Transition of the Rolling Dynamic Deflectometer Device from a Screening Tool to an Evaluation Tool for Rigid Airfield Pavement Projects

Boo Hyun Nam

ABSTRACT

Over the past decade, the Rolling Dynamic Deflectometer (RDD), a continuous deflection measurement device, has been used as a powerful screening tool in identifying problematic airport pavements to be repaired. However, the RDD has not seen much use as an evaluation tool to measure characteristics such as moduli of pavement layers and load-transfer efficiency (LTE). The primary goal of this research is to take the RDD from a screening tool to an evaluation tool for airport pavement projects by developing the hardware and software. In this study, the RDD as an evaluation tool could obtain: (1) continuous measurement of rolling deflection basins (for the backcalculation of layer moduli to be studied) and (2) continuous evaluation of joint LTEs. Four subtasks have been conducted: (*a*) investigation of parameters affecting the RDD measurements, (*b*) increase the number of rolling sensors, (*c*) improvement of RDD data processing (distance-based deflection profile with increased spatial resolution), and (*d*) a series of field tests with the RDD on a rigid airfield pavement. With all five sensors continuously being monitored during rolling, software developed was capable of selecting a zone of lateral uniformity over which it is appropriate to construct deflection basins. The improved data processing identified accurate locations of joints, and properly positioned two rolling sensors on opposite sides of the adjacent slabs in the continuous deflection profile, resulting in continuous LTE evaluation along the pavement. The RDD measurements (continuous deflection basins and LTEs) were compared with Falling Weight Deflectometer (FWD) measurements, and their comparison provided promising results.

Low-Velocity, High Mass, Wide-Area Blunt Impact on Composite Panels

Gabriela K. DeFrancisci

ABSTRACT

Impact damage resulting from collisions of ground vehicles and equipment with aircraft structural components is a significant source of damage to commercial aircraft that has potential to be unreported. Most commonly occurring are blunt impact threats such as ground maintenance and service vehicles, equipment, etc., which have attached elastomeric bumpers that, while protecting the aircraft to some degree, might not leave externally-visible evidence of an impact event. This research examines the types of impact threats to a composite airplane fuselage, impact testing of composite specimens that simulate airplane fuselage specimens and how the damage state relates to actual visible detectability. There are two distinct aspects to this test program; prediction through analysis and small scale and large scale quasi-static indentation testing.

Evaluating Air Traffic Flow Management in a Collaborative Decision-Making Environment

Douglas Fearing

ABSTRACT
The Collaborative Decision-Making (CDM) framework introduced into Ground Delay Programs (GDPs) in the late 1990s is an integral component in the Federal Aviation Administration's (FAA's) Traffic Flow Management (TFM) procedures. CDM allows the FAA to act as a mediator when managing TFM programs, pushing as much decision-making as possible to individual airlines. Though this approach has been highly successful in practice, it creates a new question for the research community – how should proposed enhancements to TFM be evaluated in a CDM environment? In our paper, we develop a sequential evaluation procedure to address this question. Our procedure includes airline disruption responses and a quasi-compression operation, attempting to mimic the three-stage CDM process. To model airline disruption responses, we develop an integer optimization model that balances operational and passenger considerations to make determinations on which flights to cancel, swap, or delay. We demonstrate the value of our procedure by analyzing an optimization-based TFM approach in the CDM environment.

Reactive chemistry in aircraft exhaust: implications on air quality

Ben H. Lee

ABSTRACT

There is growing concern regarding aviation emission and its impact on air quality, particularly given the projected increase in global air travel over the coming decades [1-3]. Plumes of exhaust emitted from jet engines contain high concentrations of combustion by-products, some of which may be damaging to human and ecosystem health. As these emitted pollutants mix with the surrounding air, they undergo chemical reactions that eventually break them down to their water-soluble or inert forms. To date, the reactivity of aircraft exhaust has been largely unexplored, and it is not known whether state-of-the-art models account for chemistry at the plume level, which directly relates to air quality in and immediately downwind of airports. To a large extent, the concentrations of hydroxyl (OH) and hydroperoxyl (HO2) radicals – collectively called HOx – present in emitted plumes determine the rate at which components of the exhaust are oxidized. In January of 2009, we quantified emissions of all HOx precursors including nitrous acid (HONO), formaldehyde (HCHO), acetaldehyde (CH3CHO) and ozone (O3) at the Alternative Aviation Fuels Experiment in Palmdale, California. We report that 1) HOx production rate due to the direct emission of precursors from jet engines is orders of magnitude faster in the exhaust plume than in "normal" urban air, 2) Concentration of pollutants in plumes do not reach typical ambient levels until it has been diluted by a factor of about 6,000 and that 3) Photolysis of HONO in these plumes is by far the biggest source of HOx during daytime. Analyses of the reactions involving HOx demonstrate that propagation of these radicals is favored over termination, which indicate chemical reactivity will continue to be enhanced in these plumes even after it has been diluted down to ambient levels.

Multi-Airport Choice Models for the New York Metropolitan Area:
An Application Based on Ticketing Data

Brittany L. Luken

ABSTRACT
This study examines the potential to use online ticketing data to model airport choice for domestic flights originating in one of the three major airports located in the New York City area. Results indicate that airport accessibility and level-of-service influence airport choice. Results also suggest that capacity constraints (reflected in sold out flights and higher fares) may lead to more switching across airports closer to flight departure dates. This underscores the importance of incorporating the actual flights available and the actual prices seen by consumers at the time they ticket into multi-airport choice models.

Modeling Emergency Evacuation of Individuals with Disabilities in a Densely Populated Airport

Matthew Manley

ABSTRACT
Emergency evacuation from airports is an important consideration given the continuing occurrence of both natural and human caused disasters affecting these locations. Such incidents have also focused attention on the needs of individuals with disabilities who are more likely to suffer during emergency situations. The agent-based model presented in this paper can be used by engineering and management professionals alike to estimate the evacuation performance of heterogeneous populations from airports in support of design and planning efforts. The model is unique because it classifies the environment according to accessibility characteristics encompassing various conditions which have been shown to have a disproportionate effect upon the behavior of individuals with disabilities during an evacuation. The results of a simulation experiment demonstrate some of the limitations of the pier airport design and identify which individuals are most at risk, those with lower stamina, and those using wheel chairs. The results also reveal areas of the airport which are prone to bottlenecks or clogging.

Estimation and Comparison of the Impact of Single Airport Delay on the National Airspace System using Multivariate Simultaneous Models

Nagesh Nayak

ABSTRACT

U.S. air transport as we all know is under significant stress, experiencing frequent delays and high levels of congestion. At certain times, individual airports become bottlenecks within the National Airspace System (NAS). Major causal factors of flight delay at airports include over-scheduling, en-route convective weather, reduced ceiling and visibility around airports, and upstream delay propagation. Delay at one airport can be passed on to other airports in the NAS. Hence, to optimally allocate resources for airport capacity expansion, the impact of single airport delay to the NAS and vice versa must be quantified. This research applies multivariate simultaneous regression models to quantify airport delay spillover effects across 34 of the 35 Operational Evolution Plan (OEP) airports and the rest of the NAS. In this analysis, delay contributors considered include average daily arrival delay, deterministic queuing delay, weather patterns, aircraft equipment type, and others. The three stage least square (3SLS) method is used to regress the models and obtain coefficients for the multivariate equations. The outcomes are used to explain the interactions among airports in the NAS and to identify the major delay contributors at each.

Evaluating Selected Airport Pavement Treatments' Sustainability Using Life-Cycle Cost, Raw Material Consumption and Greenroads Standards

Dominique M. Pittenger

ABSTRACT

Sustainability is increasingly becoming a priority for airport projects, as well as the foundation for future prosperity, in the global aviation community. Pavement structures are an airport's greatest asset and greatest liability. Pavement management systems, involve an intensive, expensive enterprise and pavement maintenance projects consume massive amounts of nonrenewable resources at every airport in the nation. Little research has been conducted to assist airport pavement managers reduce the environmental, economic and social impacts of their pavement maintenance and preservation processes. The old cliché of "what is not measured is not managed" applies and so a performance metric is required to permit pavement managers to measure sustainability. There is no standard, quantitative performance metric for sustainability in use by pavement managers to assess pavement treatment alternatives. This paper demonstrates how airport pavement managers can quantitatively analyze typical pavement treatments using life-cycle cost analysis, quantification of raw material consumption and the recently developed Greenroads standards to measure the environmental, economic and social impact of those treatments for a given pavement treatment project to enhance the overall sustainability of their programs.

A Public Policy Model of Delays in a Large Network of Major Airports

Nikolas Pyrgiotis

ABSTRACT
As more airports in the United States and in Europe become congested, it is becoming increasingly common to observe delays at one or more airports spread to other parts of the network on a daily basis. In this paper we describe an analytical model developed to study this complex phenomenon. The Approximate Network Delays (AND) model computes the delays due to local congestion at individual airports and, captures the "ripple effect" that leads to the propagation of these delays to other airports. AND can be used to explore at a macroscopic level of the implications a large number of policy alternatives and future scenarios on system-wide delays and associated costs. It has been fully implemented for a network consisting of the 34 busiest airports in the continental United States and for a network of the 19 busiest airports in Europe. We present an analysis on the estimation of ground slack in the scheduled turnaround times and its strong relation with the spreading of delays. Furthermore, we show, through AND, the effect of delay propagation in an airport network and for that reason we perform a comparison between the two main hubs in the European and US airport networks, Frankfurt International and Chicago O'Hare airports respectively. It was shown that higher local delays and more short haul flights in Chicago cause stronger delay propagation than in the Frankfurt. Finally, we show using AND that the modernization program of Chicago O'Hare can lead up to an 80% reduction of delays locally and a 5% reduction in network-wide delays under VFR conditions.

Opportunities and obstacles in obtaining air connectivity for residents of federally designated Essential Air Service communities

Maulik Vaishnav

ABSTRACT
The Essential Air Service (EAS) program was established in 1978 to guarantee air connectivity for residents of small communities to the national air transportation system. Currently, over half of EAS communities are within 70 highway-miles of another airport leading to passenger leakage at EAS airports and rising program costs. This paper presents five case studies of EAS communities to understand the reasons why local proponents support air service that is rarely used. The case studies present three main findings: the EAS program is a gateway to federal airport infrastructure funds of the Airport Improvement Program, there is an information gap between the US DOT and the EAS communities regarding the existing risky alternate programs, and local politics and airport administrators' concern about their professional future sustains support for local air service. Therefore, EAS communities in a multi-airport region that are most susceptible to passenger leakage continue to struggle in the program. The obstacles also deter establishment of transportation options that best fit communities and their residents. The study provides insights into policy changes that pay attention to the importance of small airports and rural air connectivity.

Balancing Airport Capacity Requirements with Environmental Concerns: Legal Challenges to Airport Expansion

Timothy R. Wyatt

ABSTRACT
Regulatory agencies such as the Federal Aviation Administration must balance the need to expand airport capacity with concerns about environmental impact. This balance is governed by the National Environmental Policy Act ("NEPA"), which establishes the environmental review procedures governing airport development activities that receive federal funding. This paper presents a comprehensive study of legal challenges to airport expansion, focusing on the influence of environmental procedural statutes such as NEPA. All known reported court opinions since the enactment of NEPA involving environmental challenges to physical airport expansion were reviewed and characterized with respect to the factual background of the case, the form of the legal challenge, and the disposition of the reviewing court. A regression analysis was performed to determine which factors influence a court's decision to approve the environmental review or to enjoin airport expansion pending further environmental review.