measure and develop the social equity and community aspects of sustainability. Economic information about return on investment may be readily obtainable, but research is needed to understand and quantify the issues of economic development associated with sustainability.
- *Integration of transportation systems analysis and intermodal transportation*. Ideally, the most sustainable transportation system would allow a user to pick the best travel mode for each portion of a trip.

[13] www.faa.gov/airports/environmental/sustainability/.
[14] www.faa.gov/airports/environmental/vale.
[15] www.TRB.org/ACRP/ACRP.aspx.

Integrating this modal analysis—which further research could help support—is difficult, because of institutional and funding constraints.

◆ *Long-term system funding schemes.* FAA's resources to fund recommended sustainability initiatives are limited. Research is needed to investigate and identify nontraditional funding for aviation sustainability projects. Funding opportunities via collaborative partnerships may prove more successful than funding solely by individual airports, airlines, or agencies.

◆ *Climate change adaptation for aviation.* Whether or not actions are taken to reduce greenhouse gas emissions, guidelines are needed to help airports plan for the effects of climate change, such as increased local storm events, prolonged heat waves, or drought that would require adaptations of facilities.

Continuing Commitment

The effects of the aviation industry on the environment, the communities surrounding airports, and regional and local economies are not all negative. The aviation industry performs an important function in the global economy through the movement of goods and people. By proactively addressing its negative impacts, the aviation industry will be able to sustain itself and will continue to be a productive and valued endeavor for society worldwide. The proactive efforts taken already are pointing the aviation industry in a sustainable direction, and the industry's continuing commitment to work on these important issues is key to ensuring the health and well-being of future generations.

Resources and Research Projects on Sustainability

TRB's Airport Cooperative Research Program (ACRP) has published a bookshelf of reports addressing issues relevant to aviation sustainability:

- Report 6, Research Needs Associated with Particulate Emissions at Airports
- Report 7, Aircraft and Airport-Related Hazardous Air Pollutants: Research Needs and Analysis
- Report 9, Summarizing and Interpreting Aircraft Gaseous and Particulate Emissions Data
- Report 11, Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories
- Report 14, Deicing Planning Guidelines and Practices for Stormwater Management Systems
- Report 15, Aircraft Noise: A Toolkit for Managing Community Expectations
- Report 19, Developing an Airport Performance-Measurement System
- Report 20, Strategic Planning in the Airport Industry
- Report 42, Sustainable Airport Construction Practices
- Report 43, Guidebook of Practices for Improving Environmental Performance at Small Airports
- Synthesis 1, Innovative Finance and Alternative Sources of Revenue for Airports
- Synthesis 5, Airport Ground Access Mode Choice Models
- Synthesis 6, Impact of Airport Pavement Deicing Products on Aircraft and Airfield Infrastructure
- Synthesis 7, Airport Economic Impact Methods and Models
- Synthesis 10, Airport Sustainability Practices
- Synthesis 16, Compilation of Noise Programs in Areas Outside DNL 65
- Synthesis 17, Approaches to Integrating Airport Development and Federal Environmental Review Processes
- Synthesis 21, Airport Energy Efficiency and Cost Reduction
- Web-Only Document 11, A Comprehensive Development Plan for a Multimodal Noise and Emissions Model

For more information about these titles, go to www.TRB.org/Publications/PubsTRBPublicationsbySeries.aspx and select the series.

In addition, several ACRP sustainability-related projects are under way and will publish findings:

- 02-10, Practical Greenhouse Gas Emission Reduction Strategies for Airports
- 02-11, A Handbook for Addressing Water Resource Issues Affecting Airport Capacity Enhancement Planning
- 02-15, Recycling Strategies for the Airport Industry
- 02-16, Airport Ground Support Equipment (GSE) Inventory and Emission Reduction Strategies
- 02-18, Guidelines for Integrating Alternative Jet Fuel into the Airport Setting
- 02-20, The Role of Air Travel in the Transmission and Spread of Insect-Borne Diseases
- 02-22, Incorporating Sustainability into Traditional Airport Projects
- 02-28, Airport Sustainability Practices: Tools for Evaluating, Measuring, and Implementing
- 02-30, Enhancing the Airport-Industry SAGA Website
- 02-38, Understanding Green Energy Technologies and Their Effects on Airports
- 07-11, Reducing Energy Use and Maintenance Cost with On-Demand Escalators and Moving Walkways
- 09-06, Sustainable Practices for Airport Maintenance and Operations

For more information on these ACRP projects, including scope and status, go to www.TRB.org/ACRP/FindaProject.aspx and type in the project number.

Commercial Aviation's Pursuit of Sustainable Alternative Aviation Fuels

NATHAN L. BROWN

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The commercial aviation industry has made tremendous progress in recent years in the research, testing, development, and approval of alternative jet fuels for commercial jet aircraft. What has driven this rapid advancement? Why is there such interest in alternative aviation fuels?

Promising Demonstrations

In January 2009, a Continental Airlines Boeing 737 took off into the skies over Houston, Texas, with one of its two engines powered by a 50 percent blend of biofuel made from jatropha plant and algae oils mixed with petroleum jet fuel. The 3-hour test flight was completed without a problem—the pilots reported perfect performance from the aircraft and the engine.

This flight and three other demonstrations conducted by Air New Zealand, Japan Airlines, and the Netherlands' KLM marked the first time that commercial aircraft had flown on renewable fuel. In the following years, similar flights were conducted by the Brazilian airline TAM and by the Mexican airline Interjet on an Airbus aircraft, as well as by the U.S. Department of Defense on several military aircraft.

These flights are a visible sign of commercial aviation's determined pursuit of sustainable sources of alternative energy to address a pressing concern—the economic and environmental challenges of volatile oil prices, climate change, and energy security for aviation.

The flights also signal the emergence of a new customer for the alternative fuels industry. The alternative fuels industry had focused on surface transportation fuels, such as ethanol and biodiesel; jet fuel was an afterthought, mainly because of the prohibitively strict safety and performance requirements and the rigorous testing and approval process for certifying aviation fuels.

The development of advanced alternative fuels that mimic petroleum-based fuels and that can be dropped in to today's aircraft without modifying the engines or fueling systems has made the production of sustainable alternative jet fuels an attractive target. Since 2006, the Federal Aviation Administration (FAA), the U.S. Department of Defense, and other

PHOTO: AIR NEW ZEALAND

In December 2008, Air New Zealand launched a commercial aviation test flight using a second-generation biofuel. The Boeing 747-400 jet was powered by a blend of jatropha and A-1 jet fuel.

National Renewable Energy Laboratory researcher examines algae cultures. Advanced, second-generation aviation fuels that can be blended with petroleum fuels are a growing subject of research and development in the aviation industry.

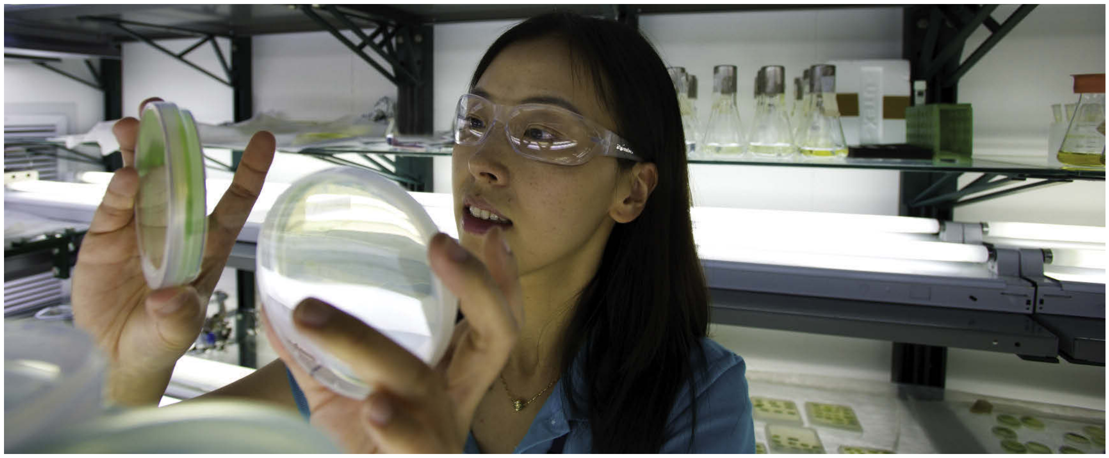


PHOTO: DENNIS SCHROEDER, NREL

federal agencies have worked with the aviation industry to explore the development and deployment of drop-in alternative jet fuels. In less than 5 years, sustainable alternative fuels for commercial jet aircraft have gone from being inconceivable to the verge of broad commercial use.

Economic Concerns

Jet fuel prices have risen dramatically in the past decade, from an average low of 87 cents per gallon in 2000 to a peak of more than $4 per gallon in the summer of 2008. In summer 2011, the average price of jet fuel hovered near $3 per gallon. For an industry that depends on liquid fuel—16 billion gallons of jet fuel were consumed in 2010 in the United States—a $1 increase in price has billion-dollar ramifications.

Although always a bottom-line concern for airlines, by 2006 fuel had become the largest airline operating cost, surpassing labor. Fuel now accounts for up to 40 percent of airline operating costs—a structural shift in the industry's economics.

Perhaps as significant to the airlines as the increase in cost has been the increase in price volatility, which has made long-term planning difficult and has increased the vulnerability of airlines to fuel supply and pricing shocks. The potential economic benefits of alternative, nonpetroleum fuels can mitigate the price increases and price volatility of petroleum-based fuels. As the U.S. and global economies recover, fuel prices are expected to rise, stoking the demand for alternatives.

Fuel storage at George Bush Intercontinental Airport in Houston, Texas. Since 2006, fuel has been the biggest operating cost for airlines.

PHOTO: WIKIMEDIA COMMONS

Environmental Concerns

Growing concerns about climate change are pressuring aviation—like other industries that rely on fossil fuels—to address its environmental impacts. Aviation accounts for a relatively small 2 percent of global emissions of man-made carbon dioxide (CO_2) but is a growing contributor to greenhouse gases (GHGs) that adversely affect the climate.

In 2010, the member countries of the United Nations' International Civil Aviation Organization (ICAO) and participating industry representatives made a commitment to address aviation's climate impacts by improving fuel efficiency by 2 percent per year between 2010 and 2050 and capping aviation's CO_2 emissions at the levels recorded in 2020, despite expected growth in commercial aviation.[1] These emissions reductions goals require improved aircraft fuel efficiency, new engines, new materials, and new air traffic control procedures that save fuel.

These measures alone, however, are not projected to be sufficient. Sustainable alternative fuels derived from biomass may offset a portion of the carbon produced by the aircraft and may help meet goals for carbon-neutral growth and eventual emissions reductions (see graphic, bottom of page 23).

Moreover, tests indicate that the use of alternative fuels also may mitigate emissions of sulphur and particulate matter and may alleviate other concerns about air quality. These emissions can have significant health impacts in the vicinity of airports and are regulated in the United States and in many other

[1] www.icao.int/icao/en/Env2010/A37_Res19_en.pdf.

countries. Sustainable alternative jet fuels, therefore, offer the prospect of environmental benefits by reducing emissions associated with climate change and poor local air quality.

Energy Security Concerns

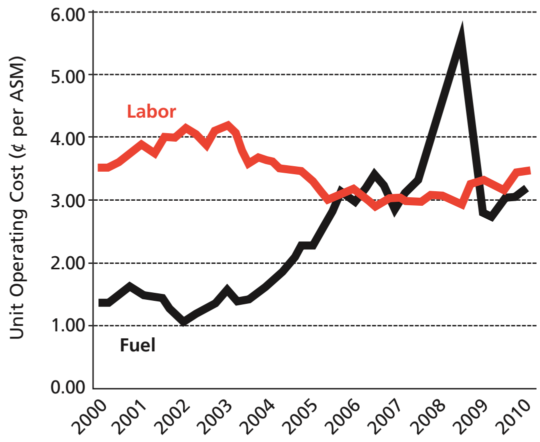
The United States imports approximately 60 percent of the petroleum it uses, mostly for transportation. Commercial aviation's demand for petroleum is far lower than that of ground transport, but aviation is still a sizeable fuel user, consuming approximately one-tenth of the transportation fuel total.

U.S. dependence on imported petroleum is a source of national concern, because much of the source is in countries or regions that are politically unstable or, in some cases, hostile to U.S. interests. Others note the significant military costs of U.S. involvement in the protection of petroleum shipping and of U.S. intervention in key energy-supplying nations. For these reasons, the U.S. military has set ambitious goals for reducing its dependence on petroleum.

The U.S. Air Force has committed to acquire 50 percent of its domestic aviation fuel from alternative blends that are greener than petroleum by 2016. The U.S. Navy plans to sail a Green Strike Group of vessels in 2012 and a Great Green Fleet by 2016 powered by renewable biofuels. In addition, the Navy aims to have 50 percent of its total energy consumption from alternative sources by 2020.

These goals require the production of more than 380 million gallons of jet fuel for the Air Force and more than 330 million gallons of jet and marine diesel for the Navy by 2016.[2] The U.S. commercial aviation industry, with roughly 10 times the jet fuel use of the military, also views petroleum dependence as a national security issue and is coordinating efforts with the U.S. military programs.

[2] Presentation by Mark Iden, Defense Logistics Agency–Energy, to the Advanced Biofuels Leadership Conference, April 19, 2011.



U.S. airline labor and fuel costs. (Note: ASM = available seat mile. Source: Passenger Airline Cost Index, Air Transport Association.)

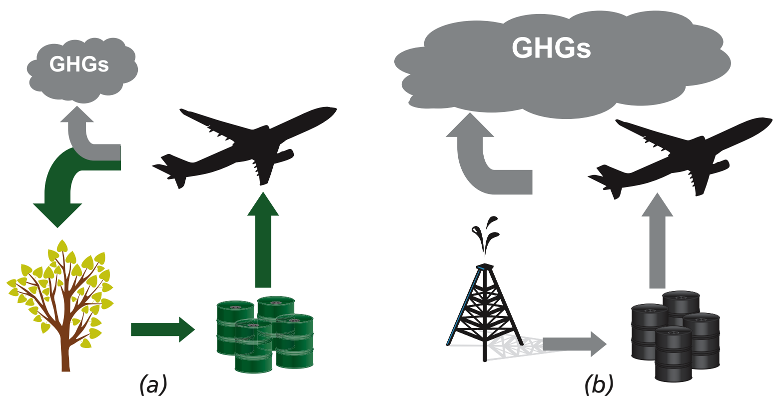
Establishing Coalitions

Public–Private Initiative

These concerns and developments prompted U.S. commercial aviation stakeholders to establish the Commercial Aviation Alternative Fuels Initiative (CAAFI) in October 2006.[3] CAAFI is a public–private coalition of airlines, aircraft and engine manufacturers, energy producers, researchers, international participants, and government agencies leading the development and deployment of sustainable alternative jet fuels for commercial aviation. FAA and three U.S. aviation trade associations—the Airports Council International–North America, the Air Transport Association of America, and the Aerospace Industries Association—are cosponsors of the initiative.

CAAFI's goal is to promote the development of drop-in, sustainable alternative jet fuel options that offer equivalent levels of safety, compare favorably on cost with petroleum-based jet fuel, and offer environmental improvement and a secure energy supply for aviation. CAAFI plays a leadership role in expediting and facilitating the evaluation, qualification,

[3] www.caafi.org



(*a*) Greenhouse gases (GHGs) produced by aircraft operations are partially offset by absorption into biobased feedstocks during photosynthesis; (*b*) no offset occurs with petroleum-derived fuels.

As part of the U.S. Navy's strategy to move toward alternative energy sources, the Green Hornet debuted in April 2010 at the U.S. Naval Air Station Patuxent River in Maryland. The F/A-18 Super Hornet is powered by a 50–50 biofuel blend.

PHOTO: U.S. NAVY

environmental analysis, and deployment of sustainable alternative fuels. CAAFI also serves as a means of exchanging information and coordinating stakeholder efforts, through

- Technical workshops;
- Outreach to domestic and international aviation, energy, and financial stakeholders;
- The development of tools for assessing the status of alternative fuel development;
- Linking active and related networks; and
- Educating the public and communicating with the media.

International Initiatives

Other initiatives are developing alternative jet fuels. Boeing, Airbus, and several international airline partners founded the Sustainable Aviation Fuel Users Group in 2008.[4] The Air Transport Action Group—an international organization that advocates the environmentally responsible development of aviation infrastructure—has set goals to support use of sustainable alternative jet fuels.[5]

Regionally focused studies and research and development activities have blossomed in many parts of the world. The European Commission and European Union have funded the Sustainable Way for Alternative Fuels and Energy in Aviation study[6] and the Alternative Fuels and Biofuels for Aircraft Development—or Alfa-Bird—program.[7] Spain, Germany, and the United Kingdom have undertaken national initiatives.

In Latin America, Brazil and Mexico are leading the way. Australia, China, and Singapore are developing efforts in the Asia Pacific region. The United Arab Emirates and Qatar have been active in the Middle East. These efforts range from demonstration flights that validate fuel performance and attract public attention, to research and development on new fuels and feedstocks, to feasibility studies for establishing supply chains and fuel production facilities.

Coordinating Approaches

Internationally, ICAO has emphasized the importance of sustainable alternative fuels in addressing aviation's global environmental challenges. ICAO facilitates communication among member countries on the status and progress of sustainable alternative aviation fuels efforts. Many of these activities involve organizations and companies already coordinating efforts with each other, underscoring the global effort.

Communication, coalition building, and the formation of innovative partnerships have been key in addressing the challenge of developing and com-

PHOTO: JIM YOST, NREL

In the Fischer-Tropsch process, synthesis reacts in the presence of a catalyst to produce fuel. Fischer-Tropsch diesel fuel (*left*) is clear, while conventional No. 2 diesel fuel (*right*) has a yellow cast.

[4] www.safug.org.

[5] www.atag.org/.

[6] www.swafea.eu/.

[7] www.alfa-bird.eu-vri.eu/.

mercializing alternative jet fuel. Through CAAFI and other organizations, aviation has established a coordinated approach to the pursuit of alternative fuels, addressing the barriers to use, and positioning the industry as a potential customer of choice for the emerging alternative fuels industry.

Qualification and Certification

Global industry fuel standards or specifications manage the quality and safety of jet fuel for commercial aviation. In the United States, approvals are developed and managed by the industry under the auspices of ASTM International, a standards-setting organization.

In September 2009, ASTM approved a specification for Aviation Turbine Fuels Containing Synthesized Hydrocarbons (ASTM D7566). The specification has enabled use of a 50 percent blend of petroleum jet fuel mixed with synthesized hydrocarbon fuel made from biomass, gas, or coal via gasification and Fischer-Tropsch synthesis—a process for creating a petroleum substitute invented in the 1920s in Germany. The specification is structured to approve additional fuels from other processes after sufficient evaluative testing. ASTM International also developed a qualification process for evaluating alternative fuels, including the testing steps for the approval of new fuels (ASTM D4054).

In July 2011, ASTM International approved the next jet fuel type, hydroprocessed esters and fatty acids (HEFA), allowing for a blend of up to 50 percent fuel from renewable bio-oils from plants, algae, or animal fats with petroleum jet fuel. The approval of HEFA jet fuel—also commonly referred to as hydrotreated renewable jet fuel or biosynthetic paraffinic kerosene—enables immediate use of renewable biofuel in commercial airliner service.

In partnership with industry, the U.S. Air Force and FAA have conducted or funded fuel evaluations and tests necessary for ASTM approval. Through the Continuous Lower Energy Emissions and Noise, or CLEEN, program,[8] FAA is cost-sharing work on fuel system compatibility, performance of 100 percent renewable biofuels, and the evaluation of early stage alternative fuels from novel feedstocks and conversion processes.

FAA and the Department of Defense are focusing on the review and approval of as many fuel options as possible. Several promising candidate fuels are entering evaluation, including jet fuels made from alcohols, sugars, cellulose (e.g., wood chips), and garbage, through advanced chemical and biological conversion processes. Both the Air Force and FAA will fund the evaluation of fuels from these processes in the next few years.

Biofuels on Commercial Flights

Airlines are beginning to use biofuel in scheduled commercial service following the approval of the jet biofuel HEFA (hydroprocessed esters and fatty acids) in July 2011. The European airlines KLM and Finnair have conducted commercial flights on a 50-50 blend of HEFA and conventional jet fuel, with passengers on board. In August, the Mexican airline Aeromexico conducted the first commercial transcontinental flight on a HEFA biofuel, between Mexico City and Madrid.

Germany's Lufthansa has undertaken a six-month trial of a 50-50 blend of HEFA biofuel in one engine of an Airbus A321, flying daily between Hamburg and Frankfurt. The major ingredients of the biofuel are certified sustainable palm oil, rapeseed, and animal fats.

Lufthansa estimates a savings of 1,500 tons of CO_2 emissions for the duration of the trial, which will examine the effects of HEFA biofuel on engine maintenance and engine life and will help determine the feasibility of regular flight operations with sustainable alternative fuels. These activities are key to establishing the commercial acceptance of alternative jet fuels.

Environmental Analysis

Alternative fuels can have both positive and negative impacts for GHG emissions, water, food, and land. The fuels' environmental viability depends on an analysis of the total GHG emissions produced throughout the entire manufacturing process or life cycle.

The life-cycle analysis includes an evaluation of the energy consumed and the GHG emissions released in harvesting crops, refining and converting the crops into fuel, transporting the fuel, and using the fuel in the aircraft. A full life-cycle environmental analysis, however, starts by identifying the direct

[8] www.faa.gov/news/fact_sheets/news_story.cfm?newsId=11538.

Sources for jet fuels being evaluated by the FAA and U.S. Air Force include wood chips (*below*), alcohol, sugars—and garbage.

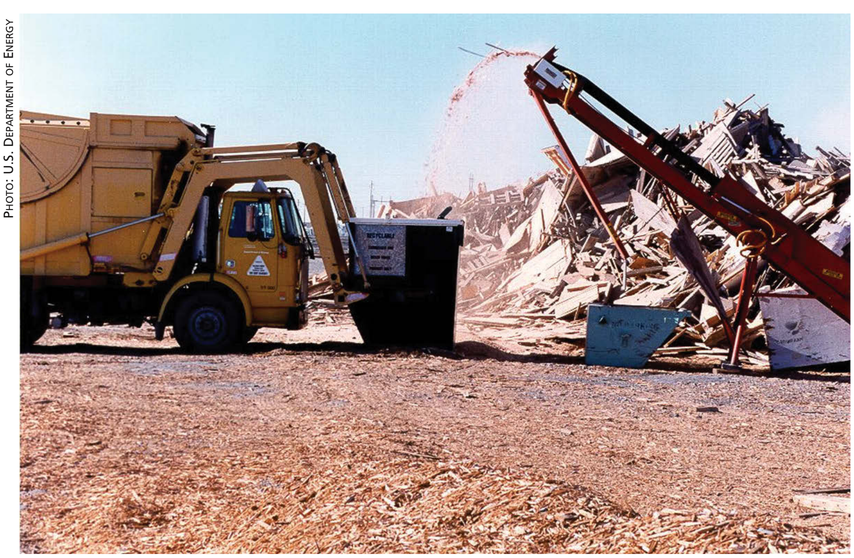


PHOTO: U.S. DEPARTMENT OF ENERGY

Photo: Carlos Donaire

Agricultural viability and environmental sustainability are major considerations in the development of crop-based biofuels such as *jatropha curcas*. A life-cycle environmental analysis can identify the direct and indirect impacts of farming for biofuel.

and indirect impacts of changes in how land is used.

For example, the development of a biofuel can require the clearing of forested land that had acted as a carbon sink, absorbing carbon dioxide, a principal GHG—this is considered a direct impact. Alternatively, the development of a biofuel can displace from agricultural land other crops that had required less energy to harvest—this is considered an indirect impact. In addition, the life-cycle analysis accounts for impacts from the biofuel crop on the availability of food and fresh water and on the native ecology, as well as for the socioeconomic impacts on the rural communities that grow the crops.

The aviation industry and government agencies are assessing the life-cycle impacts of alternative jet fuels and are supporting the development of frameworks and tools for the analyses, building on methodologies developed for ground transport fuels. Research at the Massachusetts Institute of Technology indicates that alternative fuel options are unlikely to have zero GHG emissions but could provide 10 percent to 50 percent reductions in life-cycle GHG; several options may reduce GHG emissions by as much as 80 percent.[9]

Certain fuels—notably those using coal—could double the CO_2 emissions, however, unless mixed with biomass or unless the fuels include the capture and storage of emissions from the production process—a technique known as carbon capture and sequestration. The benefits of the best alternative fuels often disappear because of the impacts from direct or indirect changes in land use.[9]

CAAFI working groups are addressing these questions in coordination with other organizations, identifying the issues and developing criteria to standardize the measurement of impacts and to ensure minimal impact from jet fuel production and use. Organizations involved in this effort include the Global Bioenergy Partnership, the Roundtable on Sustainable Biofuels, the International Organization for Standardization, the Environmental Protection Agency, the U.S. Department of Agriculture (USDA), and the Department of Energy (DOE).

Spurring Commercial Production

More than 80 percent of the 16 billion gallons of fuel consumed by commercial aviation in 2010 was dispensed through an established distribution system to 35 major airports around the country. This concentrated market, with a small number of commercial airline customers purchasing large quantities of fuel through long-term agreements, makes aviation attractive to suppliers of alternative fuels.

Large-scale commercial production of renewable alternative jet fuels, however, is not yet under way. The fuel has been produced only in small batches for testing and demonstration and at a high cost. Private financing for first-of-a-kind alternative jet fuel production facilities has not emerged because of the unfavorable economic climate and the attractiveness of other, less risky investment opportunities in more predictable markets.

To jump-start commercial production in the United States, CAAFI and the aviation industry have focused on developing a stable market for fuel suppliers. Initiatives include coordinating the purchase of fuel, developing long-term purchasing agreements, and identifying and targeting government and private-sector funding for fuel production facilities.

Airlines have partnered with the Defense Logistics Agency–Energy, which purchases fuel for the military, in a strategic alliance to coordinate the purchasing of alternative fuel, combine buying power, and strengthen market interest. The Air Transport

Photo: Wikimedia Commons

A US Airways aircraft is fueled at Fort Lauderdale–Hollywood International Airport in Florida. Commercial aviation consumed 16 billion gallons of fuel in 2010.

[9] http://web.mit.edu/aeroastro/partner/projects/project28.html.

Association, Boeing, and USDA have formed the Farm to Fly partnership, to link farmers and airlines to maximize production benefits across U.S. regions.[10] In addition, commercial airlines have contributed to the U.S. Navy's Green Initiative for Fuels Transition–Pacific, or GIFTPAC, to stimulate sustainable alternative fuels production and establish a commercial supply of bioderived alternative fuels in Hawaii.

DOE and USDA have supported programs for the development of a U.S. biofuels industry, and the aviation industry's progress in pursuit of biofuels has caught the attention of these agencies, as well as of the White House. In a speech on March 30, 2011, President Obama laid out a strategy for American energy security and released the *Blueprint for a Secure Energy Future*.[11] On the topic of transportation fuels, the President directed DOE, USDA, and the Navy to "work with the private sector to create advanced biofuels that can power not just fighter jets, but also trucks and commercial airliners."[12]

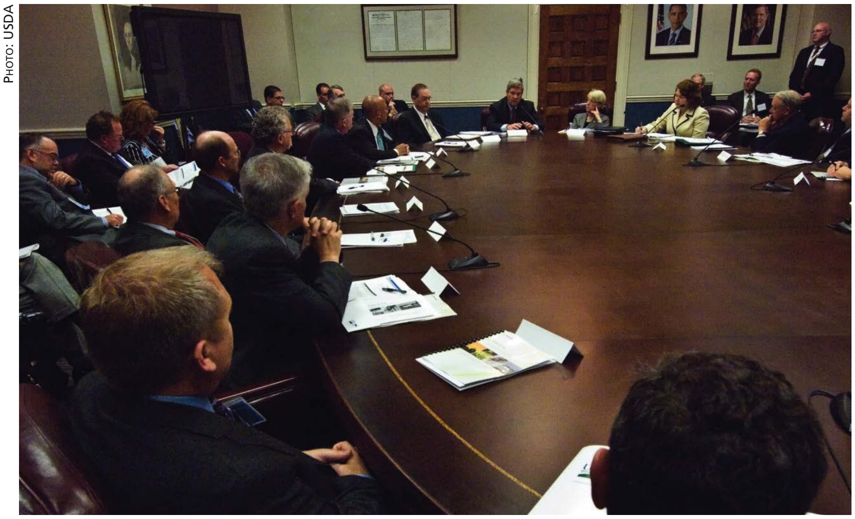
On August 16, 2011, DOE, USDA, and the Navy announced plans to use the Defense Production Act to invest $510 million over 3 years to share costs with private investors in the construction of biofuel plants and refineries to produce drop-in aviation and marine biofuels for military and commercial transportation. Developments have reached a critical stage, and government support for a small number of first-of-a-kind sustainable alternative jet fuel production projects will be pivotal in attracting private-sector capital, proving commercial feasibility, and launching a new industry.

[10] www.airlines.org/News/Releases/Pages/News_07-21-10.aspx.

[11] www.whitehouse.gov/sites/default/files/blueprint_secure_energy_future.pdf.

[12] www.whitehouse.gov/the-press-office/2011/03/30/remarks-president-americas-energy-security.

Photo: USDA



Aviation and biofuel industry executives met with U.S. Department of Agriculture Secretary Tom Vilsack at the Farm to Fly: Sustainable Aviation Biofuel Roundtable in July 2010. The agency is developing a roadmap to meet biofuel goals of the Renewable Fuels Standard.

Taking Flight

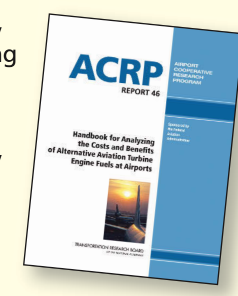
Sustainable alternative jet fuels promise economic, environmental, and energy security benefits for aviation. A unified, coordinated, and innovative approach by the commercial aviation industry and government partners is addressing barriers to approval, concerns about the environment, and support for commercial production.

Today aviation is perhaps the best coordinated and most vocal fuel user group to engage with the emerging alternative fuel industry. Air travelers should not be surprised to be taking a flight powered by alternative fuels sometime soon.

Applied Research on Alternative Jet Fuels

The Transportation Research Board's Airport Cooperative Research Program[a] (ACRP) carries out applied research on problems shared by airport operating agencies. One publication and four active projects focus on developing resources and tools for use by airports and other stakeholders in the alternative jet fuel supply chain—for example, feedstock suppliers, fuel producers, fixed-base operators delivering the fuel, and airlines—to evaluate and project the benefits and costs of alternative fuels:

- ACRP Report 46, Handbook for Analyzing the Costs and Benefits of Alternative Turbine Engine Fuels at Airports;
- ACRP Project 02-18, Guidelines for Integrating Alternative Jet Fuel into the Airport Setting;
- ACRP Project 02-23, Alternative Fuels as a Means to Reduce PM2.5 Emissions at Airports;
- ACRP Project 02-34, Quantifying Aircraft Lead Emissions at Airports; and
- ACRP Project 02-36, Assessing Opportunities for Alternative Fuel Distribution Programs.



[a] www.trb.org/ACRP/Public/ACRP.aspx.

Aviation Security Update

Policy, Management, Technologies, and Behavior Detection

ART KOSATKA, BONNIE A. WILSON, VAHID MOTEVALLI, AND RICHARD W. BLOOM

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In the 10 years since September 11, 2001 (9/11), aviation security has been a hot topic, day in and day out, for government, business, academia, and the general public. In the past year, for example, the Transportation Research Board's (TRB) Security and Emergencies Research website[1] has posted documents from the Department of Homeland Security; the Government Accountability Office; the U.S. Senate Committee on Commerce, Science, and Transportation's Subcommittee on Aviation Operations, Safety, and Security; and the U.S. House of Representatives Committee on Homeland Security Subcommittee on Transportation Security and Infrastructure Protection—as well as from a myriad of mass media sources. The array of security studies and related activities through TRB also continues to expand.[2]

But incidents of terrorism, terrorist threat, and security violations for a variety of criminal enterprises date back to aviation's beginnings. To obtain a snapshot of aviation security today and directions for the future, four authors examine different facets of aviation security. Each offers a unique perspective, reflecting the challenge of integrating differing perspectives into a holistic aviation security system.

—*Richard W. Bloom*

[1] www.TRB.org/SecurityEmergencies/SecurityandEmergencies1.aspx.

[2] http://onlinepubs.TRB.org/Onlinepubs/dva/SecurityActivities.pdf.

AVIATION SECURITY POLICY

Art Kosatka

Air travel used to be simple. Men and women wore their Sunday clothes and arrived at the airport 20 minutes before departure, paper tickets in hand, and flew to Pittsburgh. Then they flew back, without a hassle.

What happened? In the 1960s, Federal Aviation Administration (FAA)–regulated, airline-managed, minimum wage screeners operating ferrous-only magnetometers became the primary defense against airplane hijacking. Later, broad-spectrum detectors, explosives detection systems, and trace detectors tested for guns, bombs, and incendiary devices. That arrangement worked reasonably well until 9/11.

On November 19, 2001, the complex Aviation and Transportation Security Act was signed into law, creating the Transportation Security Administration (TSA). The Homeland Security Act of 2002 merged TSA and 21 other federal agencies and bureaus into the Department of Homeland Security (DHS)—the most extensive governmental reorganization in the United States since World War II.

The ensuing political problems, turf battles, diversity of cultures, budget competition, and different legislative interpretations of the nature of the problem have been only partially resolved. The 22 component agencies of DHS are subject to the jurisdiction of 88 congressional committees and subcommittees in both chambers on Capitol Hill.

Photos: Library of Congress, Prints & Photographs Division

Aviation security was minimal in the early days of airplane travel but has become a significant task for the aviation industry.

PHOTO COURTESY OF LEIGHFISHER, INC.

Transportation Security Administration (TSA) officers and employees make up a significant portion of airport personnel—sometimes outnumbering non-TSA personnel.

Because 9/11 was not viewed as a failure in implementing FAA policies and procedures—everything the hijackers did in boarding the planes was legal at the time—but as a criminal event, the first generations of TSA management primarily came from law enforcement agencies, such as the U.S. Secret Service. Law enforcement expertise is important for aviation security but is not sufficient in the openly accessible and fast-moving operational environment surrounding the public transportation of more than 1 billion people a year.[3]

Personnel Issues

How many and what kind of people are needed to oversee transportation security? One major hub airport has more than 450 TSA employees whose exclusive responsibilities are passenger and baggage screening; in contrast, only 350 employees run the entire airport, including perimeter security, airport police, and all others who keep the airport operating. Nationwide, a legislative cap applies to TSA hiring for all commercial service airports, but how Congress determines the operational needs of airports—and the budget of TSA—is not clear.

How should TSA employees be treated? In a recent survey on federal workplaces, DHS came in 28th out of 32 major governmental agencies. Within the DHS family of 22 diverse agencies, TSA's overall score was last among all major groups.[4] Employee morale and confidence in TSA leadership have been consistently low, with an accompanying low job performance and a high turnover rate—almost 600 percent greater than the governmentwide average.[5]

Attrition means a loss of the investment for recruiting, hiring, and training, as well as a loss of institutional experience. Aviation security policy has been technocentric, requiring specialized knowledge and expertise that is lost with the high turnover.

Intelligence Model

TSA has made positive strides in several areas, however. An important caveat is that its focus remains on countering threats with bigger, faster, and better technology at the airport instead of collecting and ana-

[3] In 2009, airport passengers totaled 4.796 billion worldwide; North America tallied 1.46 billion. www.aci-na.org.

[4] The Partnership for Public Service and the Institute for the Study of Public Policy Implementation, American University, annually ranks the best federal workplaces, surveying more than 263,000 workers at 290 federal organizations. www.bestplacestowork.org/BPTW/rankings/detail/HS00.

[5] According to the Partnership for Public Service, of the 15,570 total DHS hires in one recent year, 35.6 percent left in less than 2 years, and 72 percent of senior executives left between 2003 and 2007. Federal attrition rates averaged 7.6 percent in fiscal 2008 and 5.85 percent in 2009; the DHS rate is more than 600 percent higher than the annual average.

lyzing counterterrorism intelligence for necessary action. Virtually every successful deterrence of a terrorist attack in the past 15 years came about through credible intelligence and plain luck, not from technological detection—clearly the focus on technologies is misplaced. The planning for these terrorist attacks originated outside the United States, and the attacks were stopped well in advance of arriving at an airport, not in the few seconds required to pass through a machine or undergo a pat-down.

Some advocate the El Al Israel Airlines model of security, based on behavioral detection and extended passenger interviews. The model works well in Israel with two major airports but cannot be implemented in the United States with 462 hub-and-spoke airports and 1.4 billion passengers[6] in 2009. Nevertheless, a key to the El Al model is the use of intelligence and data gathering to identify bad people instead of bad things.

The U.S. intelligence community, however, may not share reliable, predictive, and operational intelligence with airlines that employ foreign nationals or with foreign carriers. Intelligence and information gathering is a dynamic process requiring constant updates, and the bureaucratic safeguards to make effective use of the intelligence most likely would gum up the system.

In conclusion, good intelligence would not eliminate the use of technologies at security checkpoints. Instead, good intelligence would improve the management of the checkpoint process, focusing the technology to sort through data on people more of risk. The same approach should apply to things more of risk—whether carry-on baggage, checked baggage, or cargo.

[6] www.aci-na.org/content/airport-traffic-reports-0. Atlanta had 88 million passengers in 2009; in comparison, the total population of Israel is 7,354,000, according to the Central Intelligence Agency's *World Factbook*.

AIRPORT SECURITY MANAGEMENT

Bonnie A. Wilson

Airports are a business like any other. Airports are in business to serve customers. Although generally not for profit, airports must maintain a level of revenue sufficient to provide for safe, efficient transportation services. This is the challenge.

Customers fly because they want to get to their destination quickly—to conduct business or enjoy leisure. Airports therefore must design and operate facilities that allow passengers to transit from the public areas to the secure flight operations area with minimal delays and encumbrances; otherwise, the value of commercial flight is diminished, so that customers choose alternative modes of travel.

Airport operators are committed to providing travelers with the best possible security. Threats to the safety of the air transport system affect all partners. The greatest difficulty airport operators have in achieving security goals is the lack of coordination and communication. Information about threats is often ill-defined and general, because key data must be controlled for intelligence efforts; yet more information can and should be shared with the airport community.

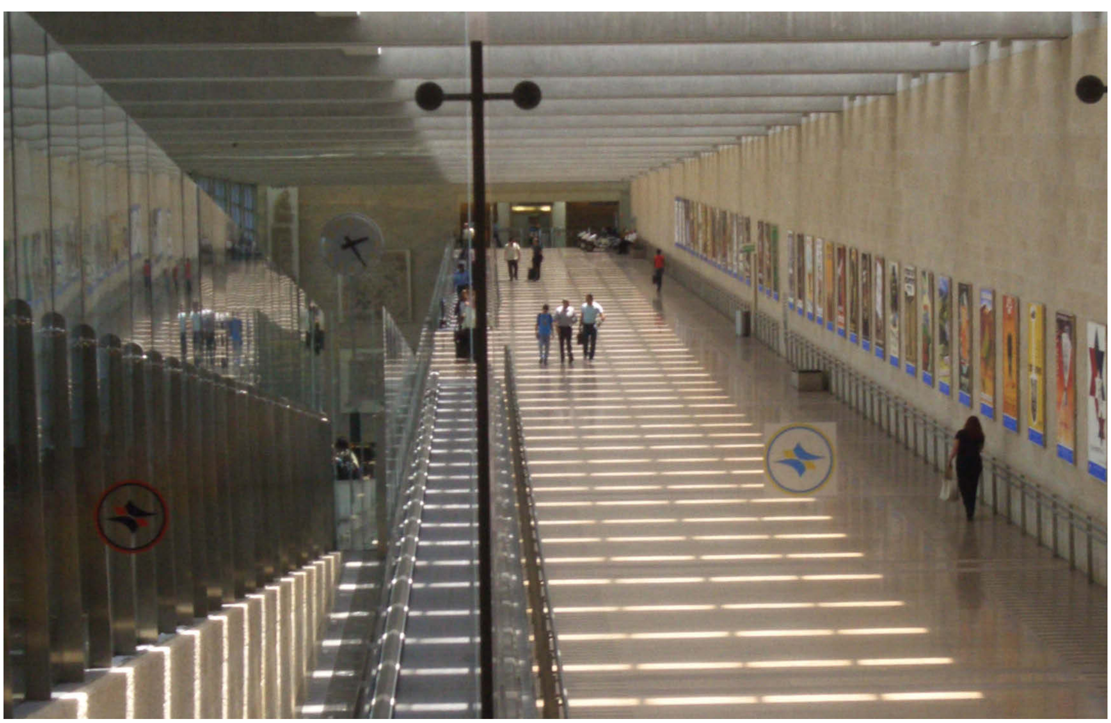


Photo: Marci Greenberger

The intensive, behavior assessment–based security measures practiced at Israeli airports such as Ben Gurion International (*pictured*) would be difficult to implement in the United States' much larger network of airports.

Seeking Practical Approaches

To expect that every potential act of terrorism be defined and categorized for the sake of creating specific deterrent or detection measures is unrealistic. Nonetheless, a practical approach would deploy applied technology in a rational manner to create a system or network of measures that could decrease the likelihood of successful terrorism yet provide for service to the majority of system users who pose no threat.

Currently, standard equipment and methods are wedged into all facilities, regardless of their size or the type of services provided, and are deployed on all persons, regardless of their threat profiles. Yet resources are not infinite, facilities are not elastic, and system users are often ill-informed. This works against the effective implementation of the standard screening regimes and equipment.

As fast as new technology is deployed, the threats morph, making the technology less effective. Before reactive equipment can be identified, acquired, and deployed, its effectiveness against the threat for which it was developed may be compromised—a sequence of events that terrorists and others targeting aviation can exploit.

Continually changing fixed facilities is unrealistic, but as a result, equipment often is installed in a less than optimal location, decreasing its effectiveness. As end users, passengers often are confused by new procedures, rules, and methods, leading to delays and frustration. This in turn distracts personnel from their primary mission of assessment, to assist with compliance instead.

Coordination and communication among the parties must improve. Airport management cannot continually build new facilities to house more equipment or to make room for longer queues. Economics does not support continual capital development, and the operational delays and mass congregation only enhance potential target areas.

Team Model

The intelligence community, technology developers, operations personnel, and facilities managers must have a forum for rational discourse and development. The integrated product team (IPT) model has a proven success record and should be applied to air transport security, with the incorporation of a nontraditional operational element.

In this variant of the IPT, members of the intelligence community can provide predictive threat information; technology researchers and developers can offer the best options for detection, and end users involved in screening and detection and in the management of facilities and operations can offer perspectives on the proposed installations and initiatives. Information exchanges across the entire system can help to identify persons or things likely to present the greatest threat.

Informed, on-scene personnel may be able to address problems that technology alone cannot solve. The flexibility of applied intelligence and direct interface adds value to the mission of assessment and deterrence.

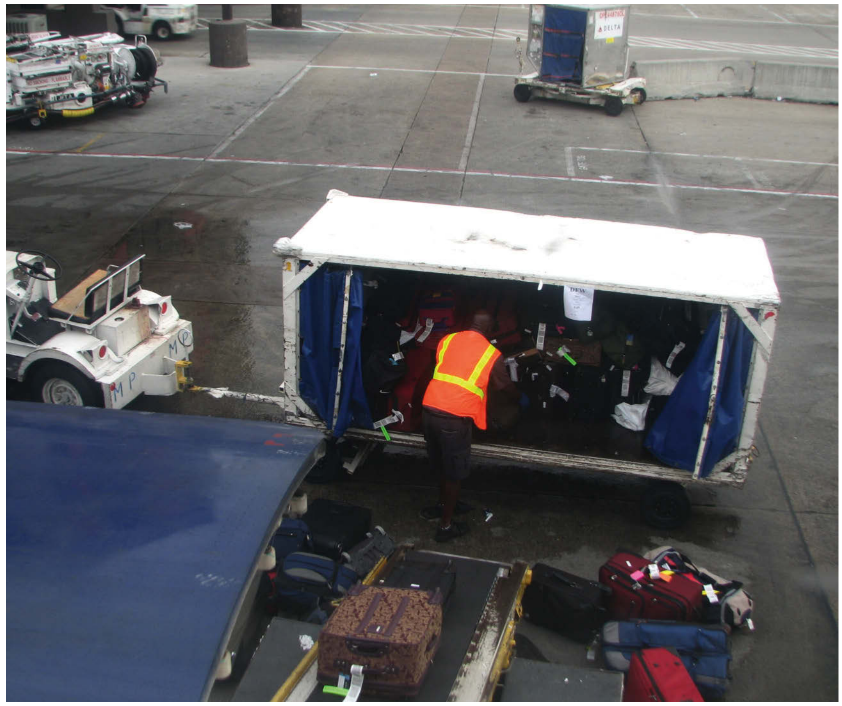


Photo: Kevin Payravi, Wikimedia Commons

The security risks to areas such as cargo operation require different measures than those used in terminals, on airplanes, or in air traffic control centers.

AVIATION SECURITY TECHNOLOGIES

Vahid Motevalli

The challenges facing U.S. aviation system security are manifold. The current approach to aviation security has not addressed the vulnerabilities of airports, air traffic control facilities, cargo operation centers, and maintenance and logistics facilities, all of which warrant different measures. The detection of threats to these areas poses challenges, yet the threats are perceived to be of lower risk, and so far these areas have proved less attractive targets for terrorists.

Will this remain the status quo? A coordinated attack on an air traffic control facility, for example, could disrupt the U.S. air transportation system significantly and could require a long recovery time. Such an attack, however, carries much less of an immediate threat and is of less psychological value to terrorists who seek to create an atmosphere of terror.

Potential terrorists have ignored critical infrastructures as targets partly because the protection has hardened, and redundancies and backup sys-


Photo: Wikimedia Commons

An X-ray screening device scans luggage at Suvarnabhumi International Airport in Thailand. Although it has flaws, X-ray has remained a standard technology for baggage screening.

tems are available. In contrast, circumventing security procedures to gain access to cargo and insert an explosive device into a passenger airplane, or introducing defective parts via a maintenance procedure, or directly attacking an airport terminal are potential threats against targets with varying degrees of vulnerability and of impact on the aviation system. The following review of threats and security technologies focuses on those associated with passenger operations.

Evaluation Criteria

Reliance on technology to detect explosives, weapons, and items that can be used for unlawful acts during a flight or within an airport sterile area is increasing. These technologies screen for items that may be carried by or on passengers, or within their belongings, or in cabin luggage or checked luggage, or by airport and airline employees and security personnel. In general, all screening systems and technologies must be evaluated for the following criteria: threat detection effectiveness, reliability, and false alarm rate; rate of throughput; infrastructure requirements, including initial and long-term maintenance costs; public acceptability; and value in deterrence.

By these criteria, having passengers remove their jackets and shoes and pass through metal detectors provides a reasonably effective screening solution. Although metal detectors cannot find explosive material hidden on a person's body, the more sophisticated technologies—such as back-scatter X-ray or millimeter wave scanners—also are not necessarily foolproof and can be defeated by specific methods or by hiding explosives in body cavities.

Reckoning the Flaws

Although the quantity of explosives that can be hidden in a body cavity is limited, small amounts of some explosives may be adequate to bring down an aircraft of a certain size. Several terrorists on a flight could provide explosives adequate for a midair explosion that could bring down a commercial passenger aircraft of any size.

Explosives-sniffing technology failed for a variety of reasons, including difficulty in maintenance and calibration and the incapability of detecting carefully packaged explosives. Many high-tech systems have proved too expensive to be deployed in large numbers or have demonstrated deficiencies. The much less expensive—but highly intrusive—pat-down is not acceptable to the public and requires rigorous training to be effective.

For decades, X-ray systems have been a staple in screening cabin baggage. Many flaws and shortcomings have been found in these systems, both in the technology and in the human factors. The systems can be defeated, but the unpredictability of when and how has aided their effectiveness.

Recent Improvements

The most recent improvements include enhanced X-ray and dual-energy X-ray machines that can distinguish organic, inorganic, and unreadable objects. Some of the more sophisticated—and more expensive—multiangle X-ray technologies can detect certain explosives. On the human factors side, such capabilities as zooming in on an area of interest, stripping features for closer inspection, and TIP (threat image projection) software tools have helped in improving operator performance.

Checked luggage screening has undergone a complete overhaul in the United States during the past decade with the mandatory use of explosives detection systems (EDS). EDS has the support of the public and a high deterrence value. The initial cost of the infrastructure expenditures will not be repeated on the same scale but remains a consideration for new terminal areas, along with the ongoing maintenance costs, which can run high.

Although the general perception of EDS reliability and throughput is positive, the actual throughput and false alarm rates, as well as missed detections, are not publicly known. This lack of information helps deterrence but the occurrence of an event due to a less than 100 percent EDS reliability rate becomes a game of probability.

Worldwide, EDS machines are becoming commonplace, but performance varies. Use of EDS does not ensure that every checked item has been reliably examined.

Trace explosive detection systems are effective and accurate but can be used only at random—for example, in a spot check. Trace detection devices are important and valuable as part of a comprehensive system—that is, one that includes appropriate and well-designed procedures for screening all employees who have access to secure areas of the aviation system.

BEHAVIOR DETECTION AND PROFILING

Richard W. Bloom

All methods to find people who intend to do bad things include the following steps: collecting and analyzing information; developing a valid link between the information and the behavior; and then taking action to prevent or minimize the behavior. The past and present are used to project the future.

The biggest problem is developing valid links between personal information and predicted behavior. Predictions of human behavior—particularly of violent behavior—are often extremely difficult. Any human social behavior is unknowable to some degree. The main challenges are manifold:

1. The same information may mean different things in different situations, especially when psychological triggers are considered.
2. People may change from terrorism-inclined to not inclined and back again, and from being inclined or not inclined in different ways.
3. Most people have less than complete conscious access to their own behaviors, thoughts, feelings, and motivations.
4. Sophisticated terrorists may not look like terrorists, expanding any search to people who do not look like terrorists but who look like almost everyone else.
5. Most people are extremely unlikely to engage in terrorism; therefore, a system to find terrorists must be highly accurate.
6. Without high accuracy in detecting a terrorist, a nonterrorist mistreated by security authorities may become a terrorist.
7. In a less than perfect security system, some terrorists inevitably will be treated as nonterrorists, with successful terrorism the result.

Because of Points 4 to 7, some experts support random screening or some modification of random screening for all air passengers.

8. Signs of stress may not indicate a terrorist, because travelers can appear stressed for many nonterrorist reasons.
9. Typical explanations of the psychology of terrorism may be superficial.

PHOTO COURTESY OF LEIGHFISHER, INC.

In conjunction with intelligence, law enforcement, and military operations; technology; and risk assessment, behavior detection—including face-to-face interviews—is an integral component of a robust aviation security policy.

10. The objectivity of psychological experts is affected by subjective assumptions that have unknown validity.
11. The language and concepts of security experts may not be conducive to understanding people in general or people with malignant intentions in particular.

Many other difficulties apply. As more people gain familiarity with the latest communications technology, human nature and the best language to describe it may be changing for groups of people and for individuals. In addition, the nature of terrorist networks and organizations and the tangible and intangible boundaries they cross are changing.

A new language may be needed to describe terrorist individuals and organizations. Nevertheless, information efforts should be crafted to influence hearts and minds, so that fewer people seek to engage in or support terrorism.

Perspectives in Summary

These four perspectives indicate that aviation security should be based on law enforcement, military, and intelligence operations aimed at identifying and neutralizing threats far away from aviation targets. Information operations drawing on all the tools of foreign policy can help minimize the threat. At the same time, technologies combined with behavior detection and profiling techniques—including data mining—should be implemented, based on risk assessment.

The continuous calculation of threats, matched to vulnerabilities, estimated probabilities, and impacts, will best inform the expenditure of security resources.

Establishing a security policy in the context of the many applicable cultural, legal, ethical, economic, political, and sociocultural variables remains a huge challenge. With different perspectives and multiple layers of analysis, applied research will help meet this challenge.

Meeting the Economic Challenges of the Aviation Industry

BRIAN DAVID BALLARD AND JOHN W. FISCHER

Ballard is Senior Economist, Gellman Research Associates, Inc., Jenkintown, Pennsylvania, and Chair, TRB Aviation Economics and Forecasting Committee. Retired from the Congressional Research Service, Fischer is a consultant in Annapolis, Maryland, and an emeritus member of the TRB Aviation Economics and Forecasting Committee.

From an economic perspective, the aviation system is a success. System users pay for services, either directly through airline fares or indirectly through aviation taxes and fees. Most private-sector participants—such as airlines, general aviation, and airframe manufacturers—are able to conduct profitable operations. Most public-sector participants—such as commercial service airports—are able to raise private and public revenues to cover operating expenses and capital requirements.

Nevertheless, the aviation system faces economic challenges. Some of these are long-standing and at times appear intractable.

Civil Aviation's Players

The U.S. aviation system consists of many players: airlines, airports, general aviation operators, aircraft manufacturers, equipment and service suppliers, and the federal government. As owner and operator of the air traffic control (ATC) system and as regulator of certain industry activities—especially safety—the Federal Aviation Administration (FAA) plays a large role in the industry.

All of these players share an interest in a well-functioning and well-integrated aviation system. Some players, however, have competing interests that often seem at odds with these common goals.

Civil aviation holds an important place in the U.S. economy. The industry comprises commercial services, airports, general aviation, and aircraft manufacturing. The most recent FAA report on the economic impact of civil aviation estimates that in 2007—including the secondary impacts from the spending of wages—the industry contributed $786 billion to the annual gross domestic product (GDP), or 5.6 percent of the GDP (*1*).

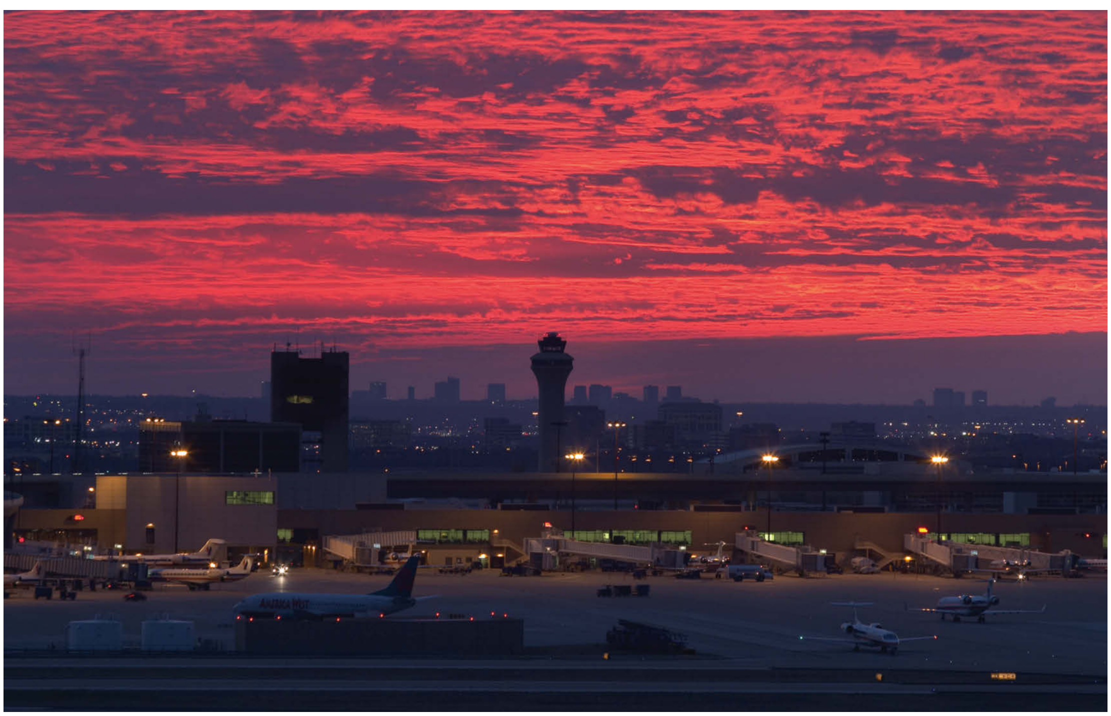


PHOTO: DALLAS–FORT WORTH INTERNATIONAL AIRPORT

Terminal B at Dallas–Fort Worth International Airport. According to FAA, the aviation industry contributes more than 5 percent of the nation's gross domestic product.

Photo: Wikimedia Commons

Construction of new terminals at Queen Alia International Airport in Amman, Jordan. In recent years, air transportation growth has been particularly strong in the Middle East, Asia, and South America.

The U.S. aviation system is a part of a global system. In recent years, growth in air transportation services has been stronger in Asia, South America, and the Middle East than in Europe and North America. Nonetheless, the opportunities and challenges for industry growth are similar across geographic regions.

Perhaps the greatest contributor to aviation growth worldwide is the increase in per capita incomes, especially outside the more mature markets of North America and Europe. Rising incomes make air travel an option for greater segments of the world's population. Growth is expected to continue in the United States, perhaps at a slower pace. Creating a national aviation system to accommodate this growth and coordinating it with international markets is a major challenge.

Airline Deregulation

The Airline Deregulation Act of 1978 freed the airline industry from economic regulation by the federal government. The landmark legislation began a process of deregulation in other industries, including telecommunications, trucking, and railroads.

Before 1978, commercial aviation was subject to decades of far-reaching federal economic regulation by the Civil Aeronautics Board (CAB). The CAB oversaw most aspects of airline services, from routes to fares—although not service levels. This led to an artificially cozy industry—airlines competed on quality of service and amenities while charging regulated fares that ensured a comfortable return for operators. This changed drastically with the 1978 act.

The act did not end all regulation. Safety regulation by FAA remains a key element of the industry's structure. The U.S. Department of Transportation (DOT) retains oversight authority, in some cases with other federal agencies, for airline certification; code sharing; international route assignments, with the Department of State; merger and acquisition approval, providing input to the Department of Justice; and certain consumer issues.

Although in business until 2001, the iconic Trans World Airlines was a casualty of the economic changes initiated by the Airline Deregulation Act of 1978.

Photo: LOC Prints and Photographs Division, HAER PA 51-PHILA 713

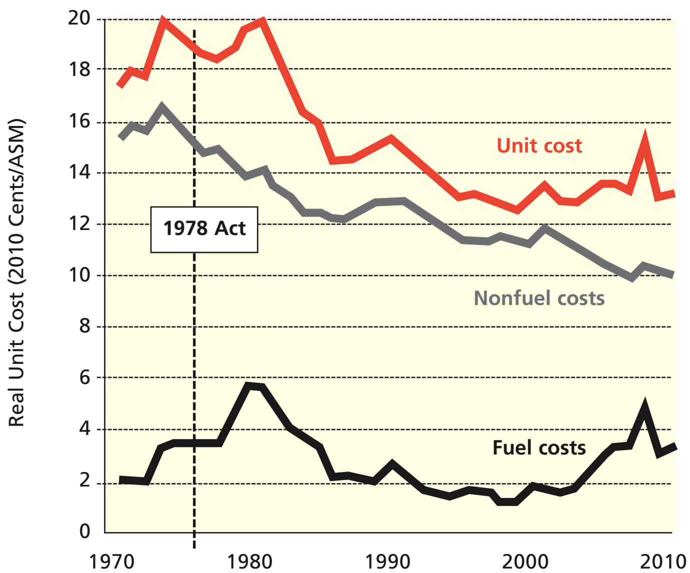


FIGURE 1 U.S. airline unit costs. (Note: ASM = available seat mile. Source: Air Transport Association Cost Index for U.S. Passenger Airlines: Third Quarter 2010. Data as of February 15, 2011. www.airlines.org/Economics/DataAnalysis/Pages/QuarterlyCostIndex.aspx.)

In addition, an independent agency, the National Transportation Safety Board, investigates accidents and makes safety recommendations to FAA. The Department of Homeland Security screens passengers, baggage, and cargo through the Transportation Security Administration (TSA).

Revenue Trends

Deregulation was not without difficulties. Economic deregulation started a process of industry disruption and adaptation that continues today. Many aviation icons like Pan Am, Eastern, and Trans World Airlines have passed from the scene. Most airlines, including carriers currently operating, have experienced bankruptcy. Mergers and acquisitions have led to greater concentration in the industry, but competition within major markets appears undiminished.

These and other changes are reflected in airline revenue trends and in the changing composition of airline costs since deregulation. Academic economists continue to take interest in the regulatory and industrial structure of the airline industry (*2*) and in airline financial performance (*3*).

The basic inflation-adjusted cost structure of the U.S. airline industry is shown in Figure 1 (above). Although the unit costs of operations—represented by the cost to airlines of providing one available seat mile—generally have declined since the deregulation of the airline industry, the cost of fuel has been increasingly volatile. Consequently, fuel's share in unit costs has grown, from 12 percent in 1971 to more than 35 percent in 2008 and 25 percent in 2010. The volatility of fuel prices has added an element of unpredictability to airline cost planning, increasing the importance of fuel-hedging strategies at some airlines.

Cost of Delays

Despite the flexibility of air transportation, demographics make some locations more popular for departure or arrival, and the traffic growth can cause congestion and unacceptable delays at these airports. All airports—especially those with challenging levels of demand and traffic congestion—are less able to accept and manage air traffic under poor weather conditions. Adverse weather not only has local effects but also can affect the flows of air service to and from other airports, disrupting the network and compounding the local difficulties.

In this environment, a seemingly cautious airline schedule or passenger travel itinerary can break down because of moderately poor weather, downstream congestion, or missed connections. These disruptions significantly increase the cost of delay. The total impact of air transportation delay to the economy was recently estimated at $30 billion per year (*4*).

Operating Airports

Airports remain regulated in many ways. The 503 commercial service airports range from simple, lightly used, single-runway, regional airports to immense and complex international gateway hubs, such as O'Hare International Airport in Chicago.

Public entities—primarily cities and regional authorities—almost entirely own these commercial service airports. In a few instances, aspects of the air-

TABLE 1 Primary Airport Revenues and Expenses, FY 2007 or FY 2008

Revenues	In Millions
Aeronautical revenues	$8,068
Nonaeronautical revenues	$7,236
Nonoperating revenues	$6,994
Total revenues	$22,298
Expenses	
Operating expenses	$10,050
Nonoperating expenses	$3,270
Total expenses	$13,320
Depreciation	**$4,445**
Net (available for capital spending)	**$4,533**

Source: Gellman Research Associates, Inc., analysis of airport Form 5100-127 filings for FY 2007 and FY 2008.

port's operations may be privatized or contracted to private firms. In most cases, airports are local or regional monopolies—competition between U.S. airports occurs only infrequently. For example, an airline seeking to serve the New York metropolitan region has a choice of airports, but all are owned and operated by the Port Authority of New York and New Jersey.

The economics of operating an airport as a public entity differs in many respects from the competitive pressures on an airport's major tenants, the airlines. Airports meet their operating and capital expenses through a range of fees and receipts, including landing fees, concession rentals, and parking. U.S. airports also receive funds from passenger facility charges (PFCs), a tax on airport passengers that is subject to legal limitations and federal approval. PFCs are a major source of controversy between the airline and airport communities.

Airport size also affects airport economics, because large metropolitan airports are more likely to be self-supporting, but smaller commercial airports routinely need support from outside sources such as the local community—that is, the owners. Table 1 (page 36) reports aggregate revenue and expense data for the nation's 390 primary airports for fiscal years (FY) 2007 or 2008.

Modernizing Air Traffic Control

Commercial aviation relies on a system of infrastructure and manufacturing supply chains that transform a technical capability—powered flight—into a commercially viable transportation network. The transit of aircraft between airports is managed at an unparalleled level of safety by an air traffic management and control network operated and maintained by FAA. In the past century, this ATC system has transformed from beacon lights and wind flags to the digital tools and automated capabilities of the emerging next generation, or NextGen, air traffic management system.

Although the U.S. ATC system has performed well, it could be more efficient. The NextGen modernization, described in the article on page 7, is behind schedule and perhaps over budget, although some individual elements have remained on time and within cost estimates. Users of the ATC system eagerly anticipate the promises of NextGen—more efficient flight routing, closer trailing distances between aircraft, and other changes that will save fuel, time, and therefore money.

The U.S. ATC system is one of the few in the industrialized world that has not undergone organizational

Photo: Kansas City Aviation Department

Concession rentals, like this storefront at Kansas City International Airport in Missouri, provide a source of income for airports.

Photo: Dwight Burdette

As the air traffic control system transitions from the use of airport beacons and wind flags to satellite technology, the costs and benefits of modernization come into focus.

reform, such as privatization or corporatization. Canada, for example, corporatized its ATC system in the 1990s with the creation of NAV CANADA, widely viewed as a success. Because of its independence from direct government interference, NAV CANADA had an easier time than FAA in implementing more efficient practices and acquiring new technology. In the 1990s, the Clinton Administration proposed a form of corporatization but failed to gain congressional approval. If NextGen implementation goes astray, organizational and financial issues are likely to become issues of national concern once again.

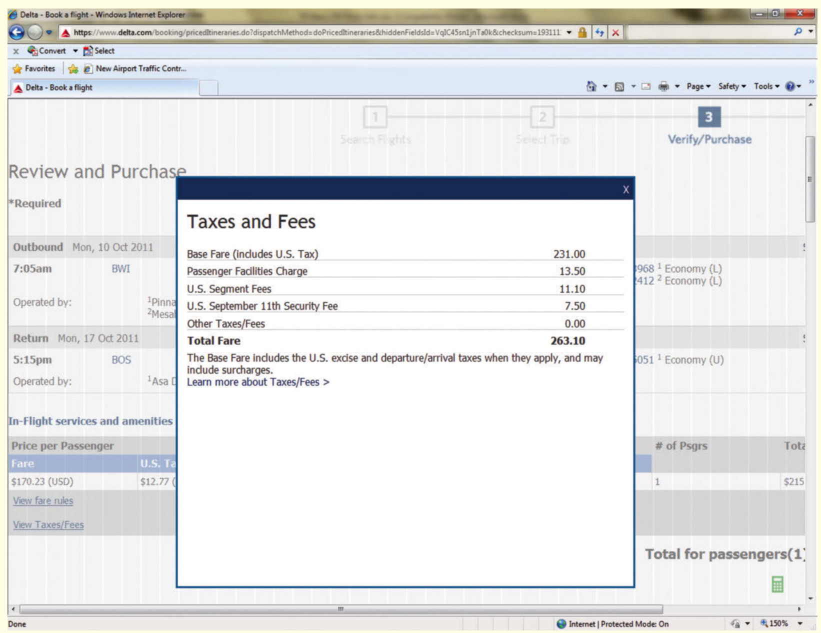
Financing Improvements

A large portion of airport infrastructure improvements and a majority of investments in the infrastructure of the air traffic management network are financed by a complicated system of federally imposed taxes and fees on passengers, freight, and other system users. The bulk of these taxes and fees is placed in the Airport and Airway Trust Fund, better known as the aviation trust fund.

Airports collect PFCs separately for local use. The Transportation Security Administration (TSA) charges an aviation security fee to airline passengers

Turbulence in Federal Funding

Federal Aviation Administration (FAA) funding is provided through periodic Acts of Congress. These authorization and reauthorization acts typically support FAA's activities for a defined period, usually two to four years. Since the end of Fiscal Year 2007, however, Congress has been unable to agree with either the Bush Administration or the Obama Administration on a long-term plan for agency funding. This has produced a series of short-term extensions of the program's authorization, also providing for the collection of taxes and fees, primarily through the Airport and Airway Trust Fund. As of September 2011, the program has received 21 extensions, and the consensus for passing long-term legislation remains elusive.



Airplane passengers in the United States pay four taxes and fees on domestic flights.

Unlike its predecessors, the 21st extension was not completed before the expiration of the previous extension; this led to a partial shutdown of some of FAA's nonsafety and non–air traffic control activities for approximately two weeks. During this period, 4,000 of FAA's more than 47,000 employees were furloughed, and work on FAA infrastructure projects was suspended, with the loss of many construction industry and related jobs nationwide. At the same time, many of the taxes and fees collected for the trust fund were suspended, with the U.S. Treasury losing approximately $30 million per day.

FAA is funded through a complex set of taxes and fees imposed on users of the National Aviation System. Many of these taxes are reauthorized with FAA programs. The airline ticket tax is the largest source of ongoing funding for FAA, and the two-week discontinuance of this tax is the source of much of the recent loss of trust fund revenues. The discontinuance of FAA's tax authority, however, did not affect the collection of passenger facility charges, which provide direct funding to airports, and did not affect the airlines' collection of the security-related fees which partially fund the Transportation Security Administration.

The Budget Control Act of 2011, signed by President Obama on August 2, calls for significant cuts in federal discretionary spending in two stages, with a small cut in the near term and a larger cut at the end of the year. Included in the discretionary portion of the federal budget is the General Fund contribution to FAA.

Funding for some FAA programs, therefore, probably will be reduced in the years ahead, creating a new element of uncertainty for FAA and its activities. At a minimum, the annual General Fund contribution to FAA's budget will be under pressure, and certain programs supported through the trust fund, like the Airport Improvement Program and Facilities and Equipment, may be reevaluated and may face budget reductions to offset the loss in General Fund support.

Photo: Metropolitan Washington Airports Authority

The new control tower at Dulles International Airport. Among the economic challenges faced by the aviation industry is the ability of the aviation trust fund to support the modernization of the ATC system.

to help pay for the screening of passengers and baggage, as well as for other TSA activities. Airlines collect all of these taxes and fees as part of a passenger's ticket transaction. TSA imposes an additional fee directly on the airlines.

Historically, the aviation trust fund has supplied more than 80 percent of FAA's annual budget, including three of FAA's major lines of business—the Airport Improvement Program; Facilities and Equipment; and Research, Engineering, and Development. FAA Operations and Maintenance is financed in part through the fund, with additional support from U.S. Treasury general funds.

This public interest contribution is sometimes controversial and has varied in size. Before 2000, the contribution ranged from 18 percent to 20 percent of the total FAA budget. In FY 2010, however, the contribution rose to 33 percent, and the Congressional Budget Office expected it to remain near this level for the next few years.

In FY 2010, FAA funding was just under \$16.1 billion; \$10.9 billion of this was provided from the aviation trust fund.[1] Collections of aviation taxes and fees in the same year contributed \$10.4 billion to the fund, resulting in a small, unexpended balance in the account. Two fees outside the fund also produced significant revenues: PFCs accounted for an additional \$2.8 billion in collections for airports, and aviation security fees accounted for \$2.1 billion.

[1] All data in this section are from the March 2010 Congressional Budget Office baseline.

Passenger Fees

The passenger fees that finance ATC, airports, and aviation security can be described as proxies for user fees. Some of the passenger taxes are based on the value of services rendered by airlines, not on the cost of the services.

Passengers pay four taxes and fees on tickets for U.S. domestic air travel. The federal ticket tax is an ad valorem tax set at 7.5 percent of the base fare; the federal segment tax, PFCs, and the federal security fee are unit taxes that vary in value from \$2.50 to \$4.50 per flight segment. These unit taxes are fixed dollar amounts, and only the federal segment tax is inflation-adjusted.

Therefore, two passengers on the same flight who pay different fares may pay substantially different amounts of taxes and fees. As a result, passenger taxes are poorly aligned with the cost of providing airport and ATC services to aircraft.

Despite the complicated structure, aviation taxes have hovered at an average of \$50 per round-trip ticket for the past 15 years. In the same period, air fares have become drastically cheaper for consumers because of increased competition—base fares have dropped by more than one-quarter. Consequently, the relative share of taxes and fees has grown from an average of 11 percent added to the base fare in the early 1990s to nearly 17 percent in 2009.

This has made the airline industry more sensitive to increases in any of the tax rates. Airlines argue that increases in PFCs or other taxes or fees are experienced by passengers as increases in fares or in the

Airport Cooperative Research Program (ACRP) Report 48, *Impact of Jet Fuel Price Uncertainty on Airport Planning and Development*, assists airport operators and planners in gauging the impact of jet fuel price changes on supply and demand for air service.

cost of flying, which has a negative effect on travelers' willingness to fly.

Challenges Ahead

Aviation faces several economic challenges in the next few years. Prominent among these issues are the following:

◆ **Effects of economic growth.** Growing incomes and growing demand for consumer and other goods affect all sectors of the world economy, putting new pressures on energy and other natural resources. Unless world supplies, adjusted for efficiencies in use, keep pace with growth in demand, fuel costs for aviation—as for all other modes that rely on fossil fuels—only can rise, affecting the affordability of transportation.

◆ **Environmental costs.** Concerned about the potential effects of climate change, many nations are writing regulations and searching for mechanisms to limit emissions—for example, cap and trade. Economic tools—such as taxes or carbon permits—to limit emissions from aircraft and other sources will affect the cost of air travel, along with the industry's capability for growth. Many analysts believe that community objections to aviation noise will continue to restrict aviation growth and that airports also will need to deal with the costs of environmental remediation, such as for stormwater runoff.

◆ **Cost of fuel.** Fuel price fluctuations are a major uncertainty for the airline industry. Although improvements in engine and airframe efficiency have reduced fuel consumption per passenger-mile flown, fuel is replacing labor as the largest cost in airline operations. Continued fuel efficiency improvements and the introduction of alternatives to traditional oil-based aviation fuels may offset these costs.

Fuel price uncertainty affects airport planning related to supply and demand for air service at commercial service airports. ACRP Report 48, *Impact of Jet Fuel Price Uncertainty on Airport Planning and Development,*[2] provides resources to measure these effects.

◆ **Infrastructure investment.** Growth in aviation activity, especially in regions with modest aviation infrastructure, will require new investments in airport and air traffic management infrastructure. Regions with well-developed aviation sectors will look to improvements in airport, aircraft, and air traffic management efficiencies to increase the capability of already congested systems to handle more activity.

◆ **Filling the aviation trust fund.** The structure of the aviation trust fund, aviation taxes, and fees may not be adequate to meet future system needs. Many have questioned federal assistance not only for the largest airports but for smaller airports, especially when funds serve local economic development instead of national system needs.

The current funding system also may not provide the annual increases in resources to meet FAA funding needs. From the industry perspective, when taxes and fees reach a certain level, the impact on air travel is negative, depressing industry revenues.

If the costs of upgrading and operating the ATC system increase at a rate faster than trust fund revenues can grow, a funding problem may arise similar to that experienced by surface transportation modes that depend on Highway Trust Fund accounts. Complicating the matter is that some system users believe they pay more than their fair share for the operation of the system than other users pay.

Complex Interplay

The future of the aviation industry, like its past, reflects the interplay of technical and aeronautical innovation, business model development and competition, and evolving passenger and shipper tastes, preferences, and requirements. A growing and developing global economy will continue to make use of the unique capabilities of aviation.

The challenge for the aviation industry will be to make the necessary changes that will allow the private portions of the industry to remain profitable and capable of meeting the increased demand. This also will require funding of the public portions of the system with adequate revenues and access to capital to support the necessary expansion of the aviation system's infrastructure.

Acknowledgments

The authors acknowledge the contributions of Paul M. Aussendorf, Assistant Director, U.S. Government Accountability Office, Seattle, Washington, and of Joakim Karlsson, Principal and Operations Research Analyst, MCR Federal, LLC, Bedford, Massachusetts.

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SAN DIEGO INTERNATIONAL AIRPORT

Better Communication to Mitigate Complaints About Aircraft Noise

Initiatives at San Diego International Airport

DAN FRAZEE

The author is Director, Airport Noise Mitigation, San Diego International Airport.

Airport managers and staff often receive complaints from neighboring communities about aircraft noise and the associated inconveniences. According to the Federal Aviation Administration, aircraft-related noise is the major deterrent for airport expansion. Inviting and understanding community concerns, informing the residents about measures to mitigate aircraft-related noise, and seeking solutions to the issues related to aircraft noise are the ongoing missions of the Airport Noise Mitigation Department at San Diego International Airport (SDIA).

Problem

Airports across the country are experiencing increases in complaints about aircraft noise from residents outside the federally defined, impacted area, determined by a noise contour of 65 DNL (day–night average noise level). For many in the industry, the inquiries and complaints from stakeholders such a distance from the airport raise a variety of questions: What is causing these stakeholders to voice concerns about aircraft noise? What is their agenda? What measures do these stakeholders expect the airport to take? How can airport managers help community stakeholders understand the airport's limitations in mitigating aircraft noise?

The noise mitigation team at SDIA constantly assesses the effectiveness of mitigation and attenuation efforts and searches for new tools that can help manage issues related to aircraft noise to the maximum extent possible.

San Diego International Airport.

Photo: SDIA

Solution

Research conducted under the Airport Cooperative Research Program (ACRP) has identified best practices for airports in communicating with residents affected by aircraft noise (*1*). The best practices underscore the importance of building relationships with the public; the research presents the outcomes of effective relationships with the surrounding community.

In addition, an ACRP synthesis of airport practice provides airport operators, stakeholders, and policy makers with information about actions that airports take to address aircraft noise outside the 65-DNL contour (*2*). For example, the airport can provide the community with access to web-based visualizations of flight tracks and can encourage residents to voice concerns, opinions, and suggestions by participating on noise-specific airport advisory committees.

The research provided ideas and direction for communications approaches suitable for airports with differing operational profiles. The publications provided airport managers with insights, ideas, perspectives, and tools to address aircraft noise issues and deal with community concerns about noise impacts more effectively. The research produced an extensive toolkit and a self-assessment instrument to help airport managers evaluate programs, review options for sound attenuation, apply alternative metrics for noise, and deal with community input.

For example, SDIA focused on aircraft operators in implementing a measure to mitigate aircraft noise and to benefit communities that had felt the impacts. Signs posted at each end of the runway (see photo-

PHOTO: SDIA

Sign at end of runway noting restrictions on takeoffs at night.

graph, above) advise aircraft operators about the noise curfew that prohibits takeoffs during two nighttime periods, based on how noisy the aircraft is. This measure benefits the community most affected by takeoffs late at night.

The ACRP research revealed that a cookie-cutter approach to aircraft noise mitigation is not appropriate—airports must customize approaches to match local conditions. For example, a basic communication approach would be appropriate for smaller airports that have only an airport manager as staff, but medium-size airports can augment the basic guidance by following the suggestions on staffing and communication techniques; and large airports may find suitable ideas for improving techniques or strategies already in place.

ACRP Report 15, *Aircraft Noise: A Toolkit for Managing Community Expectations*, and ACRP Synthesis 16, *Compilation of Noise Programs in Areas Outside DNL 65*, provided best-practice models adapted and applied for community outreach by the noise mitigation department at San Diego International Airport.

Application

SDIA has implemented several of the research findings to enhance communication with the community, to ensure that measures are taken to deal effectively with aircraft noise issues, and to demonstrate to the community the benefits of airport operations. SDIA also modified its Internet-based flight visualization system to include an integrated, changeable script area, so that staff can update the community about changes in flight patterns, inclement weather, or operational restrictions.

The San Diego County Regional Airport Authority relies on continuous input from an Airport Noise Advisory Committee of 18 members from various political organizations, local residential land use planning areas, aircraft noise technicians, and airport-related professional associations. The committee provides a forum for collaborative discussion of airport noise issues and related matters and for demonstrating the benefits of the airport to the community.

Benefits

California airport noise managers also meet regularly to identify and address airport-specific noise issues and to share information, so that new measures that deal effectively with aircraft noise in one community are brought to the larger group's attention.

SDIA considers actions for implementation that have not been previously considered. For example, the modification of the flight visualization system is likely to reduce the aircraft noise-related complaints from the affected community. The advisory committee participants are encouraged to share information from the meetings with their constituents, gaining credibility and support for proactive measures.

The communication efforts and the application of other research findings have contributed to better public understanding of the benefits of airport operations for the community and of the efforts to deal with aircraft noise issues. Airport operations provide opportunities for economic growth and benefits to the neighborhood that are difficult to quantify in dollar amounts—nevertheless, the opportunities greatly affect community prosperity and enhance community–airport cooperation.

For more information, contact Dan Frazee, Director, Airport Noise Mitigation, San Diego International Airport, P.O. Box 82776, San Diego, CA 92138; 619-400-2781; dfrazee@san.org.

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EDITOR'S NOTE: Appreciation is expressed to Amir Hanna, Transportation Research Board, for his efforts in developing this article.

Suggestions for "Research Pays Off" topics are welcome. Contact G. P. Jayaprakash, Transportation Research Board, Keck 488, 500 Fifth Street, NW, Washington, DC 20001 (202-334-2952; gjayaprakash@nas.edu).

CALENDAR

TRB Meetings

2011

November

2–3 Improving Transportation Safety Programs Through University–Agency Partnerships Conference
Washington, D.C.

7–9 2nd Road Dust Best Management Practices Conference*
Las Vegas, Nevada

15–19 8th International Conference on Managing Pavement Assets*
Santiago, Chile

December

5–7 Strategies for Meeting Critical Data Needs for Decision Making in State and Metropolitan Transportation Agencies (*invitation only*)
Irvine, California

7–10 1st Conference of the Transportation Research Group of India
Bangalore, India

2012

January

21 Data Analysis Working Group Forum on Pavement Performance Data Analysis
Washington, D.C.

22–26 TRB 91st Annual Meeting
Washington, D.C.
www.TRB.org/AnnualMeeting

February

7–9 2nd Biennial National Evacuation Conference
New Orleans, Louisiana

29 Emergency Medical Services Systems, Safety Strategies, and Solutions Summit
Washington, D.C.

April

TBD Innovations in Travel Demand Forecasting
Tampa, Florida

16–18 9th National Conference on Asset Management
San Diego, California

17–19 Joint Rail Conference: Technology to Advance the Future of Rail Transport*
Philadelphia, Pennsylvania

22–24 Symposium on Mileage-Based User Fees and Transportation Finance Summit*
Philadelphia, Pennsylvania

29–May 1 3rd International Conference on Communications-Based Train Control and Train Efficiency
Denver, Colorado

30–May 3 International Conference on Winter Maintenance and Surface Transportation Weather
Coralville, Iowa

May

7 Relationship Between the Design and Construction of Rockfall Mitigation Techniques
Redding, California

20–25 14th International Conference on Alkali–Aggregate Reactions*
Austin, Texas

22–24 14th International HOV–HOT and Managed Lanes Conference
Oakland, California

23–25 International Society for Asphalt Pavements Symposium on Heavy Duty Pavements and Bridge Deck Pavements*
Nanjing, China

June

2–8 11th International and 2nd North American Symposium on Landslides*
Banff, Alberta, Canada

4–7 North American Travel Monitoring Exposition and Conference (NATMEC): Improving Traffic Data Collection, Analysis, and Use
Dallas, Texas

20–22 7th RILEM International Conference on Cracking in Pavements
Delft, Netherlands

Additional information on TRB meetings, including calls for abstracts, meeting registration, and hotel reservations, is available at www.TRB.org/calendar. To reach the TRB staff contacts, telephone 202-334-2934, fax 202-334-2003, or e-mail TRBMeetings@nas.edu. Meetings listed without a TRB staff contact have direct links from the TRB calendar web page.

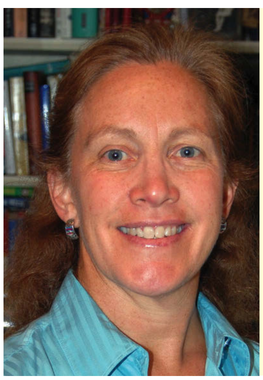
*TRB is cosponsor of the meeting.

Shari Schaftlein

Federal Highway Administration

From the beginning of her career to her current position as Program and Policy Development Team Leader in the Federal Highway Administration's (FHWA) Development and Environmental Review Office, Shari Schaftlein has stepped into newly created roles and piloted new initiatives in the expanding field of environmental research. "Substantive changes in environmental law, policy, procedures, or court findings send a ripple across the country as transportation professionals assimilate the changes," she observes.

Since joining FHWA in 2004, Schaftlein has helped develop responses to policy changes, integrating new legislation to meet a variety of societal goals efficiently. When the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) was passed in 2005, Schaftlein organized a diverse group of staff to examine SAFETEA-LU's environmental review provisions. She participated in and supported teams in proposing rules and guidance for implementation, sought input from stakeholders, and organized a recognition program for staff.



"Now the [environmental agenda] is putting all the research pieces and our best collaborative skills together to serve a transportation system that has more livable and sustainable outcomes."

Schaftlein received a bachelor's degree in public affairs and a master's degree in environmental science from Indiana University in Bloomington. In 1985, she became director of water resource programs at the West Michigan Environmental Council, leading local and state efforts to reduce combined sewer overflows and initiating adopt-a-stream programs; in 1991, she went to Washington State to serve as the environmental program director for the Quileute Tribal Council.

In 1993, Schaftlein was hired to lead stormwater research efforts at the Washington State Department of Transportation (DOT). "We needed to figure out where runoff was leaving the highway, how to treat the runoff to improve water quality, and how to retain the water to reduce physical impacts to the streams," she notes. Around the same time, she came to her first TRB Annual Meeting to present a paper on developing a stormwater outfall inventory; although a blizzard complicated her travel plans, she has attended nearly every Annual Meeting since. She has been particularly impressed with fellow attendees' dedicated efforts on behalf of the nascent field of environmental research.

"We all knew it was becoming harder and harder to lay a new highway lightly on the landscape and leave the environment and community a better place," Schaftlein comments. She continues to develop the dialogue as a member of the TRB Environmental Analysis in Transportation Committee, as the FHWA representative to the American Association of State Highway and Transportation Officials' Standing Committee on the Environment, and by supporting FHWA's environmental research activities.

Schaftlein's success at building a water quality program at Washington State DOT earned a promotion to environmental initiatives manager in 1997. The newly created position was part of the department's efforts to strengthen its environmental compliance and become a national leader in environmental management systems. In 1998, Schaftlein became assistant director of environmental services. She reorganized staff, expanded administrative and financial capacity, and led collaborative efforts between the department and regulators, building cooperation and removing points of conflict.

"In a few years, Washington State DOT moved from being part of the problem to being part of the solution," she recalls.

Schaftlein's job at FHWA has evolved along with new environmental initiatives. She has championed implementation of the 2006 Eco-Logical report and coordinated the effort to launch the \$1.4 million Eco-Logical grant program. Other responsibilities include planning, programming, budgeting, and evaluating FHWA Office of Project Development and Environmental Review programs; supervising project development specialists; environmental process timeliness and regulatory compliance; and collaborating with other FHWA offices.

Schaftlein points to an evolution of the national environmental research agenda in the past 18 years, beginning with the separation of various fields for individual study—such as water quality, hazardous materials, and endangered species—and gradually focusing on streamlining and stewardship. "Now the wave is putting all the research pieces and our best collaborative skills together to serve a transportation system that has more livable and sustainable outcomes," she notes.

Schaftlein advises new professionals to enlist a mentor and utilize the vast amount of information available on transportation and the environment.

Nan Shellabarger

Federal Aviation Administration

Nan Shellabarger always has used models, information, and analysis to investigate and solve problems, for both the industry and government sides of aviation. She graduated from the University of Michigan's (UM) School of Natural Resources and Environment in 1976, feeling "pretty well-equipped to become a park ranger, work for a lumber company, or go on to graduate school." After working at the university libraries for several years, Shellabarger enrolled at UM's School of Business Administration. She received a master's degree in business administration in 1981 and pursued a job that would draw on her interest in operations research, statistics, and finance—even though at the time, she recalls, many women with business degrees focused on marketing or personnel.

She soon found a position at a Republic Steel Corporation mill in Masillon, Ohio, where she used a newly installed statistical analysis system to investigate and implement improvements in making steel. "I looked for trends, outliers, and anomalies in the data. When I found something, I worked with industrial engineers and the cost department to gain the trust of mill supervisors and managers and validate what I was finding," Shellabarger recalls. She was transferred to corporate finance headquarters in Cleveland, Ohio, but when Republic Steel closed, she joined United Airlines in Chicago, Illinois.

"I've come to understand policy as making choices. Any time you make a choice, you are making policy."

"I quickly fell in love with aviation, and I have been up to my eyeballs ever since," Shellabarger affirms. At United, she optimized scheduling for pilots and flight attendants, planned for major capital investments, and delivered cost-effective pilot training. She was promoted to controller of flight operations, responsible for overseeing resource allocation for pilots and airplane operation. "Because pretty much everything involves some form of resource allocation, that gave me license to be involved with almost anything that seemed interesting," she comments.

Among the many changes in the aviation industry then were the introduction of the Global Positioning System and the technology that has allowed airplanes to fly far more efficiently—even in bad weather. Shellabarger consulted with airlines and newly privatized air traffic control entities in other countries when United expanded its operation overseas, first across the Pacific and then to Europe and Latin America. She advised the United Nations' International Civil Aviation Organization (ICAO) when it met to revise its guidelines for the user charges levied by international airports and air traffic service providers.

In 1994, Shellabarger attended congressional hearings on the Clinton Administration's proposal to corporatize air traffic control in the United States. Three years later, when a position involving planning and analytical support for some of the same issues at the Federal Aviation Administration (FAA) opened up, she seized the opportunity. Developing a strategic plan for government helped Shellabarger, at the time a self-described Washington outsider, to learn about agency practice and to appreciate the value of long-term research. "I was in the Policy Office, yet I had never had a class in public policy," she notes. "Someone had to explain to me the difference between authorization and appropriation."

As executive director for Aviation Policy and Plans at FAA, Shellabarger chairs the NextGen Review Board and is helping form the administration's Strategy, Budget, and Performance Committee. Her projects have included research into causes of and solutions to airport congestion, a new proposal for restructuring the agency's financing, and a process to auction scarce capacity at constrained airports. In 2008, she finalized a rule on the reduction of fuel tank flammability and currently is finalizing a rule to lessen pilot fatigue. Each year, Shellabarger presents the FAA's Aerospace Forecasts—econometric aviation activity projections for the next 20 years—and guides its annual strategic plan. As the Next Generation Air Transportation System—the comprehensive overhaul of the national airspace system—is implemented, Shellabarger pilots research-backed advances in aviation policy to keep up with the technological changes. She notes that TRB's Airport Cooperative Research Program has provided an important source of information on airport-related issues of concern to practitioners and policy makers.

"I've come to understand policy as making choices. Any time you make a choice, you are making policy," Shellabarger observes. "Often, the type of policy work we do in my office involves setting the framework for a series of choices: what the goals, criteria, and guidelines are; who provides the inputs; and who gets to decide."

Shellabarger often represents FAA at meetings of the TRB Executive Committee and is the U.S. member of ICAO's Air Navigation Service Economics Panel.

How We Travel
A Sustainable National Program for Travel Data

NANCY P. HUMPHREY

The author, who served as the study director, retired in April 2011 as Senior Program Officer, TRB Division of Studies and Special Programs.

Good travel data are essential to support the critical policy choices and multimillion-dollar investments made by decision makers. The travel data available today, however, are inadequate for these tasks.

To develop ways to meet the needs for public and private transportation policy analysis and decision making, the National Research Council of the National Academies appointed a study committee under the auspices of the Transportation Research Board (TRB) and the Committee on National Statistics (see box, page 49). In *Special Report 304: How We Travel: A Sustainable National Program for Travel Data,* the expert committee recommends the organization of a National Travel Data Program built on a core of essential travel data sponsored at the federal level and well integrated with travel data collected by states, metropolitan planning organizations (MPOs), transit and other local agencies, and the private sector.

Data Gaps and Needs

The U.S. transportation system serves hundreds of millions of travelers and handles millions of tons of freight each day, supporting personal goals and domestic and international commerce. As the following examples illustrate, critical data are lacking to inform policies and decisions affecting the system:

◆ A well-functioning transportation system is essential for business travel and tourism, but no national data have been collected since 1995 on long-distance, intercity passenger travel via surface transportation modes.

◆ A strong economy depends on state and regional investments in freight corridors to keep freight moving, but industry-based data on freight shipments, focused on supply-chain links and local goods movement, are not collected. Only coarse national-level data are available on intercity commodity flows.

Photo: North Carolina Department of Transportation

A North Carolina Department of Transportation project replaces road bridges near a railroad switching yard. Critical data are essential to the safety and stability of all U.S. transportation modes—freight, passenger rail, highways, and more.

Photo: Alan Turkus

Passengers check train schedules at New York's Penn Station. System users depend on accurate travel information; data integrated from various modes can be used to measure performance and ensure precision.

◆ Increased energy efficiency and reductions in greenhouse gas emissions from vehicular travel can reduce the transportation sector's adverse environmental impacts, but the data on vehicle use necessary to monitor progress are no longer being collected.

The federal government collects the most comprehensive data through periodic surveys, but the coverage of these surveys is incomplete, the sample sizes sometimes are insufficient to support meaningful analyses, and the results often are not timely. Moreover, because of shifting political priorities, funding for these surveys is at risk for cancellation.

Study Scope

The TRB Executive Committee initiated the study, with funding from TRB, the Research and Innovative Technology Administration (RITA), and the Federal Highway Administration, along with the American Association of State Highway and Transportation Officials through the National Cooperative Highway Research Program. The study committee was charged with assessing travel data collected at the federal, state, and local levels and defining an achievable and sustainable travel data system to support public and private transportation decision making.

The primary goal was to develop a strategy for structuring, conducting, and funding the collection of critical travel data. The study is national in scope, recognizing that travel data are collected and used at multiple geographic levels and by multiple sectors. The approach covers all travel modes, with a focus on measuring the performance of the transportation system as a whole.

Building on a Core

To support the wise use of public resources for transportation, particularly at a time of slow growth and massive budget deficits, a National Travel Data Program should be built on a core of essential travel data collected under federal sponsorship and coordinated with the travel data gathered by states, MPOs, transit and other local agencies, and the private sector. To manage and track the development and implementation of the program, a multiyear plan should be designed to assure Congress, the data partners of the U.S. Department of Transportation (DOT), and constituents that the National Travel Data Program is moving ahead.

U.S. DOT should be responsible for leading the effort, despite past failures to develop a comprehensive and effective travel data program, because these data are essential to its mission. The secretary of transportation should assume a leadership role, with program design and coordination carried out by RITA and its Bureau of Transportation Statistics (BTS), the federal statistical agency for transportation, which already has a mandate for data collection and coordination. A National Travel Data Program Advisory Council, representing major travel data constituencies, should be formed to provide strategic advice directly to the secretary of transportation.

In collaboration with its data partners, RITA should invest in researching and testing new methods for data collection, integration, management, and dissemination. The new methods should include continuous data collection and greater use of technology.

The committee estimated that the additional cost of collecting the required data would be $9 million

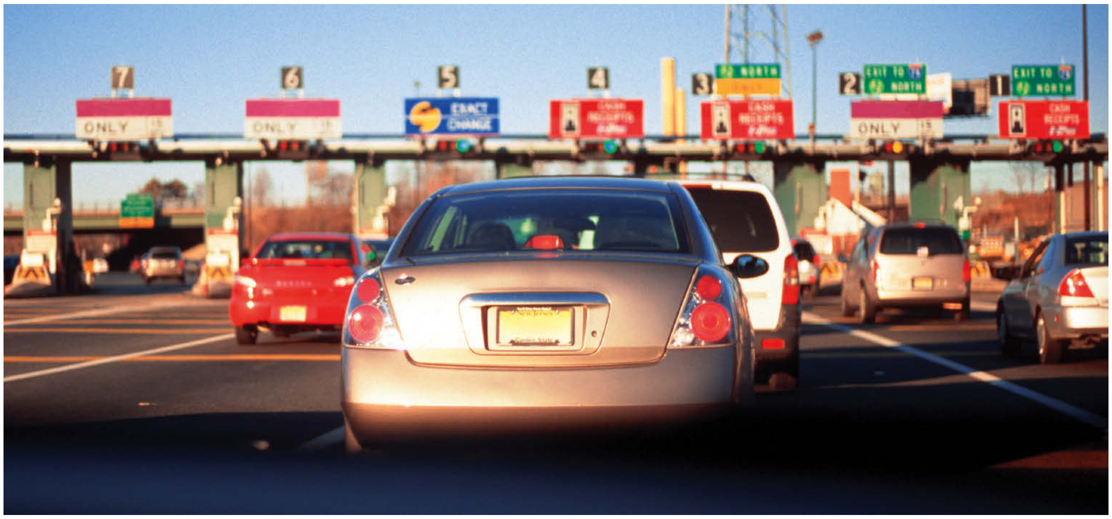


PHOTO: ISTOCKPHOTO

A National Travel Data Program would provide comprehensive, effective data for efficient and better-informed decision making.

to $14 million annually, and additional funds would be needed for BTS to take on the coordinating role. The next reauthorization of surface transportation legislation offers a strategic opportunity to secure the necessary funding.

Detailed Findings and Recommendations

Program Concept

Addressing critical policy and investment issues—particularly in today's constrained funding environment—requires a strategic, interlinked system of passenger and freight travel data. A strong federal role is necessary in organizing and combining travel data from numerous sources into a coherent national program that is well integrated in terms of data architecture—that is, the framework and relational structure—timing, and methods of data collection and sharing.

Collaborations and Partnerships

Developing the next generation of passenger and freight travel data surveys and data collection activities will require the participation and sustained support of many data partners. Private-sector data providers are key, because they generate, aggregate, and disseminate data essential to transportation decisions. They must play an important role in the development of a National Travel Data Program.

U.S. DOT should work cooperatively with public agencies at all government levels, with private-sector data providers, and with professional and nonprofit associations to organize and implement a National Travel Data Program. The proposed program would advance the current travel data collection system by employing more consistent data definitions, stronger quality controls, better integration of data sets, and more strategic use of privately collected data.

A process for working collaboratively and on a continuing basis with states and MPOs is needed, to develop common formats to integrate state and regional travel data and to aggregate the data across jurisdictions for analysis and decision making. Opportunities for partnering with the private sector should be pursued for mutual benefits, to access and use private-sector data, yet protect proprietary interests and leverage private-sector expertise in data collection, aggregation, display, and dissemination.

Organization and Leadership

A successful National Travel Data Program that serves policy makers and planners will require an alignment of leadership, methods, funding, and the understanding of market requirements. U.S. DOT remains the logical and most appropriate agency to spearhead this kind of program, because good national travel data are central to its mission.

The secretary of transportation should assume the leadership role for the proposed National Travel Data Program, to ensure success at the federal level and to affirm that the data needs of U.S. DOT and the nation are met. RITA and BTS have the appropriate mission and mandate to carry out the design and management of the proposed program. Congress

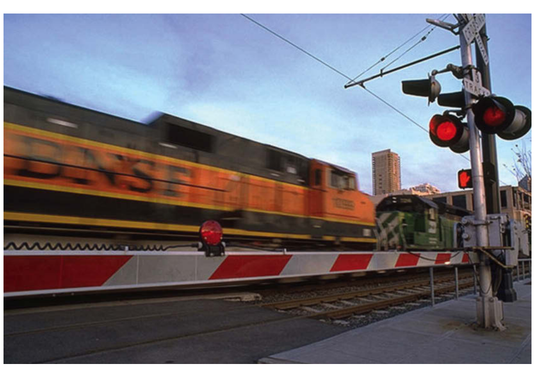


PHOTO COURTESY OF PORT OF SEATTLE

A freight train leaves the Port of Seattle in Washington State. Data sharing between the public and private sectors could prove beneficial to both sides of the transportation industry.

should provide the necessary funding and should hold the department accountable for making progress in developing the needed data.

New Approaches

Realizing the vision of a well-integrated, coordinated National Travel Data Program will require addressing many significant barriers to data collection, integration, and sharing. Traditional methods of collecting data through large-scale, periodic surveys need to be adapted to gain public acceptance and to take advantage of evolving technologies and data collection approaches.

Through BTS and in collaboration with its data partners, RITA should invest aggressively in the design and testing of alternative methods for data collection, integration, management, and dissemination. A major redesign effort, for example, will be required if a new freight survey, focused on the supply chain, is to be mounted and if other gaps in freight travel data are to be filled.

Sufficient and Sustained Funding

Funding for federal travel data programs has been limited, considering the need for data, and has been inconsistent, threatening key program components and causing the elimination of others.

The proposed National Travel Data Program should receive sustained funding for its core activities, which by the committee's estimates would require $150 million to $200 million over the next decade—an average of $15 million to $20 million per year. The proposed funding represents a sustained increase of approximately $9 million to $14 million above current annual federal spending of approximately $6 million on core travel data collection activities.

The funding would support the core national passenger and freight travel data surveys and the recommended design and development effort. In addition, BTS will need funding to fulfill its role in coordinating data and to establish a national clearinghouse and a data archiving function to facilitate data integration. Increased set-asides for data collection by states and MPOs also will ensure effective collaboration among these partners.

Constituent Support

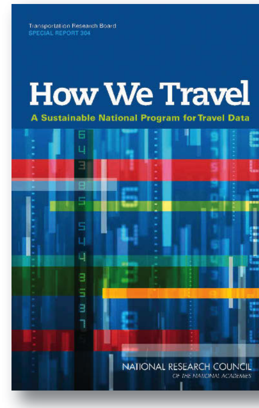
Current federal travel data programs fail to meet all the needs of their customers; moreover, data users are widely dispersed and have no mechanism for voicing their needs. A National Travel Data Advisory Council representing the major travel data constituencies should be formed to provide strategic advice to the secretary of transportation on the design and conduct of the National Travel Data Program and on emerging data needs.

Management and Accountability

An implementation plan establishing action steps, roles and responsibilities, and milestones is needed to ensure accountability to those who fund, develop, and use the National Travel Data Program. U.S. DOT should develop a multiyear plan for implementing the National Travel Data Program in collaboration with data partners; move rapidly to take the steps necessary to put the plan into operation; and report on progress biennially to Congress, its data partners, and its constituents.

Ensuring Better Outcomes

The nation depends on its transportation system. Managing the performance of the system depends on good data, the foundation for prudent and sound decisions. U.S. DOT should make substantial improvements in national travel data to support more effective management of the transportation system. With billions of dollars at stake, the investment of the modest increment in funding to ensure better outcomes, as recommended in this study, is both necessary and prudent.



Special Report 304, *How We Travel: A Sustainable National Program for Travel Data*, is available from the TRB online bookstore, www.trb.org/bookstore; to view the book online, go to http://onlinepubs.trb.org/onlinepubs/sr/sr304.pdf.

Committee on Strategies for Improved Passenger and Freight Travel Data

Joseph L. Schofer, Northwestern University, Evanston, Illinois, *Chair*
Joseph G. B. Bryan, Halcrow, Cambridge, Massachusetts
Anne P. Canby, Surface Transportation Policy Partnership, Washington, D.C.
Anand Desai, Ohio State University, Columbus
Mortimer L. Downey III, Parsons Brinckerhoff, Washington, D.C.
Lance R. Grenzeback, Cambridge Systematics, Inc., Cambridge, Massachusetts
Hermann Habermann, independent consultant, Arlington, Virginia
Timothy A. Henkel, Minnesota Department of Transportation, St. Paul, Minnesota
Charles E. Howard, Jr., Puget Sound Regional Council, Seattle, Washington
James M. Lepkowski, University of Michigan, Ann Arbor
Daniel C. Murray, American Transportation Research Institute, St. Paul, Minnesota
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Photo: Wikimedia Commons

Consumer decisions to purchase plug-in hybrid electric vehicles, like the Chevrolet Volt, may be influenced by social networks, as well as by pricing.

Social Influences Play Role in Mobility Decisions

Little-studied influences on buyer behavior may affect the decision to buy electric vehicles, according to a study by Jonn Axsen and Kenneth S. Kurani of the University of California, Davis. Policy makers predominantly rely on price changes as incentives or disincentives or on sharing information about the benefits of a particular mode of transportation to influence mobility decision making; consumers, however, do not always follow neatly modeled decision-making processes, according to the study.

Using data from consumer surveys, interviews, observation of social networks, and consumer design games, Axsen and Kurani explored the influence of social conditions on a household's values and behavior, particularly how social conditions affect the decision to purchase a vehicle.

The report offers several theoretical perspectives on interpersonal influence—contagion, conformity, dissemination, translation, and reflexivity—and applies these to consumer perceptions of plug-in hybrid electric vehicles (PHEVs), a new technology that can be perceived in various functional and symbolic ways. Interviews with 40 individuals in nearly a dozen different social networks in Northern California allowed researchers to study more than 250 interpersonal interactions in the context of a PHEV demonstration project.

In the study, subjects who were thinking of buying a PHEV consulted many members of their social network—from friends and family to strangers—during the decision-making process. Researchers found that a basic understanding of the vehicles' technology, transitional lifestyles, and shared values were the factors most likely to cause study participants to develop socially and environmentally conscious interpretations of PHEVs. When consulting behavior models, the report notes, policy makers should consider consumer perceptions and social influence.

To see the report, visit http://pubs.its.ucdavis.edu/publication_detail.php?id=1468.

Strategic Lessons from Stimulus-Funded Projects

Florida received $1.7 billion from the 2009 American Recovery and Reinvestment Act (ARRA) transportation stimulus package and spent $1.1 billion in the state's major metropolitan centers such as Central and South Florida, Tampa Bay, and Jacksonville. An analysis of stimulus spending on Florida transportation infrastructure projects by the Collins Center for Public Policy found that the agencies responsible for these projects—Florida Department of Transportation (DOT), transit agencies, and metropolitan planning organizations (MPOs)—employed different approaches.

Author Robert Dunphy, Urban Land Institute, observes that Florida's commitment to infrastructure maintenance allowed agencies to concentrate their stimulus money on new projects, rather than on repairs. He also notes that Florida DOT was able to begin construction soon after the arrival of ARRA funds because much of its project development was completed during the wait for the money. Factors such as a lack of focus on integrative planning and a mandate that projects must be "shovel ready," however, led transit agencies and MPOs to concentrate more on short-term, low-impact rehabilitation than on projects that increased long-term capacity, according to the report.

For more information, visit www.collinscenter.org.

Costs of Trucking on the Rise

Trucking costs have fallen since 2008 but are back on the rise, according to the American Transportation Research Institute (ATRI). An update to a 2008 study analyzed trucking costs in 2009 and the first quarter of 2010. The original survey of truckload, less-than-truckload, and special carriers yielded an average marginal cost per mile of $1.65.

In the updated report, researchers revised the methodology for determining truck speed and for analyzing survey responses about weight; the calculations yielded an average marginal cost per mile of

Photo: Missouri DOT

Trucking costs, on the decline since 2008, are expected to rise.

$1.45 in 2009 and $1.49 in the first quarter of 2010. At an empirically derived average speed of 39.98 mph, trucks incurred average marginal costs per hour of $66.07 in 2008, $58.00 in 2009, and $59.61 in early 2010.

Expenses included driver wages and benefits, fuel and oil costs, vehicle payments, repair and maintenance, insurance premiums, permits and licenses, tires, and tolls. In 2008, fuel costs represented the largest share of total marginal cost (38 percent), but this figure fell to 28 percent in 2009 and to 31 percent in the first quarter of 2010. Concurrently, driver wages and benefits as a share of marginal cost rose from 35 percent in 2008 to 37 percent in 2009 and 2010. After fuel costs and driver wages, vehicle payments comprised the next largest portion of total marginal cost: 13 percent in 2008, 18 percent in 2009, and 16 percent in the first quarter of 2010.

According to the ATRI report, average marginal cost is expected to rise, along with fuel prices and freight demand.

For more information and a copy of the report, visit www.atri-online.org.

Data Analysis Tool Uncovers Flight Anomalies

To prevent flight accidents and examine their causes, analysts often inspect evidence from airplanes' digital data recorders after an accident. But according to Massachusetts Institute of Technology (MIT) professor John Hansman, this approach may obscure important information. Working with Maxime Gariel and Lishuai Li of MIT and Rafael Palacios of Comillas Pontifical University in Spain, Hansman developed a tool that uses cluster analysis to detect flight glitches. The technique filters data into subsets of flights that share common patterns; data outside the subsets are flagged for further inspection.

Researchers tested data from 365 Boeing 777 flights on a now-defunct international airline that took place over one month and had a range of origins and destinations. They took measurements on aircraft position, speed, acceleration, winds, and environmental pressure and temperature at 1-second intervals and then mapped each flight at takeoff and landing.

The team found several flights that deviated from the normal cluster, with anomalies that mostly stemmed from crew actions instead of mechanical problems. One flight took off with significantly less power than the others, an indication of either an incorrect thrust setting or a potential power-systems issue. Another takeoff had erratic pitch behavior, signifying that the pilot had difficulty rotating on takeoff. A third flight was low on approach with an unusually high flap setting that created drag and forced the plane to apply more thrust than usual.

For more information, contact Caroline McCall at cmccall5@mit.edu.

INTERNATIONAL NEWS

Report Finds Flaws in Fleet Renewal Programs

According to a report from the FIA Foundation and the International Transport Forum (ITF), fleet renewal programs in the United States, France, and Germany did not deliver on their environmental and safety promises. Researchers examined major car fleet renewal programs introduced in the three countries to stimulate consumer spending on cars after the 2008 economic crisis, and investigated the impact of 2.8 million automobile trades on emissions of carbon dioxide (CO_2) and oxides of nitrogen (NO_x).


PHOTO: WIKIMEDIA COMMONS

Cars traded-in under the 2009 U.S. Cash for Clunkers program await disposal.

Because many of the older cars in the U.S. car renewal program were destroyed, the report states, societal costs from destroyed assets were nearly $1.4 billion. The monetized value of reductions in CO_2 emissions was less than $7 million in the United States and less than €10 million ($13.7 million) in France and Germany. The impact from NO_x emissions reductions was greater: approximately $430 million in the United States, €300 million ($411 million) in Germany, and €100 million ($137 million) in France. According to the report, this suggests that replacing vehicles older than 15 years reduces the most NO_x emissions; when older cars are replaced with diesel-powered vehicles, the benefit is eroded substantially.

According to the report, the estimated safety effects of the car replacement programs translated to 40 fewer automobile fatalities and 2,800 fewer serious injuries in the United States, 60 fewer deaths and 6,100 fewer injuries in Germany, and 20 fewer deaths and 330 fewer injuries in France.

For more information, contact Hans Michael Kloth at michael.kloth@oecd.org.

SAFETY ON WHEELS—Ken Campbell (*left*), chief program officer for TRB's Second Strategic Highway Research Program (SHRP 2), explains the in-car equipment for the naturalistic driving study to National Public Radio correspondent Joe Palca (*right*). The car, instrumented with cameras and data collection devices to study participants' real-life driving habits, was on display as part of the sixth annual SHRP 2 Safety Research Symposium, July 14–15, 2011, at the National Academies' Keck Center in Washington, D.C. The symposium allowed researchers, contractors, and members of the public to share progress on the naturalistic driving study and other SHRP 2 safety projects.

Social Media Facilitate Research Sharing

In early 2010, the Airport Cooperative Research Program (ACRP) Oversight Committee charged Manager Michael R. Salamone to convene a committee to disseminate the results of program research via electronic media. Committee members, who had direct experience with electronic media, encouraged Salamone to experiment with social media for research sharing. He joined the professional online networking site LinkedIn and began exploring the site's blog and contact features.

LinkedIn soon proved an efficient way to aggregate contacts and share ACRP news and updates. After a year and a half of using the site, Salamone counts 2,500 contacts in the network. Besides providing a portal to respond to requests for information about the program, the site's blog feature provides a platform to post new ACRP publications and announcements—which, when tagged to an RSS feed on TRB's website, can be set to update automatically.

LinkedIn also has streamlined the panel nomination process. Recruiting to fill specific slots on ACRP panels typically can be a time-consuming process, Salamone notes; a Microsoft Outlook add-on allows him to view the

COOPERATIVE RESEARCH PROGRAMS NEWS

Improving Noise Model Accuracy for General Aviation Airports

Although the Federal Aviation Administration has developed and improved its integrated noise model since the 1970s, most of the improvements have focused on the sound level database for large commercial jets. Information from some general aviation airports suggests that the model has overpredicted noise impacts, however, yielding an inaccurate representation of noise contours. The inaccurate noise contours can compromise compatible land use planning and can result in unnecessary and costly noise mitigation measures.

Harris Miller Miller & Hanson Inc. has received a $400,000, 20-month contract [Airport Cooperative Research Program (ACRP) Project 02-37, FY 2011] to assess the predictive accuracy of the integrated noise model for general aviation aircraft, identify the causes of deviations between actual and predicted values, and identify potential improvements to the model.

For further information, contact Joseph D. Navarrete, TRB, 202-334-1649, jnavarrete@nas.edu.

Mitigating the Risk of Disease Transmission at Airports and on Aircraft

Air travel can foster the spread of infectious diseases such as influenza, norovirus, and tuberculosis. A recent TRB symposium on the transmission of disease in airports and on aircraft highlighted gaps in available research; the H1N1 influenza pandemic in 2009 revealed a need for airports and aircraft operators to understand exposure risks and to respond effectively to routine and emerging outbreaks.

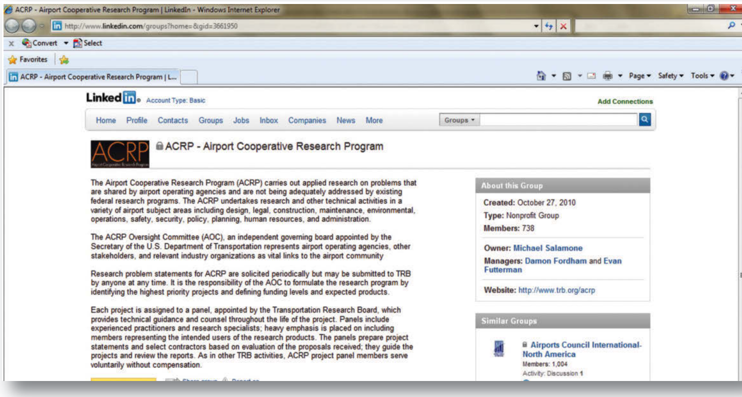
Environmental Health & Engineering, Inc., has received a $199,400, 18-month grant (ACRP Project 02-20A, FY 2011) to determine areas and activities on aircraft and at airports that are at high risk for the spread of human disease, to identify mitigation measures for addressing these risks, and to provide guidance for airports and aircraft operators.

For further information, contact Joseph D. Navarrete, TRB, 202-334-1649, jnavarrete@nas.edu.

Airport Sustainability Practices: Tools for Evaluating, Measuring, and Implementing

Many airports incorporate sustainability practices into their planning, construction, and daily operations but sometimes are met with obstacles including limited resources, lack of evaluation tools, staffing challenges, and inadequate understanding and awareness. A tool is needed to help airports evaluate and select sustainability best practices, as well as a rating system to gauge airport sustainability performance.

Photo: Kansas City Aviation Department



e-mail addresses of LinkedIn contacts in his e-mail and is searchable by job description, title, or name. This allows Salamone and other ACRP staff members to gather the information of potential panel members quickly and efficiently and to contact them at once. He finds that 10 to 15 minutes a day, plus some additional time each week to build connections, is sufficient to keep an active connection to the LinkedIn network.

ACRP also has its own LinkedIn group, which features a discussion board to facilitate discussion about new ACRP publications.

For more information, contact Michael R. Salamone at 202-334-1268 or msalamone@nas.edu.

IN MEMORIAM

Daniel W. (Bill) Dearasaugh, 1936–2011

Daniel W. (Bill) Dearasaugh, retired Engineer of Design with TRB's Technical Activities Division, died August 7, 2011, in Highlands Ranch, Colorado. He was 74.

A U.S. Navy veteran, Dearasaugh started at TRB in 1988 as Senior Program Officer, managing projects for the National Cooperative Highway Research Program (NCHRP). He assisted in the review of many proposals for the Innovations Deserving Exploratory Analysis program of the first Strategic Highway Research Program.

In 1993, Dearasaugh moved to the Technical Activities Division to become Engineer of Design, a position he held until his retirement in October 2001. He was a liaison to many project panels for NCHRP and the Transit Cooperative Research Program, and staff representative for many TRB standing committees. He coordinated the 5th International Bridge Engineering Conference in 2000.

Vanasse Hangen Brustlin, Inc., has received an $800,000, 18-month contract (ACRP Project 02-28, FY 2010) to develop a sustainability practice decision tool for airports, along with a prototype rating system, and to assess industrywide adoption of the system and of a voluntary certification program.

For further information, contact Joseph D. Navarrete, TRB, 202-334-1649, jnavarrete@nas.edu.

Airline and Passenger Choice in Regions with Multiple Airports

In regions with multiple airports, the goals of improving, expanding, and retaining commercial air service—and attracting more passengers—are complicated by the additional choices available to passengers. Air carrier service decisions are based on such considerations as profitability, competition, and perceptions of consumer behavior; passengers select airports based on schedule and reliability, airfare, accessibility, and other criteria. It is important for airports to understand the unique dynamics of a multiairport system.

InterVISTAS Consulting has received a $250,000, 16-month contract (ACRP Project 03-26, FY 2011) to assist airports and their stakeholders in understanding the factors that drive airline service decisions and passenger choice in multiairport regions. The research findings can help set realistic expectations for commercial air service and passenger activity and can focus limited resources on improving, expanding, and retaining service.

For further information, contact Joseph D. Navarrete, TRB, 202-334-1649, jnavarrete@nas.edu.

Performance-Related Specifications for Asphaltic Binders in Surface Preservation Treatments

Although the properties of asphaltic binders are crucial to the performance of surface preservation treatments, the binders often are selected based on availability and other factors not necessarily related to performance—this sometimes leads to stripping and raveling or other distress. Performance-related specifications can provide guidance on long-term quality and can help users select the proper asphaltic binder for a specific application.

North Carolina State University has received a $500,000, 30-month contract (National Cooperative Highway Research Program Project 9-50, FY 2011) to develop performance-related specifications for asphaltic binders used in preservation treatments for large sections of roadway—chip seals, microsurfacing, and slurry seals, for example. Research also will evaluate binder tests and will identify and develop performance tests.

For further information, contact Amir N. Hanna, TRB, 202-334-1432, ahanna@nas.edu.

Photo: Wikimedia Commons

Close-up of an asphaltic concrete layer of a new road under construction.

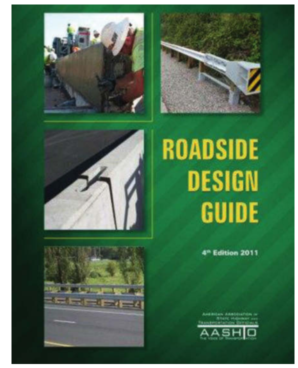
Issues in Commuting and Pilot Fatigue: An Interim Report
Committee on the Effects of Commuting on Pilot Fatigue; National Research Council; National Academies Press, 2011; 40 pp.; $15; 978-0-309-18712-1.

Concerns about the dangerous effects of pilot fatigue in the aviation context have been expressed by airlines and pilots for decades. More recently, however, experts have begun to ask how commuting conducted in a pilot's off-duty time affects fatigue on the job. In this interim report, the National Academy of Sciences reviews available information related to the prevalence and characteristics of pilot commuting; sleep, fatigue, and circadian rhythms; airline and regulatory oversight policies; and pilot and airline practices. The final report will present a review, along with the committee's conclusions and recommendations.

The High Cost of Free Parking
Donald Shoup. American Planning Association (APA), 2011; 765 pp.; APA members, $24.95; nonmembers, $34.95; 978-1-93236-496-5.

First published in 2005, *The High Cost of Free Parking* changed the way many cities managed their parking policies. It is now available in paperback, with a new preface and afterword by the author that highlights parking policy improvements since the book's first publication. Donald Shoup, a professor at the University of California at Los Angeles, argues that parking without paying is neither free nor supportable. The true costs of free parking—subsidizing off-street parking, increased traffic congestion, and distorted urban landscapes—are devastating U.S. cities, Shoup contends. He offers a solution: set the right price for curb parking, return parking revenue to pay for local public services, and remove minimum parking requirements.

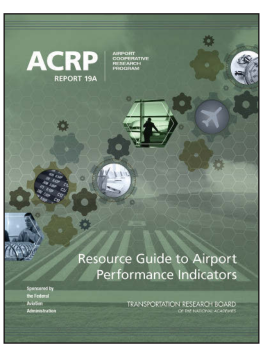
Roadside Design Guide, 4th Edition
American Association of State Highway and Transportation Officials (AASHTO), 2011; 365 pp.; AASHTO members, $180; nonmembers, $216; 1-560-51509-8.



The fourth edition of the *Roadside Design Guide* synthesizes current information and operating practices related to roadside safety. Written in metric and U.S. customary units, this guide has been updated to include hardware that has met the evaluation criteria contained in *National Cooperative Highway Research Program (NCHRP) Report 350: Recommended Procedures for the Safety Performance Evaluation of Highway Features* and details the most current evaluation criteria contained in the 2009 *Manual for Assessing Safety Hardware*. Although much of the material in the guide has universal application, several recommendations are subjective and can be modified for local conditions.

The books in this section are not TRB publications. To order, contact the publisher listed.

TRB PUBLICATIONS



Resource Guide to Airport Performance Indicators
ACRP Report 19A

Explored are airport performance indicators for benchmarking and performance measurement, along with more than 800 performance indicators in three main categories: core indicators, fundamental to the operation of the airport; key indicators, for airport functions and department operations; and other indicators, useful as secondary departmental unit performance indicators but not critical to the airport's function. The print publication includes a CD-ROM of the interactive resource guide (CRP-CD-94).

2011; 279 pp.; TRB affiliates, $64.50; nonaffiliates, $86. Subscriber category: aviation.

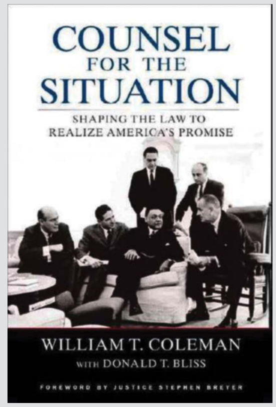
Understanding Airspace, Objects, and Their Effects on Airports
ACRP Report 38

This report presents a comprehensive description of the regulations, standards, evaluation criteria, and processes for protecting the airspace surrounding airports. Aviation practitioners, local planning and zoning agencies, and developers must understand and apply the appropriate airspace design and evaluation criteria to ensure a safe operating environment for aircraft and to maintain airports' operational flexibility and reliability—without unnecessary restrictions on building development and local economic growth.

2010; 156 pp.; TRB affiliates, $46.50; nonaffiliates, $62. Subscriber categories: aviation; policy.

Counsel for the Situation: Shaping the Law to Realize America's Promise

William T. Coleman, Jr., with Donald T. Bliss. Brookings Institution Press, 2010; 450 pp.; $34.95; 978-0-81570-488-1.
Review by Alan E. Pisarski



Although memorable, the tenure of former U.S. Transportation Secretary William T. Coleman, Jr., was a small part of a long and illustrious career. Coleman, who recently celebrated his 90th birthday, has written a memoir with longtime colleague Don Bliss; recounting his work as Secretary during the dramatic months of the Ford Administration may only cover approximately 50 pages of the 450-page book, but it is compelling reading.

Among the extraordinary array of issues addressed by Coleman in 23 months were the decision to permit supersonic transport planes into the United States; granting permission for I-66 access to Washington, D.C.; provisions for airbags in automobiles; full funding of the Washington, D.C., Metro transit system; acceptance of the Big Dig proposal for Boston, Massachusetts; extending women's roles in the U.S. Coast Guard; the desegregation busing plan in Boston; decisions related to the newly created Conrail railroad company; and comprehensive proposals for deregulating all transportation modes.

In 1975, Coleman produced the first *Statement of National Transportation Policy*, followed by *National Transportation: Trends and Choices (to the Year 2000)* in 1977, which sought to establish plans for the policies that Coleman referred to as the most comprehensive basis for decision making since the Gallatin Plan of 1808. This document was updated 25 years later by then-Transportation Secretary Rodney Slater with *The Changing Face of Transportation.* In his last days in office, Coleman addressed departmental organization, administration consolidation, and a modally funded Transportation Trust Fund.

Perhaps most importantly, the book discusses the Coleman method, which might have served as an effective standard procedure for subsequent transportation secretaries. Coleman's decision-making process involved setting down pertinent issues in the *Federal Register*, inviting written responses, and conducting a hearing. He then issued an extensive written brief to present his decision, the reasoning behind it, and his response to any comments. These statements—models of reasoning and clarity—stood many tests in later court actions and legislation. Also noteworthy is a list of rules for a new U.S. Secretary, shared with Coleman by former Attorney General Elliot Richardson.

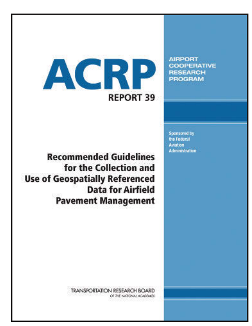
The 2007 recipient of TRB's W. N. Carey, Jr., Distinguished Service Award, Pisarski participated in the activities of the U.S. Department of Transportation during the tenure of U.S. Transportation Secretary William T. Coleman, Jr., working on the Statement of National Transportation Policy *and* National Transportation: Trends and Choices (to the Year 2000). *He is a consultant in private practice in Falls Church, Virginia.*

TRB PUBLICATIONS *(continued)*

Recommended Guidelines for the Collection and Use of Geospatially Referenced Data for Airfield Pavement Management
ACRP Report 39

Data on pavement structure, condition, traffic, climate, maintenance actions, and testing and evaluation are essential for the effective management of airfield pavements; airports regularly collect these data as part of their pavement management systems. Data collections often differ, however, in their definition and format among agencies, making the data difficult to interpret and use. State-of-the-art data collection technologies and processes—for example, employing the capabilities of the Global Positioning System—have not yet been applied effectively in collecting airfield management systems data. This report recommends guidelines for agencies in collecting and using geospatially referenced data.

2010; 100 pp.; TRB affiliates, $39.75; nonaffiliates, $53. Subscriber categories: aviation; data and information technology.



Airport Curbside and Terminal Area Roadway Operations
ACRP Report 40

The authors present a cohesive approach to analyzing traffic operations on airport curbside and terminal area roadways. Examined are operational

TRB PUBLICATIONS *(continued)*

performance measures and methods of estimating the measures. The report introduces a quick analysis tool for curbside operations and low-speed roadway weaving areas, highlights techniques for estimating traffic volumes, and presents common ways of addressing operational problems.

2010; 73 pp.; TRB affiliates, $35.25; nonaffiliates, $47. Subscriber categories: aviation; design; operations and traffic management.

Guide to the Decision-Making Tool for Evaluating Passenger Self-Tagging
ACRP Report 41

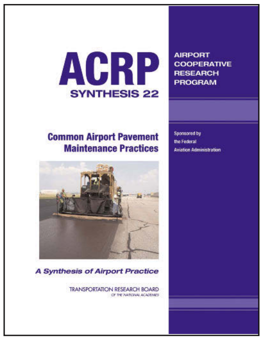
This report provides information and tools to assist airports and airlines in determining whether to pursue passenger self-tagging—if it is allowed in the United States. The decision-making tools can be used to assess passenger self-tagging in relation to organizational needs or the airport's strategic plan. An accompanying CD-ROM includes the tools to input airport-specific information, such as facility size and passenger flows, and provides industry averages to assist airports and airlines that have not yet collected their own information.

2011; 62 pp.; TRB affiliates, $41.25; nonaffiliates, $55. Subscriber category: aviation.

Sustainable Airport Construction Practices
ACRP Report 42

This report explores best practices, methods, and materials for airport construction that may have sustainable and positive economic, operational, environmental, or social effects. The users guide categorizes construction phases and practices by policies and regulations, construction methods, logistics, equipment, surface transportation, reuse and recycling materials, and sustainable materials.

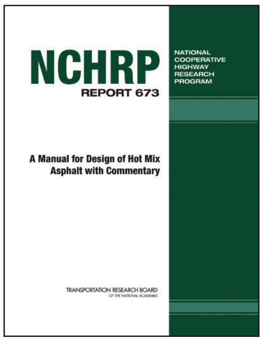
2011; 210 pp.; TRB affiliates, $58.50; nonaffiliates, $78. Subscriber category: aviation.



Common Airport Pavement Maintenance Practices
ACRP Synthesis 22

Every airport operator must maintain airside pavements, using the available budget, for safe and efficient aircraft operation. This synthesis describes current practices in pavement maintenance—pavement condition tracking and inspection, maintenance scheduling, identifying necessary funds, and treating distresses in asphalt and concrete pavements.

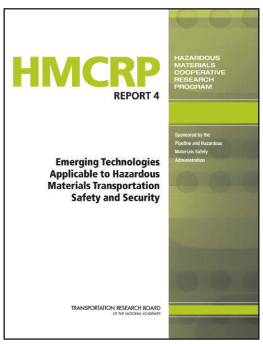
2011; 103 pp.; TRB affiliates, $40.50; nonaffiliates, $54. Subscriber categories: aviation; maintenance and preservation; pavements.



Manual for Design of Hot-Mix Asphalt with Commentary
NCHRP Report 673

This complete, up-to-date reference incorporates advances in materials characterization and hot-mix asphalt (HMA) mix design technology that have been developed since the conclusion of the first Strategic Highway Research Program. Key features include a single mix design method for dense-graded, open-graded, and gap-graded HMA and warm-mix asphalt; tests to estimate potential permanent deformation, fatigue cracking, and low-temperature cracking behavior of mix designs; and integration of mix and structural design with *Mechanistic–Empirical Design Guide* software.

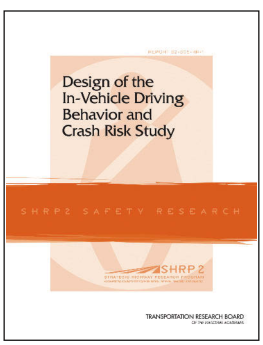
2011; 273 pp.; TRB affiliates, $57; nonaffiliates, $76. Subscriber categories: highways; materials.



Emerging Technologies Applicable to Hazardous Materials Transportation Safety and Security
HMCRP Report 4

For use by shippers, carriers, emergency responders, or government regulatory and enforcement agencies, this report investigates technologies to enhance the safety and security of hazardous materials transportation. Also highlighted are possible technical, economic, legal, and institutional impediments to the development, deployment, and maintenance of these technologies.

2011; 123 pp.; TRB affiliates, $42.75; nonaffiliates, $57. Subscriber categories: aviation; highways; marine transportation; motor carriers; pipelines; railroads; environment; freight transportation; safety and human factors; security and emergencies; terminals and facilities; vehicles and equipment.



Design of the In-Vehicle Driving Behavior and Crash Risk Study
SHRP2 Report S2-S05-RR-1

This report outlines the design for a field study involving at least 2,500 instrumented vehicles operated over a period of 2 to 3 years, and conducted in three to four geographic areas. Included are selection criteria for the study areas, a defined selection plan, and testing procedures for drivers and vehicles that produce a complete, functioning data system and a management and implementation plan for the full study, which will be conducted with volunteer drivers using instrumented vehicles in their daily routines.

2011; 32 pp.; TRB affiliates, $30.75; nonaffiliates, $41. Subscriber categories: highways; safety and human factors.

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FEATURES are timely articles of interest to transportation professionals, including administrators, planners, researchers, and practitioners in government, academia, and industry. Articles are encouraged on innovations and state-of-the-art practices pertaining to transportation research and development in all modes (highways and bridges, public transit, aviation, rail, and others, such as pipelines, bicycles, pedestrians, etc.) and in all subject areas (planning and administration, design, materials and construction, facility maintenance, traffic control, safety, geology, law, environmental concerns, energy, etc.). Manuscripts should be no longer than 3,000 words (12 double-spaced, typed pages). Authors also should provide charts or tables and high-quality photographic images with corresponding captions (see Submission Requirements). Prospective authors are encouraged to submit a summary or outline of a proposed article for preliminary review.

RESEARCH PAYS OFF highlights research projects, studies, demonstrations, and improved methods or processes that provide innovative, cost-effective solutions to important transportation-related problems in all modes, whether they pertain to improved transport of people and goods or provision of better facilities and equipment that permits such transport. Articles should describe cases in which the application of project findings has resulted in benefits to transportation agencies or to the public, or in which substantial benefits are expected. Articles (approximately 750 to 1,000 words) should delineate the problem, research, and benefits, and be accompanied by one or two illustrations that may improve a reader's understanding of the article.

NEWS BRIEFS are short (100- to 750-word) items of interest and usually are not attributed to an author. They may be either text or photographs or a combination of both. Line drawings, charts, or tables may be used where appropriate. Articles may be related to construction, administration, planning, design, operations, maintenance, research, legal matters, or applications of special interest. Articles involving brand names or names of manufacturers may be determined to be inappropriate; however, no endorsement by TRB is implied when such information appears. Foreign news articles should describe projects or methods that have universal instead of local application.

POINT OF VIEW is an occasional series of authored opinions on current transportation issues. Articles (1,000 to 2,000 words) may be submitted with appropriate, high-quality illustrations, and are subject to review and editing.

BOOKSHELF announces publications in the transportation field. Abstracts (100 to 200 words) should include title, author, publisher, address at which publication may be obtained, number of pages, price, and ISBN. Publishers are invited to submit copies of new publications for announcement.

LETTERS provide readers with the opportunity to comment on the information and views expressed in published articles, TRB activities, or transportation matters in general. All letters must be signed and contain constructive comments. Letters may be edited for style and space considerations.

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◆ All manuscripts should be supplied in 12-point type, double-spaced, in Microsoft Word, on a CD or as an e-mail attachment.

◆ Submit original artwork if possible. Glossy, high-quality black-and-white photographs, color photographs, and slides are acceptable. Digital continuous-tone images must be submitted as TIFF or JPEG files and must be at least 3 in. by 5 in. with a resolution of 300 dpi. A caption should be supplied for each graphic element.

◆ Use the units of measurement from the research described and provide conversions in parentheses, as appropriate. The International System of Units (SI), the updated version of the metric system, is preferred. In the text, the SI units should be followed, when appropriate, by the U.S. customary equivalent units in parentheses. In figures and tables, the base unit conversions should be provided in a footnote.

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