ACRP UNIVERSITY STUDENT PROGRAMS

ACRP Website Improvements Project

Abstracts

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Lung Deposition of Jet Engine Exhaust Particulate Matter

Elizabeth A. Black

ABSTRACT
Particulate matter (PM) from on-road vehicular traffic has been correlated to increases in mortality and morbidity as PM concentrations increase. Like vehicular exhaust PM, jet engine exhaust (JEE) PM falls within the size range of interest when considering health effects. Despite this, no information currently exists on the inhalation health impact of JEE PM. JEE PM has unique properties with respect to deposition, retention kinetics, and clearance pathways in the human respiratory system, and is composed of sizes that readily travel gas streamlines that penetrate the deepest regions of the lung; this is a concern as deposited JEE PM in these regions could potentially cross the blood-membrane barrier and migrate into the bloodstream. Using JEE PM data collected during plume studies performed down-wind of active runways at the Hartsfield-Jackson Atlanta and Oakland International Airports, lung deposition probabilities of JEE PM (as a function of particle size) can be determined using the International Committee of Radiological Protection (ICRP) lung deposition model. Surface area, however, is the characteristic PM parameter most strongly correlated with health impacts. Using the deposition probabilities and size resolved number distributions, a Surface Area Deposition Index (SADI) was developed. This new parameter, SADI, quantizes JEE PM lung deposition as the surface area of deposited PM per kilogram fuel burned. As constructed, SADI allows for equitable comparison among jet engine types while also proving a surface area metric for meaningful health impact correlations. Two interesting conclusions to this preliminary study are that statistically significant differences among engine types are not seen in SADI, and variations in SADI are not correlated with temporal changes or changes in meteorological conditions.

Exploring Pilot Reliability Certification Program and Changing Attitudes on the Reduction of Errors in FAR 91 and 135 Pilots

Dan Boedigheimer

ABSTRACT

The greatest opportunity for further improving aviation safety is to focus on reducing human errors in the cockpit. The purpose of this research was to evaluate if there was knowledge gain and difference in attitudes towards reducing human error in the cockpit after the implementation of the Pilot Reliability Certification (PRC) program at FAR 135 air carriers and FAR 91 corporate flight departments. The PRC program is a human factors training curriculum focused on personal vulnerabilities to human error and countermeasures in support of aviation safety. Three levels of measurement were used; reactions to the training, a knowledge test, and a modified version of the Cockpit Management Attitudes Questionnaire to measure attitude change. A mixed-method approach was used with quantitative data to measure knowledge gain and attitude change along with qualitative data to explore pilot reactions to the training. A quasi-experimental group (n = 41) who completed the two-day PRC course was compared to a control group (n = 62). The control group did not show a significant improvement in attitude related to CRM skills or the PRC objectives. The quasi-experimental group had a significant improvement in attitudes and knowledge gain. Reaction to the training was also positive with pilots citing the largest benefit was a strengthened human factors knowledge base. They felt the training differed from previous human factors training by being more detailed and in-depth. Pilots cited they would be more conscious of evaluating themselves, their flying partners and their attitude after taking the course.

Understanding Non-Fiscal Barriers to Airport Development and Exploring Federal Policy Solutions

Daniel Favarulo

ABSTRACT

Airport development projects are vulnerable to an array of non-fiscal challenges that can significantly delay or prevent projects. Through a survey of twenty airports this research paper identifies the non-fiscal barriers to airport development and provides an analysis of the characteristics and effects each has on the development process. In addition, a thorough literature review as well as meetings with industry professionals and Federal Aviation Administration staff was utilized to further explore these challenges and federal policy solutions. Research findings have revealed that community opposition, political opposition, airport stakeholder opposition, land availability, and environmental requirements are the most frequent non-fiscal challenges to airport development. These non-fiscal challenges have resulted in a lengthy and highly complex process in which runway expansion projects take a significant amount of time to complete. The impact of this on the national aviation system warrants a serious commitment by the federal government to address these non-fiscal challenges. Specifically, the federal government needs to more aggressively tackle these obstacles by expanding programs and reforming policies. By acquiring a better understanding of the non-fiscal challenges to airport development and exploring federal policy solutions, aviation system planners can move closer to achieving capacity, safety, and environmental goals.

A Hybrid System Model of Air Traffic Controller Cognition

Haomiao Huang

ABSTRACT

Increased automation in air traffic control has many benefits, but to safely and effectively incorporate advanced automation tools requires careful analysis of their impact on human controllers. The cognitive psychology and human factors literature have produced many qualitative models that describe the cognitive processes of controllers, as well as a variety of computational models that attempt to directly reproduce the way controllers make decisions. The work presented here uses these results to form a novel hybrid system framework for modeling human cognition, and describes a model of air traffic controller cognition based upon this framework. The thought process is modeled as a set of critical variables that represent the human controller's picture of a given air traffic situation, with the evolution over time of these variables described by a set of hybrid dynamics where the discrete variables correspond to different thought processes and cognitive tasks. The primary contribution of this paper is to place the cognitive model within the formal mathematical framework of hybrid systems theory, allowing verification and online estimation and control to be performed using the tools of hybrid systems.

Strategic Development of Airport Systems for Capacity Enhancement and Environmental Impact Reduction

Hernando Jimenez

ABSTRACT
Enabling the long-term growth of air transportation is a vital endeavor supporting economic development and improving quality of life. However, this growth cannot be sustained if increasing air travel demand is not met with sufficient system capacity enhancements. Moreover, growing traffic volumes and the operational inefficiencies that result from insufficient capacity exacerbate the magnitude of aviation's environmental footprint and further thwart its growth. Though this observation is widely applicable across the entire system, nowhere else is it more pronounced and critical than at airports and their terminal airspace. Recognizing the systemic complexity inherent in airport performance, as well as the operational environmental interrelationship at its core, methodological shortcomings in the traditional strategic airport planning paradigm are inevitably revealed. In particular, the quantitative characterization of complex relationships between airport performance metrics and various exogenous and endogenous factors, as well as relevant terminal area improvements, can be made more transparent and explicit, readily revealing the interactions and sensitivities that provide greater insight and empower both analysts and decision-makers when exploring critical tradeoffs. To achieve this, the proposed methodological improvements leverage on recent advances on airport operations and environmental impact modeling, as well as on established statistical techniques that shed light on the significance of factors of interest and their mutual interactions with respect to airport performance metrics, while observing limitations on analytical and computational resources. The approach is illustrated as applied to Atlanta's Hartsfield-Jackson International Airport, for which a variety of representative results are described in detail.

An Optimal, Closed-Loop Passenger Screening Strategy for Enhancing Aviation Security

Adrian J. Lee

ABSTRACT
Passenger screening at aviation security checkpoints is a critical component in protecting airports and aircraft from terrorist threats. Recent developments in screening device technology have increased the ability to detect these threats; however, the average amount of time it takes to screen a passenger still remains a concern. This paper addresses the queueing process for a multi-level airport checkpoint security system, where multiple security classes are formed through subsets of specialized screening devices. A closed-loop assignment policy is obtained that balances the expected number of true alarms with the expected amount of time a passenger spends in the security system. Performance of a two-class system is compared to that of a security system containing primary and secondary levels of screening, where the selection process for passengers undergoing secondary screening is fine-tuned. The key contribution is that the optimal, closed-loop passenger screening strategy obtained herein allows airport security operations personnel to increase security and passenger throughput by efficiently and effectively utilizing available screening resources.

Using On-Line Data to Explore Competitive Airline Pricing Policies: A Case Study Approach

Stacey Mumbower

ABSTRACT
Since the mid 2000's, the airline industry has seen volatile fuel prices, a record number of carriers ending service, and a merger between two major airlines. In a time of such turmoil in the industry it is increasingly important to understand the relationship between airline consolidation and competitive pricing policies, as this relationship will directly impact the formation of future airline policies associated with competition policy (anti-trust), deregulation, and mergers. However, there is a lack of consensus about market concentration and its influence on airfares, mainly due to data limitations of past research. Given the emergence of on-line booking engines, there is a new opportunity to collect detailed fare data. This project uses disaggregate, on-line airfare data to study the relationship between market concentration and pricing policies. The dataset includes 62 markets that cover a broad range of market structures. A case study approach is used to analyze the data. Using disaggregate fare data, this study finds low price dispersion can be associated with both low and high levels of market concentration. As the day of departure approaches, price dispersion is seen to either increase or decrease, depending on the specific market. Additionally, peak and off-peak periods demonstrate differing pricing strategies. Also, markets with codeshares are shown to sometimes exhibit unusually high price dispersion.

Exposure at the Airport/Community Interface
Quantifying Metrics of Exposure in the Vicinity of Public-Use, Non-Towered Airports

Christian M. Salmon

ABSTRACT
This paper presents research conducted to model exposure of communities in the vicinity of public-use, non-towered airports to aviation accidents that results in crash sites outside the immediate confines of a runway. Two primary exposure metrics are explored: 1) a relative exposure, termed the *crash hazard*, defined as the probability that a crash site will be located in a specific area, if a crash were to occur at an airport, and 2) the absolute exposure, termed *crash risk*, defined as the expected number of crashes expected per year within any defined area. Results of this research are presented as a series of choropleth maps that define boundaries, as contours, within which either of these metrics exceed some defined threshold. A specific application of this research is presented within the context of a model airport.

Analysis and Control of Airport Departure Processes to Mitigate Congestion Impacts

Ioannis Simaiakis

ABSTRACT
Taxiing aircraft contribute significantly to the fuel burn and emissions at airports. This paper investigates the possibility of reducing fuel burn and emissions from surface operations through a reduction of the taxi times of departing aircraft. Data analysis of the departing traffic in four major US airports provides a comprehensive assessment of the impact of surface congestion on taxi times, fuel burn and emissions. For this analysis two metrics are introduced: one that compares the taxi times to the unimpeded ones and another that evaluates them in terms of their contribution to the airport's throughput. A reduction in taxi times may be achieved through the queue management strategy known as NControl, which controls the pushback process so as to keep the number of departing aircraft on the surface of the airport below a specified threshold. An earlier developed model is used to quantify the impact of N-Control on taxi times, delays, fuel burn and emissions at BOS. Finally, the benefits and implications of N-Control are compared to the ones theoretically achievable from a scheme that controls the takeoff queue of each departing aircraft.