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Transportation Research Board

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AIRPORT COOPERATIVE RESEARCH PROGRAM
Sponsored by the Federal Aviation Administration

Responsible Senior Program Officer: Lawrence D. Goldstein

Research Results Digest 19

GRADUATE RESEARCH AWARD PROGRAM ON PUBLIC-SECTOR AVIATION ISSUES UPDATE: 2008–2013

This digest summarizes the results of the Graduate Research Award Program on Public-Sector Aviation Issues (ACRP Project 11-04). This program, sponsored by the FAA and administered by the ACRP, is designed to encourage applied research on airport-related aviation system issues and to foster the next generation of aviation community leaders. Under the program, up to ten awards of $10,000 each are made to full-time graduate students for successful completion of a research paper on public-sector airport-related aviation issues during the academic year. Candidates must be full-time students enrolled in a graduate degree program at a North American accredited institution of higher learning during the academic year. Successful papers are presented at the TRB Annual Meeting following completion of the program, and exceptional papers have been published in subsequent volumes of the *Transportation Research Record: Journal of the Transportation Research Board.* This digest provides initial information for the 2013–2014 academic year, includes abstracts for student papers from the 2012–2013 and 2011–2012 academic years, and lists papers from prior academic years beginning in 2008–2009. Abstracts for the earlier papers are available in *ACRP RRD 14,* which may be accessed online at www.trb.org.

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INTRODUCTION

An original FAA-sponsored, TRB-administered Graduate Research Award Program on Public-Sector Aviation Issues began during the 1986–1987 academic year and continued through 1995–1996. At that time, funds were discontinued and the program was allowed to end. In mid-2007, the program was reintroduced within ACRP beginning with the 2008–2009 academic year, and ACRP funds were allocated to accommodate up to ten annual, individual awards of $10,000 each.[1] The program emphasized that research should be problem-solving and practical, applicable to airports, and useful to airport operators and other airport and aviation industry participants.

Since 2008, to help implement and manage the reinstituted program, a panel of ten experts has included individuals representing the academic world, airport operators, research specialists, private airport/aviation consultants, aircraft manufacturers, FAA liaisons, and state aviation experts.

The composition of the panel may change as individuals rotate and new members join as replacements. Because panel members' expertise cannot be all-encompassing, it was recognized from the outset that additional assistance might be necessary to cover review of topic areas outside of the particular experience of the panel members. Thus, each year, in addition to selection of proposals, the panel

[1]FAA has elected to fund more than ten awards in some years.

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identifies and recruits mentors to assist overseeing the students' research. Mentor participation has proved to be an important asset of the program.

From the beginning, a broad approach to airport and aviation research was incorporated into the program design to meet the objective of stimulating future participation by graduate students in the field. Areas of interest were identified to guide the initial selection of candidates and continue to frame the program. In general, research completed under the program is expected to

- attract the interest of U.S. airport managers and operators;
- address problems that are shared by airport operating agencies but are not adequately addressed by current research efforts, with applied research including problems that airport operators experience but cannot easily solve on their own;
- address broad analytical areas, such as airport development, capital investment, demand forecasting, safety planning, environmental issues, airline/airport interaction, operational and institutional issues and analyses to help inform policy and decision making;
- address airport/airspace system issues, with an emphasis on improving system performance, safety, and security; and
- build on existing research, such as previously completed ACRP research reports that raise additional issues not funded by the completed research efforts.

Via an open call for proposals, students enrolled in a full-time graduate program leading to a degree in a subject related to airports and aviation are invited to submit applications. Students are encouraged to select a research topic that will contribute to completion of their degree requirements. A detailed application form is offered through the TRB website. Submission requirements include details about the student's background; long-term career goals; writing samples; past academic achievements; and, of major importance, recommendations from academic advisors and others familiar with the student's work.

In 2008, solicitation of applications began during the spring, with the first group of students selected early that summer. Subsequent program solicitations have begun early each calendar year, with submissions due in late spring. Selections are made during the summer, in time for program initiation with the beginning of each new academic year. Student participants are invited to attend the TRB Annual Meeting. In the years since the program reemerged, 61 students have participated representing 38 different universities (Table 1).

Table 1 Universities represented in the Graduate Research Award Program since 2008.

1. Arizona State University	20. The University of Oklahoma
2. Carnegie Mellon University	21. University of Arkansas
3. Cranfield University–Bedfordshire, United Kingdom	22. University of California, Berkeley
4. Embry-Riddle Aeronautical University	23. University of California, Irvine
5. George Mason University	24. University of California, San Diego
6. Georgia Institute of Technology	25. University of Connecticut
7. Harvard University	26. University of Illinois at Urbana–Champaign
8. Johns Hopkins University	27. University of Maryland, College Park
9. Massachusetts Institute of Technology	28. University of North Dakota
10. Mississippi State University	29. University of Pennsylvania
11. Missouri University of Science and Technology	30. University of South Florida
12. Northcentral University	31. University of Tennessee, Knoxville
13. Oregon State University	32. University of Texas at Austin
14. Purdue University	33. University of Toledo
15. Southern Illinois University, Carbondale	34. Utah State University
16. Stanford University	35. Vanderbilt University
17. Texas A&M University	36. Villanova University
18. Texas State University, San Marcos	37. Wake Forest University School of Law
19. The George Washington University	38. Washington University in St. Louis

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ACADEMIC YEAR 2013–2014

Applications for the academic year 2013–2014 were due in May 2013. Thirty-seven submissions were received from students representing 28 different universities. The applicant pool included 30 PhD candidates and 7 master's degree candidates. The selection panel met in Washington, D.C., for 2 days in August to evaluate the submittals. Ten applicants were selected, each of whom will receive a stipend of $10,000 for successful completion of a research paper on the subject chosen by the applicant (Table 2).

At publication of this *Research Results Digest*, students were preparing the initial scopes of work to guide their research throughout the academic year. Following submission, completed papers will once again be considered for presentation at the TRB Annual Meeting and outstanding papers will be considered for publication in an upcoming volume of the *Transportation Research Record*.

The program has recently initiated a process to survey past student participants, panelists, mentors, and student advisors to determine how many students have continued in the field of aviation, where they are working, and what positions they currently hold. The first step in that process was completed in late 2012/early 2013 and resulted in a summary of current positions and status of more than 40 past student participants. At that time, status ranged from continuing to complete graduate degrees to serving as assistant professors, working in airport operation, serving in the legal profession, and other broad disciplines. In the future, this outreach effort will also include steps to expand knowledge of the program at universities that sponsor graduate research in aviation and related fields.

Table 2 Research papers selected for academic year 2013–2014.

Student	Degree	Research Topic	University
Sarah-Blythe Ballard	PhD	Air shows in the U.S.: Airport safety and crash epidemiology, 1993–2012	Johns Hopkins University
Sophine Clachar	PhD	Identifying and Analyzing Atypical Flights Using Supervised and Unsupervised Approaches	University of North Dakota
Tara Conkling	PhD	Factors Affecting Wildlife Non-Identification Rates in Aviation Strike Reporting	Mississippi State University
Jeffrey J. Eloff	PhD	Airport Infrastructure Investment: Strategic Interaction or Strategic Allocation?	University of Toledo
Makarand Gawade	PhD	Airport Users' Perception Towards "Remote and Virtual" Control Towers at Small Airports	University of South Florida
Maria Chiara Guercio	PhD	Quantifying the Performance of Energy-Conscious Materials in Flexible Airfield Pavements	Villanova
Jaime A. Hernandez-Urrea	PhD	Airfield Pavement Response Due to Heavy-Aircraft Takeoff: Advanced Modeling for Gear Interaction Consideration	University of Illinois at Urbana-Champaign
Evan D. Humphries	Master's	An Evaluation of Pavement Preservation and Maintenance Activities at Small- and Medium-Sized Airports in Texas: Current Practices, Perceived Effectiveness, Costs, and Planning	Texas State University, San Marcos
Paulos Ashebir Lakew	PhD	Airport Traffic and Metropolitan Economies: Determinants of Passenger and Cargo Traffic	University of California, Irvine
Richard Penn	Master's	A Comparison of Airlines' Real-Time Flight Delay and Cancellation Notifications	Georgia Institute of Technology

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ACADEMIC YEAR 2012–2013

Applications for the academic year 2012–2013 were due in May 2012. Thirty-eight submissions were received from students representing 28 different universities. The applicant pool included 29 PhD candidates and 9 master's degree candidates. The selection panel met in Washington, D.C., for 2 days in the summer to evaluate the submittals. Ten applicants were selected, each of whom would receive a stipend of $10,000 for successful completion of a research paper on the subject chosen by the applicant (Table 3).

Table 3 Research papers selected for academic year 2012–2013.

Student	Degree	Research Topic	University
Derek Doran	PhD	An Analytic Model of Airport Security Checkpoint Screening Times	University of Connecticut
Benjamin Jeffry Goodheart	PhD	Identification of Causal Paths and Prediction of Runway Incursion Risk Using Bayesian Belief Networks	Embry-Riddle Aeronautical University
Susan L. Hotle	PhD	The Role of Competitor Pricing on Multi-Airport Choice	Georgia Institute of Technology
Alexandre Jacquillat	PhD	Congestion Mitigation at JFK: The Potential of Schedule Coordination	Massachusetts Institute of Technology
James C. Jones Jr.	PhD	Methods for Curbing the Exemption Bias in Ground Delay Programs Through Speed Control	University of Maryland, College Park
Yi-Hsin Lin	Master's	Prediction of Terminal-Area Weather Penetration Based on Operational Factors	Massachusetts Institute of Technology
Yi Liu	PhD	Ground Delay Program Performance Evaluation	University of California, Berkeley
Parth Vaishnav	PhD	Low-Hanging Fruit? The Costs and Benefits of Reducing Fuel Burn and Emissions from Taxiing Aircraft	Carnegie Mellon University
Thomas A. Wall	PhD	Exploring the Use of Egocentric Online Social Network Data to Characterize Individual Air Travel Behavior	Georgia Institute of Technology
Amber Woodburn	PhD	Airport Capacity Enhancement and Flight Predictability	University of Pennsylvania (current); University of Tennessee, Knoxville (former)

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PAPERS SCHEDULED FOR PUBLICATION 2012–2013

At publication of this *Research Results Digest*, final versions of papers submitted in September 2012 have been reviewed and accepted for publication in the *Transportation Research Record: Journal of the Transportation Research Board, No. 2400*. Papers are now undergoing final edits and will be published in early 2014. The following copy presents abstracts for the candidate papers. For each paper, the names that follow the lead (student) author represent the student's academic advisers and others who made specific contributions to the paper.

1. An Analytic Model of Airport Security Checkpoint Screening Times

Derek Doran, Swapna Gokhale, and Nicholas Lownes

Abstract. Security checkpoints at airports across the United States are essential to prevent passengers from boarding airplanes with dangerous weapons, explosives, and other threats, but the multiple screening technologies and different speeds of passengers lead to unpredictable and sometimes long waiting times. Security agencies and airport managers must thus find ways to minimize checkpoint screening times without compromising the security of aviation transportation. This paper introduces an analytic model that derives the distribution of completion times for passengers through a security checkpoint given its architecture, passenger profiles, and expected service times at different checkpoint components. By varying the model's parameters and checkpoint architecture, security agencies and airport managers can quickly understand how the end-to-end completion times of passengers are affected by policy changes and checkpoint reconfigurations. The model can also be used to forecast the performance of future checkpoint architectures utilizing new components and policies. The utility of the model is demonstrated by analyzing a prototypical security checkpoint.

2. Identification of Causal Paths and Prediction of Runway Incursion Risk Using Bayesian Belief Networks

Benjamin Jeffry Goodheart

Abstract. In the United States and worldwide, runway incursions are acknowledged as a critical concern for aviation safety. Nonetheless, the rate at which these events occur in the United States has steadily risen. Analyses of runway incursion causation have been made, but these are frequently limited to discrete events and do not address the dynamic interactions that lead to breaches of runway safety. This paper emphasizes the need for cross-domain methods of causation analysis applied to runway incursions in the United States. A holistic modeling technique using Bayesian belief networks to interpret causation in the presence of sparse data is outlined, with intended application at the systems level. Further, the importance of investigating runway incursions probabilistically and incorporating information from human factors and technological and organizational perspectives is supported. A method for structuring Bayesian networks using quantitative and qualitative event analysis in conjunction with structured expert probability estimation is outlined and results are presented for propagation of evidence through the model as well as causal analysis. The model provides a dynamic, inferential platform for future evaluation of runway incursion causation. The results in part confirm what is known about runway incursion causation, but more importantly they shed light on multifaceted causal interactions in a modeling space that allows causal inference and evaluation of changes to the system in a dynamic setting. Suggestions for future research are discussed, most prominent of which is that this model allows for robust and flexible assessment of mitigation strategies within a holistic model of runway safety.

3. The Role of Competitor Pricing on Multi-Airport Choice

Susan L. Hotle and Laurie A. Garrow

Abstract. This paper investigates how competitors' low fare offerings in multi-airport regions influence customers' online search behavior at a major carrier's website. Clickstream data from a major U.S. airline is combined with detailed information about competitors' low fare offerings for 10 directional markets. A truncated negative binomial model was used to predict the number of searches on the carrier's website as a function of low fare offerings in the same airport pair, as well as competing airport pairs in the region. The number of searches was found to decrease as the difference between the carrier's lowest fare and competitors' lowest fare increases.

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Trip characteristics, however, were found to have a larger impact on search behavior than the fare variables. Overall searches on the carrier's website were limited, with less than 5% of customers searching for fares across multiple airports. The findings provide insights into the role of competitor pricing on multi-airport choice, as it relates to customers' online search behaviors.

4. Congestion Mitigation at JFK: The Potential of Schedule Coordination

Alexandre Jacquillat and Amedeo R. Odoni

Abstract. With the large growth in air traffic experienced over past decades, airport capacity has become an increasingly costly constraint. Flight delays reached record-high levels in 2007, with a nationwide impact estimated at over $30 billion for that calendar year. At airports where capacity expansion and improvements in operational efficiency are not feasible, congestion could be mitigated in the short- and medium-term through the implementation of schedule coordination mechanisms. Such measures essentially reduce peak-hour scheduling levels. On the other hand, they have also been criticized for the constraints they might create on airline scheduling. This paper presents a schedule coordination model that reduces flight delays while minimizing interference with airlines' scheduling, then applies the model to one of the most congested U.S. airports, John F. Kennedy (JFK) International Airport. The analysis suggests that it may be possible to reduce peak arrival and departure delays by over 30% and 50%, respectively, without eliminating any flights, any aircraft connections, and any passenger connections, and without modifying the scheduled time of any flight by more than 30 minutes. This underscores the potential of schedule coordination as a means of achieving substantial congestion cost savings at the busiest U.S. airports. The paper discusses the opportunities and challenges associated with the implementation of such a mechanism.

5. Methods for Curbing the Exemption Bias in Ground Delay Programs Through Speed Control

James C. Jones and David J. Lovell

Abstract. Ground delay programs allow flights originating beyond a specified distance to become exempt from any delay imposed by the program. This exemption leads to a biased allocation that favors longer flights over shorter flights and alters an otherwise fair allocation. This paper presents two algorithms to reduce the exemption bias through speed control. The first algorithm attempts to assign the maximum possible delay achievable through speed control to the exempt flights. The second algorithm begins by prescribing the maximum possible delay to exempt flights but works to improve on this allocation by acting to fill holes in the schedule with speed controlled exempt flights whenever possible. Both algorithms demonstrated considerable delay transfer relative to distance-based ration-by-schedule; however, the second algorithm also revealed some ability to improve throughput.

6. Prediction of Terminal-Area Weather Penetration Based on Operational Factors

Yi-Hsin Lin and Hamsa Balakrishnan

Abstract. Convective weather is known to reduce airspace capacity, but the extent of the impact is not well understood. Understanding how weather impacts terminal area capacity is essential for quantifying the uncertainty in weather forecasts, determining how accurately the weather needs to be forecast for developing an optimal mitigation strategy. Prior research has focused on the overlap between convective weather cells and air routes, but has not sufficiently analyzed the differences that arise due to factors such as aircraft types and pilot behavior. This paper examines the interactions between convective weather and aircraft trajectories in the arrival airspace surrounding Chicago O'Hare International Airport. Case studies based on operational data are used to determine potentially relevant operational factors, and a predictive model is built using these factors to forecast if a flight will pass through hazardous weather. The results of the analysis suggest that these operational factors are secondary compared to the weather itself in determining whether a pilot will deviate from or penetrate hazardous weather.

7. Ground Delay Program Performance Evaluation

Yi Liu and Mark Hansen

Abstract. GDPs are frequently used to keep the U.S. air transportation system safe and efficient. Most previous research on GDPs has focused

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on optimal design and implementation but retrospective performance evaluation has garnered little attention. This research fills this gap by identifying GDP performance criteria, developing associated performance metrics, and evaluating the GDP performance metrics across airports and over time. GDP performance criteria are established and associated performance metrics are specified for five performance goals: capacity utilization, efficiency, predictability, equity and flexibility. By defining multiple performance metrics, this research enables FAA traffic managers and flight operators to review GDP performance after the fact in a comprehensive way and uncover GDP performance trends across airports and over time. Using ADL and ASPM data, historical GDP performance is assessed for SFO and EWR for 2006 and 2011. For both airports, capacity utilization and efficiency scores are high, on average, reflecting the importance that the FAA and flight operator community attach to making effective use of available capacity and keeping air transport efficient and safe. In contrast, predictability performance is weaker and more variable. Lack of consensus on how predictability should be measured or valued could have diminished the importance of predictability in GDP decision making. On average, SFO GDPs have higher capacity utilization and predictability, whereas EWR GDPs are more efficient, equitable, and flexible. Comparing results for 2006 and 2011, GDPs were found to be more predictable, but capacity was less effectively utilized in the later year.

8. Low-Hanging Fruit? The Costs and Benefits of Reducing Fuel Burn and Emissions from Taxiing Aircraft

Parth Vaishnav

Abstract. Aircraft are powered by their main engines while taxiing. This paper estimates the cost and emissions reductions that could be achieved by using tugs, or an electric motor embedded in the landing gear, to propel the aircraft on the ground. The use of tugs would result in a savings of $20 per tonne of carbon dioxide emissions avoided, if the measure were adopted for all domestic flights. Estimates of average net savings for airlines vary from $100 per flight at JFK to a loss of $160 per flight at Honolulu. Electric taxi would save between $30 and $240 per tonne of carbon dioxide emissions avoided. Either approach could reduce carbon dioxide emissions from domestic flights in the United States by about 1.5 million tonnes each year, or about 1.1% of the total emissions in 2006. If the switch were limited to large narrowbody aircraft on domestic service at the busiest airports in the United States, the total reduction in emissions would be 0.5 million tonnes of carbon dioxide annually, accompanied by a savings of $100 per tonne. Air quality benefits associated with lower main engine use were monetized using the Air Pollution Emission Experiments and Policy (APEEP) model, and ranged from over $500 per flight in the New York area to just over $20 per flight in the Dallas/Fort Worth area. The analysis also demonstrates that emissions reductions from different interventions (e.g., single-engine taxi and the use of tugs) are often not independent of each other, and therefore cannot be combined in a simple way.

9. Exploring the Use of Egocentric Online Social Network Data to Characterize Individual Air Travel Behavior

Thomas A. Wall, Gregory S. Macfarlane, and Kari Edison Watkins

Abstract. The rapid growth of online social networking over the past decade has generated tremendous amounts of data about individuals and their social relationships. Recent research studies investigating social relationships and travel behavior have sought connections between individuals' social networks and social-related travel; however, the authors' review of the literature revealed none that has pursued the use of online social networking data to do so. This paper explores the use of online social network data in characterizing individuals' air travel behavior. Data were collected using a web-based survey that gathered information about individuals' air travel history and online social network information, specifically participants' Facebook networks. The data were then analyzed to address a series of hypotheses about the association between online social network characteristics (specifically Facebook) and air travel behavior; in particular, travel distance, leisure-related travel, and trip generation. This study found a positive relationship between the size and distribution of individuals' Facebook social networks and their engagement in air travel, and also the odds that their air travel would be leisure-related or include a leisure component.

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10. Airport Capacity Enhancement and Flight Predictability

Amber Woodburn and Megan Ryerson

Abstract. Justifications for airport capacity enhancements are often framed in terms of delay reductions, but improvements to flight predictability also offer substantial benefit to the health of the aviation system. This paper defines predictability as block time adherence and measured as the difference between scheduled and actual block time. This research quantifies, using historical data, the impact of one airport's infrastructure capacity enhancement on flight predictability. A case study utilizing statistical methodologies, including cluster analysis of NAS days and quantile regression of flights, was used to identify how deployment of the fifth runway at Hartsfield-Jackson Atlanta International Airport impacted arrival flight predictability. In four scenarios, defined according to the level of national airspace strain and terminal airspace weather disruption, inclusion of the fifth runway in the runway configuration was associated with either predictability improvement or predictability degradation. If broad gains are to be made in predictability improvements for the national airspace, then capacity enhancements may offer a limited contribution to what must be a multifaceted solution.

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ACADEMIC YEAR 2011–2012

Applications for the academic year 2011–2012 were due in May 2011. Thirty-one submissions were received from students representing 24 different universities. The applicant pool included 21 PhD candidates and 10 master's degree candidates. The selection panel met in Washington, D.C., for 2 days in late July to evaluate the submittals. Eleven applicants were selected, each of whom would receive a stipend of $10,000 for successful completion of a research paper on the subject chosen by the applicant. For the first time, one stipend was shared by two students who were working together on one study. Completed papers were considered for presentation at the TRB Annual Meeting, and outstanding papers were selected for publication in the *Transportation Research Record: Journal of the Transportation Research Board, No. 2325* (Table 4).

Table 4 Research papers selected for academic year 2011–2012.

Student	Degree	Research Paper	University
Sakib bin Salam	Master's	Is There Still a Southwest Effect?	Oregon State University
Kristin Biondi	Master's	Behavioral Traits and Airport Type Affecting Mammal Incidents with U.S. Civil Aircraft	Mississippi State University
Yi Cao	PhD	Benefit and Trade-Off Analysis of Continuous Descent Approach in Normal Traffic Conditions	Purdue University
Stephen Feinberg	PhD	Dispersion Modeling of Lead Emissions from Piston Engine Aircraft at General Aviation Facilities	Washington University in St. Louis
Donald Katz	PhD	Depeaking Schedules: Beneficial for Airports and Airlines?	Georgia Institute of Technology
Fabrice Kunzi	PhD	Reduction of Collisions Between Aircraft and Surface Vehicles: Conflict Alerting on Airport Surfaces Enabled by Automatic Dependent Surveillance–Broadcast	Massachusetts Institute of Technology
Stephen Remias and Alexander Hainen*	PhD PhD	Leveraging Probe Data to Assess Security Checkpoint Wait Times	Purdue University
Clayton Stambaugh	Master's	Social Media and Primary Commercial Service Airports	Southern Illinois University
Prem Swaroop	PhD	Consensus-Building Mechanism for Setting Service Expectations in Air Traffic Flow Management	University of Maryland
Kleoniki Vlachou	PhD	Mechanisms for Equitable Resource Allocation When Airspace Capacity Is Reduced	University of Maryland

**Shared award*

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PUBLISHED PAPERS 2011–2012

Ten student papers from the 2011–2012 academic year were published in the *Transportation Research Record: Journal of the Transportation Research Board, No. 2325*. The following copy presents abstracts for the published papers. For each paper, the names that follow the lead (student) author represent the student's academic advisors and others who made specific contributions to the paper

1. Is There Still a Southwest Effect?

Sakib bin Salam and B. Starr McMullen

Abstract. The U.S. airline industry is in a period of consolidation through mergers between leading carriers. A number of recent mergers have been approved by the Antitrust Division of the Department of Justice (DOJ), in part because of the presence of Southwest Airlines in the affected markets. In its approval of the mergers, DOJ makes a key assumption that Southwest is unresponsive in its pricing strategy to the reduced competition when its competitors merge. Numerous studies have validated the so-called Southwest effect, through which potential or actual entry into a market by Southwest Airlines is associated with lower market fares. However, considerably less work has examined Southwest's postentry pricing strategies. This study finds that Southwest raised fares more between 2005 and 2010 in markets affected by the Delta–Northwest and US Airways–America West mergers than in other markets. Southwest's fares either decreased or rose by less when the company was facing direct or adjacent competition from a low-cost carrier (LCC). DOJ's approval of Southwest's merger with AirTran, its biggest LCC competitor and strongest deterrent to raising fares in merger-affected markets, raises questions about Southwest's ability to continue as a suitable deterrent to postmerger fare hikes, particularly in the absence of other LCCs in those markets.

2. Behavioral Traits and Airport Type Affecting Mammal Incidents with U.S. Civil Aircraft

Kristin M. Biondi

Abstract. Wildlife incidents with aircraft are estimated to have cost the U.S. civil aviation industry more than $1.4 billion in damages and lost revenue from 1990 to 2009. Mammal incidents are five times as likely to cause damage as other wildlife incidents. The behavioral traits, the size of mammal species, and the differences in mammal management techniques may produce incident variation. The FAA National Wildlife Strike database (1990 to 2010) was used to characterize and analyze these incidents by airport type: Part 139 certified (certificated) and general aviation (GA). Relative hazard scores were generated for the species most frequently involved in incidents on the basis of damage and effect on flight. Incidents were found to be most frequent in October (n = 215) at certificated airports and in November (n = 111) at GA airports, but more incidents were reported in August (n = 310) at all airports. Most (63.2%) incidents at all airports (n = 1,523) occurred at night, but the greatest incident rate occurred at dusk (177.3 incidents per hour). Certificated airports had more than twice as many incidents as GA airports and other airports, but more incidents with damage (n = 1,594) occurred at GA airports (38.6%) than at certificated airports (19.0%) or other airports (n = 1.76%). Overall, the relative hazard score increased with increasing log body mass. From these findings, it is recommended that biologists evaluate mammal species on airport grounds on the basis of aircraft hazard information provided here and consider prioritizing management strategies that emphasize reducing the occurrence of species on airport property.

3. Benefit and Trade-Off Analysis of Continuous Descent Approach in Normal Traffic Conditions

Yi Cao, Daniel DeLaurentis, and Dengfeng Sun

Abstract. The continuous descent approach (CDA) has long been known as a fuel-efficient procedure because it eliminates level flights at low altitudes. However, many studies that examine fuel savings fail to consider the increased separation uncertainties that accompany CDA and that may cause extra fuel consumption for safe spacing. This study evaluates the fuel benefits of CDA at Hartsfield–Jackson Atlanta International Airport in Georgia and takes into account the delays that result from conflict resolutions. Fuel burn is estimated by using a corrected thrust-specific fuel consumption model that is designed specially for descent. The conflict-free CDAs are determined in such a way that total arrival delays are minimized in each look-ahead time window. Resultant delays

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are converted to speed advisory or air-holding commands executed in cruise phase to account for the impact of increased separations in CDAs. The fuel consumption of CDA is compared with that of real step-down trajectories extracted from radar track data. Results show that executing CDA to avoid conflicts does not guarantee fuel savings for individual arriving flights, but overall fuel consumption at the airport is reduced. The estimated fuel savings is less than that observed in the terminal airspace only because deconfliction entails extra fuel consumption for delay absorption beyond the immediate terminal airspace.

4. Dispersion Modeling of Lead Emissions from Piston Engine Aircraft at General Aviation Facilities

Stephen N. Feinberg and Jay R. Turner

Abstract. In 2008, the national ambient air quality standard (NAAQS) for lead was tightened by an order of magnitude. General aviation is now the largest source of lead emitted to the atmosphere. The accuracy of modeled lead impacts from general aviation airports is unclear because of uncertainties in both emissions estimation and dispersion modeling. Aviation industry and environmental policy makers must understand how well such modeling can perform when data on aircraft activities at an airport are limited. To estimate the lead impacts at an airport with lead monitoring, this study used aggregate activity information and simple assumptions about the nature of activities; the goal was to evaluate the level of accuracy that could be achieved in the collection of data on lead emissions. Dispersion modeling of general aviation lead emissions was performed for Centennial Airport, Englewood, Colorado, to estimate near-field impacts from airport operations in 2011. Emissions were estimated with the use of FAA's Air Traffic Activity System and Emissions and Dispersion Modeling System. The annual emission estimate for 2011 was 0.43 ton, much lower than the 0.73 ton estimated by the 2008 National Emissions Inventory. Sensitivity analyses were conducted by varying several emission parameters. Modeled concentrations at the on-site lead sampler were quite sensitive to the amount of run-up emissions. Concentrations modeled with Automated Surface Observing System meteorology have greater correlation with on-site measured values than those modeled with integrated surface hourly meteorology. Three-month average impacts modeled at the on-site lead-sampling location ranged from 10 to 20 ng/m^3, well below the lead NAAQS of 150 ng/m^3.

5. Depeaking Schedules: Beneficial for Airports and Airlines?

Donald Katz and Laurie A. Garrow

Abstract. After deregulation, many U.S. airlines created hubs with banked schedules. However, in the past decade, these same airlines began to experiment with depeaking their schedules to reduce costs and to improve operational performance. Little research has investigated revenue shifts associated with depeaked schedules, yet an understanding of the tradeoffs between revenue, costs, and operational performance at a network level is critical before airlines will consider further depeaking and related strategies for managing congestion. This paper develops data-cleaning and data analysis methodologies that are based on publicly available data used to quantify airport- and network-level revenue changes associated with schedule depeaking. These methodologies are applied to a case study of Delta's depeaking at the airport in Atlanta, Georgia. Results show that this depeaking was associated with Delta's revenue increasing slower than that for the rest of the network and the industry as a whole but that the depeaking could have been profitable if costs had been cut to a sufficient degree. The Atlanta airport likely benefits from the increase in connection time. The methodologies developed in this paper can be extended to other depeaking cases to provide a comprehensive assessment of revenue shifts and to understand airport and network characteristics that are most conducive to schedule depeaking.

6. Reduction of Collisions Between Aircraft and Surface Vehicles: Conflict Alerting on Airport Surfaces Enabled by Automatic Dependent Surveillance–Broadcast

Fabrice Kunzi

Abstract. Automatic dependent surveillance–broadcast (ADS-B) will be the basis of future surveillance systems in the United States as well as in many

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other countries. The more frequent and more accurate information available with ADS-B could improve the performance of conflict-alerting systems for vehicles operating on airport surfaces. Ten years of National Transportation Safety Board (NTSB) and Aviation Safety Reporting System (ASRS) airport surface accident reports were reviewed, and four encounter scenarios representing the most commonly observed interactions between aircraft and airport surface vehicles were created. A concept of operation was then defined for how an ADS-B–based alerting system could take advantage of ADS-B–specific information to generate alerts in each of those four encounter scenarios. Through the use of historical ADS-B data from the Boston, Massachusetts; Philadelphia, Pennsylvania; and Louisville, Kentucky, airports, proof of concept was established. The concepts show promise in reducing the uncertainty in alerting systems that is present because of lack of knowledge of the intent of the operator. Instead of guessing at future states by propagating trajectories, an alerting system would compare expected behavior to actual behavior and alert personnel if a deviation were observed.

7. Leveraging Probe Data to Assess Security Checkpoint Wait Times

Stephen M. Remias, Alexander M. Hainen, and Darcy M. Bullock

Abstract. The process of traveling to an airport, passing through various processes, and ultimately departing the airport involves many activities. This paper focuses on the use of probe data obtained from phones with discoverable Bluetooth devices to sample the time needed for passengers to travel from the nonsterile to the sterile side of an airport facility. To collect these data, the Kenton County Airport Board partnered with Purdue University to conduct a study at the Cincinnati–Northern Kentucky International Airport, Hebron, over a 4-week period during the 2011 Thanksgiving holiday. Bluetooth monitoring stations (BMSs) were used to collect unique identifiers from approximately 46,000 devices and to compute more than 1.5 million travel times between 17 BMSs. With a Pareto distribution approach, hourly security wait times were ordered, and a methodology was developed to identify periods for which opportunities might exist to reduce wait times (relative to a specified maximum wait time) by opening more security lanes, as well as periods for which opportunities might exist to reduce the number of lanes operating. With this methodology, it was determined that only 5 hours during the study period had median wait times of greater than 20 minutes during November 2011. The paper concludes by discussing how this technique can be used to perform longitudinal comparisons between airports as additional airports begin automating the collection of checkpoint wait times.

8. Social Media and Primary Commercial Service Airports

Clayton Lee Stambaugh

Abstract. Throughout the past decade, the aviation industry in the United States has continually encountered significant socioeconomic burdens. Most notably, the tragic events of September 11, 2001, left the industry highly susceptible to economic turmoil, such as the global recession accentuated by record-high fuel prices, as well as sociological events like the world pandemic in the form of severe acute respiratory syndrome. The nation's airports, the infrastructure supporting this industry, are no exception. In conjunction with these onerous events, continuing cuts in intergovernmental funding sources, as well as weakened revenue streams, have forced airports to use contemporary tools, strategies, and techniques to reinforce traditional management functions. The use of social media platforms, such as blogs, Facebook, Twitter, YouTube, and Foursquare, is a growing trend throughout various public and private industries to increase effectiveness, efficiency, and overall yield in relation to marketing and communication strategies. Consistent with new public management techniques and the reinvention of government in the 1980s, conducive to cost efficiency and customer-centric approaches, airports use social media to increase self-sufficiency by reducing expenditures associated with traditional marketing and communication modes. In addition, social media technologies enable airports to target, engage, and foster two-way communication more effectively with a multitude of audiences. This study provides an overview of these popular social media services and empirically examines, both quantitatively and qualitatively, the current usage of social media throughout primary commercial service airports. Statistics on airport usage and best practices

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are provided to support preliminary guidance on the use of social media at airports.

9. Consensus-Building Mechanism for Setting Service Expectations in Air Traffic Flow Management

Prem Swaroop and Michael O. Ball

Abstract. A significant challenge of effective air traffic flow management (ATFM) is to allow various competing airlines to collaborate with an air navigation service provider (ANSP) in determining flow management initiatives. Over the past 15 years, this challenge has led to the development of a broad approach to ATFM known as collaborative decision making (CDM). A set of CDM principles has evolved to guide the development of specific tools that support ATFM resource allocation. However, these principles have not been extended to cover the problem of providing strategic advice to an ANSP in the initial planning stages of traffic management initiatives. This paper describes a mechanism in which competing airlines provide consensus advice to an ANSP by means of a voting mechanism. The mechanism is based on the recently developed majority judgment voting procedure. The result of the procedure is a consensus real-valued vector that must satisfy a set of constraints imposed by the weather and traffic conditions of the day in question. Although this problem was developed and modeled on the basis of specific ATFM features, it appears to be highly generic and amenable to a much broader set of applications. Analysis of this problem involved several interesting subproblems, including a type of column generation process that created candidate vectors for input to the voting process.

10. Mechanisms for Equitable Resource Allocation When Airspace Capacity Is Reduced

Kleoniki Vlachou and David J. Lovell

Abstract. During bad weather and under other capacity-reducing restrictions, FAA uses various initiatives to manage air traffic flow to alleviate problems associated with imbalanced demand and capacity. A recently introduced alternative concept to airspace flow programs is the collaborative trajectory options program, in which aircraft operators are allowed to submit sets of alternative trajectory options for their flights, with accompanying cost estimates. It is not clear that these sets of alternative trajectory options can be generated or evaluated quickly enough to respond to flow programs that arise unexpectedly or that the program is intended to be folded into a formal resource allocation mechanism. This research proposes (*a*) a meaningful, yet simple, way for carriers to express some preference structure for their flights that are specifically affected by flow programs and (*b*) a resource allocation mechanism that will improve system efficiency and simultaneously take these airline preferences into account. The results are compared with the events that could occur if an airspace flow program were run by using a ration-by-schedule approach, with or without the opportunity for carriers to engage in swaps among their own flights.

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ACADEMIC YEAR 2010–2011

For the academic year 2010–2011, the panel received 31 submissions from students representing 25 different universities. The applicant pool included 23 PhD candidates and 8 master's degree candidates. Ten applicants were selected, each of whom would receive a stipend of $10,000 for successful completion of a research paper on the subject chosen by the applicant. Of the ten students selected, seven were PhD students and three were master's degree students. All ten student papers from the 2010–2011 academic year were published in the *Transportation Research Record: Journal of the Transportation Research Board, No. 2266.*

In the list that follows, the name of the student author appears first, followed by the degree earned (in parentheses), the names of academic advisors or others who made specific contributions to the paper, the name of the university, and the title of the final paper as published in the *Transportation Research Record*. Abstracts of these papers are available in *ACRP Research Results Digest 14*, which can be accessed online at www.trb.org by searching on "ACRP RRD 14."

1. Regina R. L. Clewlow (PhD), Joseph M. Sussman, and Hamsa Balakrishnan, Massachusetts Institute of Technology: Interaction of High-Speed Rail and Aviation: Exploring Air–Rail Connectivity.
2. Francisco Evangelista, Jr. (PhD), Jeffrey R. Roesler, and C. Armando Duarte, University of Illinois, Urbana–Champaign: Prediction of Potential Cracking Failure Modes in Three-Dimensional Airfield Rigid Pavements with Existing Cracks and Flaws.
3. Josephine D. Kressner (PhD) and Laurie A. Garrow, Georgia Institute of Technology: Lifestyle Segmentation Variables as Predictors of Home-Based Trips for Atlanta, Georgia, Airport.
4. Sameer Kulkarni (Master's), Rajesh Ganesan, and Lance Sherry, George Mason University: Dynamic Airspace Configuration Using Approximate Dynamic Programming: Intelligence-Based Paradigm.
5. James K. D. Morrison (Master's), Brian Yutko, and R. John Hansman, Massachusetts Institute of Technology: Transitioning the U.S. Air Transportation System to Higher Fuel Costs.
6. Quentin Noreiga (PhD) and Mark McDonald, Vanderbilt University: Parsimonious Modeling and Uncertainty Quantification for Transportation Systems Planning Applied to California High-Speed Rail.
7. Jeffrey J. Stempihar (PhD), Mena I. Souliman, and Kamil E. Kaloush, Arizona State University: Fiber-Reinforced Asphalt Concrete as a Sustainable Paving Material for Airfields.
8. Vikrant Vaze (PhD) and Cynthia Barnhart, Massachusetts Institute of Technology: Airline Frequency Competition in Airport Congestion Pricing.
9. Jinfeng Wang (PhD) and Edwin E. Herricks, University of Illinois, Urbana–Champaign: Risk Assessment of Bird–Aircraft Strikes at Commercial Airports: Submodel Development.
10. Kai Yin (Master's), Chunyu Tian, Bruce X. Wang, and Luca Quadrifoglio, Texas A&M University: Analysis of Taxiway Aircraft Traffic at George Bush Intercontinental Airport, Houston, Texas.

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ACADEMIC YEAR 2009–2010

Applications for the academic year 2009–2010 were due in May 2009. Forty-three submissions were received from students representing 28 different universities. The applicant pool included 27 PhD candidates, 15 master's degree candidates, and 1 law degree candidate. Of the 11 students selected, 7 were PhD candidates, 3 were master's degree candidates, and 1 was a law school candidate. As in the first year, each applicant selected would receive a stipend of $10,000 for successful completion of a research paper on the subject chosen by the applicant. FAA provided an additional grant to cover the 11th student so that a research subject of particular interest could be included in the program. As was true for the first year, the completed papers were considered for presentation at the TRB Annual Meeting following submission. All 11 papers were selected for publication in the *Transportation Research Record: Journal of the Transportation Research Board, No. 2206.*

In the list that follows, the name of the student author appears first, followed by the degree earned (in parentheses), the names of academic advisors or others who made specific contributions to the paper, the name of the university, and the title of the final paper as published in the *Transportation Research Record*. Abstracts of these papers are available in *ACRP Research Results Digest 14,* which can be accessed online at www.trb.org by searching on "ACRP RRD 14."

1. Gabriela K. DeFrancisci (PhD), Zhi M. Chen, and Hyonny Kim, University of California, San Diego: Low-Velocity, High-Mass, Wide-Area Blunt Impact on Composite Panels.
2. Douglas Fearing (PhD) and Cynthia Barnhart, Massachusetts Institute of Technology: Evaluating Air Traffic Flow Management in a Collaborative Decision-Making Environment.
3. Ben H. Lee (PhD), Ezra C. Wood, Richard C. Miake-Lye, Scott C. Herndon, J. William Munger, and Steven C. Wofsy, Harvard University: Reactive Chemistry in Aircraft Exhaust: Implications for Air Quality.
4. Brittany L. Luken (PhD) and Laurie A. Garrow, Georgia Institute of Technology: Multiairport Choice Models for the New York Metropolitan Area: Application Based on Ticketing Data.
5. Matthew Manley (PhD), Yong Seog Kim, Keith Christensen, and Anthony Chen, Utah State University: Modeling Emergency Evacuation of Individuals with Disabilities in a Densely Populated Airport.
6. Boo Hyun Nam (PhD), University of Texas at Austin: Transition of the Rolling Dynamic Deflectometer Device from a Screening Tool to an Evaluation Tool for Rigid Airfield Pavement Projects.
7. Nagesh Nayak (Master's degree) and Yu Zhang, University of South Florida: Estimation and Comparison of Impact of Single Airport Delay on National Airspace System with Multivariate Simultaneous Models.
8. Dominique M. Pittenger (Master's), University of Oklahoma: Evaluating Sustainability of Selected Airport Pavement Treatments with Life-Cycle Cost, Raw Material Consumption, and Greenroads Standards.
9. Nikolas Pyrgiotis (PhD), Massachusetts Institute of Technology: Public Policy Model of Delays in a Large Network of Major Airports.
10. Maulik Vaishnav (Master's), University of Illinois, Urbana–Champaign: Opportunities and Obstacles in Obtaining Air Connectivity for Residents of Federally Designated Essential Air Service Communities.
11. Timothy R. Wyatt (JD), Wake Forest University School of Law: Balancing Airport Capacity Requirements with Environmental Concerns: Legal Challenges to Airport Expansion.

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ACADEMIC YEAR 2008–2009

During the first year of the program, the application deadline was in June 2008. Twenty-five submissions were received from students representing 18 different universities. The panel met in Washington, D.C. for 2 days in late July to evaluate the submittals. Ten applicants were selected, each of whom would receive a stipend of $10,000 for successful completion of a research paper on the subject chosen by the applicant. Completed papers were considered for presentation at the TRB Annual Meeting, and six outstanding papers were selected for publication in the *Transportation Research Record: Journal of the Transportation Research Board, No. 2184.*

In the list that follows, the name of the student author appears first, followed by the degree earned (in parentheses), the names of academic advisors or others who made specific contributions to the paper, the name of the university, and the title of the final paper as published in the *Transportation Research Record*. Abstracts of these papers are available in *ACRP Research Results Digest 14*, which can be accessed online at www.trb.org by searching on "ACRP RRD 14."

1. Stacey Mumbower (PhD) and Laurie A. Garrow, Georgia Institute of Technology: Using Online Data to Explore Competitive Airline Pricing Policies—A Case Study Approach.
2. Haomiao Huang (PhD) and Claire J. Tomlin, Stanford University: Hybrid System Model of Air Traffic Controller Cognition.
3. Ioannis Simaiakis (PhD) and Hamsa Balakris, Massachusetts Institute of Technology: Impact of Congestion on Taxi Times, Fuel Burn, and Emissions at Major Airports.
4. Christian M. Salmon (DSc), Vahid Motevalli, John Harrald, and Johan René van Dorp, The George Washington University: Quantifying Metrics of External Airport Risk Exposure in Vicinity of Public Use, Nontowered Airports.
5. Daniel Favarulo (MS), George Mason University: Understanding Nonfiscal Barriers to Airport Development and Exploring Federal Policy Solutions.
6. Dan Boedigheimer (PhD), Northcentral University: Exploring the Pilot Reliability Certification Program and Changing Attitudes on Reducing Pilot Errors: Pilots Covered by Federal Aviation Regulations 91 and 135.

The papers of three additional award recipients were published elsewhere:

1. Elizabeth Black (PhD), Missouri University of Science and Technology: Lung Deposition of Jet Engine Exhaust Particulate Matter.
2. Hernando Jimenez (PhD), Georgia Institute of Technology: Strategic Development of Airport Systems for Capacity Enhancement and Environmental Impact Reduction.
3. Adrian Lee (PhD), University of Illinois at Urbana–Champaign: An Optimal, Closed-Loop Passenger Screening Strategy for Enhancing Aviation Security.

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APPENDIX: PROGRAM PARTICIPANTS

The following individuals have served as panel members and mentors and provided oversight of the research program beginning with the 2008–2009 academic year. Their assistance has been invaluable in attracting students, overseeing their research efforts, and preparing documents for presentation and publication.

Panel Members

Active

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