FAA Joint University Program - Quarterly Meeting

April 21 and 22, 2016

Princeton University

Venue: J223 – Engineering Quadrangle – Olden Street

April 21, 2016

1:15 pm Welcome

1:30 – 5:15 pm MIT – Briefings

Introduction: *John Hansman*

Potential Safety Benefits of RNP Approach Procedures
Sandro Salgueiro

Required Navigation Performance (RNP) approach procedures have been a recent focus of NextGen efforts to modernize navigation in the NAS. With the recent increase in implementation and usage of RNP procedures, real tracking data can now be more easily obtained for flights that make use of these approaches. In this study, we aim to evaluate the potential safety benefits of RNP procedures using airport surveillance data such as ASDE-X. Of specific interest are potential improvements in approach stability, defined by parameters such as deviation from target glideslope and approach speed.

Trajectory Clustering and Classification For Characterization of Air Traffic Flows
Mayara Condé Rocha Murça

The growing availability of massive aviation data has created an opportunity for developing “Big Data” analytics tools that can be useful for post-event efficiency assessment, monitoring and alerting and real time decision support in the air traffic management system. In this context, the use of data mining techniques has been recognized as a prominent way to extract patterns of system behavior during actual operations and evaluate their associated causes and performance. In this work, we developed an integrated data-mining framework for characterization of air traffic flows based on recorded radar tracks. The first part of the framework relies on trajectory clustering in order to learn the typical network of operations and identify the airspace structure, in other words, the nominal air traffic flows to/from an airport. Based on this knowledge, a trajectory classification scheme is built to assign new sets of flight trajectories to the previously identified patterns. For any time scale, it is then possible to assess the conformance of flight trajectories against typical patterns and to evaluate the dynamics of airspace use and operational behavior under various operating conditions. In order to illustrate the usability of the proposed framework, an assessment of tactical ATC operations in the transition/terminal airspace was performed for the New York Metro region.

Quantifying Noise from Advanced Operational Approach Procedures of Current and Future Aircraft
Jacqueline Thomas

Increasing concerns regarding aircraft noise has encouraged the push to reduce noise via operational adjustments. The objective here to expand analysis capabilities to enable modeling of the impact on aircraft noise due to advanced operational approach procedures, such as delayed deceleration approaches and steep approaches, for current and future aircraft designs. Current industry standard noise models rely on flight test data interpolation and do not fully capture noise impacts from airframe configuration (aerodynamic noise, shielding, etc.), or advanced operational techniques. This is critical for noise assessment because airframe noise becomes a significant factor relative to the low thrust levels characteristic of advanced operational approaches, and it is not immediately obvious which of the two noise sources will be dominate for a given approach. A new method combining aircraft sizing and performance tools with NASA’s

Aircraft NOise Prediction Program (ANOPP) has been performed to capture those noise impacts. ANOPP is used because of its capability of computing noise received at ground observers due to both engines and airframe of aircraft flying any flight procedure. Inputs into ANOPP are the aircraft geometry, the flight procedure, and the engine performance during the flight procedure. The Transport Aircraft System OPTimization (TASOPT) model is used to compute the engine performance inputs into ANOPP via first principles, physics-based methods. A separate tool was developed to compute the specifics of the flight procedure (max glide slope obtainable for a particular velocity and configuration, required thrust levels, etc.) based on drag polar supplied either by the Base of Aircraft Data (BADA 4) for current aircraft or by TASOPT for new aircraft. Benefits of this modeling framework include the flexibility in the aircraft and procedure analyzed and the ability to predict the noise of future aircraft configurations without relying on existing data. Next steps include further use of this model to evaluate the noise benefits or detriments of advanced operational approaches.

Impacts of Aircraft Flight Track Dispersion on Noise
Morrisa Brenner and Cal Brooks

Performance-Based Navigation (PBN) is a central component of the FAA's NextGen program and promises many efficiency benefits. Implementation of certain arrival and departure PBN procedures, however, has led to a significant increase in noise complaints, which now threaten the future of PBN. Since a major impact of PBN procedures is a decrease in the dispersion of actual flight tracks, a method was developed for quickly evaluating the impact of different dispersion scenarios on day-night level (DNL). This presentation will outline the modeling and analysis approach and present preliminary results. These results demonstrate that, while dispersion slightly lowers DNL values under the center of the track, it causes a disproportionate noise increase over previously unaffected areas around the central track.

3:30- 3:45 Break

Evaluating Environmental Tradeoffs at the Local and System Level in Air Transportation System Design

Luke Jensen

Air transportation impacts the environment at local and system levels, resulting in disaggregate costs and benefits for different stakeholders. Calculating and valuing multi-stakeholder environmental trade spaces is an important problem in air transportation system design. This talk introduces the methods which air can evaluate transportation technology changes at local and system levels, with an emphasis on the tradeoff between emissions and community noise. A fast modeling solution is proposed, with potential applications for policy decisions on a wide variety of environmental design problems in aerospace.

Operational Aspects of On Demand Mobility: A Case Study in Los Angeles

Parker Vascik

On Demand Mobility (ODM) is an emerging transportation paradigm that leverages increased connectivity through smartphones to enable the real-time matching of consumers and service providers to provide point-to-point transportation. Ride-share companies such as Uber and Lyft have emerged at the forefront of this novel market sector in recent years. Through the convergence of advanced electric propulsion and autonomy in aviation, numerous entities now aim to provide ODM services via aircraft within the next decade. However, despite significant advances in small aircraft design, ODM providers and regulators must address five operational challenges to realize market implementation. These five operational challenges are: airspace integration, air traffic interaction, ground infrastructure availability, noise management, and operations certification. This research conducts a case study of Los Angeles to identify the constraints imposed on ODM operations by each of these five categories. Considering these constraints, a short-term concept of operations (ConOps) will be proposed that enables ODM operations with existing vehicle technology without regulatory or airspace alterations. Furthermore, a long-term ConOps will also be proposed that expands the market or service potential of ODM aircraft operations by relaxing specific operational constraints.

Understanding the Cognitive Factors Involved in Air Traffic Controller's Management of Unmanned Aircraft

Brandon Abel

In order to ensure the safe integration of Unmanned Aircraft Systems (UAS) into the National Airspace System (NAS), integrated operations between Air Traffic Controllers (ATC), UAS, and manned aircraft pilots is required. Previous research has investigated ATC's cognitive processes while controlling manned aircraft, but ATC's cognition while controlling unmanned aircraft is not as well understood. The goal of this research is to understand the factors involved in Air Traffic Controller's management of mixed manned and unmanned operations. Previously, an exploratory ethnographic study of Air Traffic Controllers with experience in managing unmanned aircraft was conducted. Methods included a regulatory and procedural analysis, field observations, and focused interviews of controllers. This research concluded variable aircraft characteristics might be a more significant factor for controllers than whether the aircraft is manned or unmanned. A follow-on study was conducted to further explore the findings from the ethnographic study that aircraft performance factors may dominate UAS factors in controller decision making. This study consisted of a computer-based ATC simulation to investigate the relationship between aircraft performance (e.g. velocity) and response latency, which is expected to be higher for UAS. Finally, a part-task ATC simulation is presented to further understand the effects of UAS characteristics on controller's mental model accuracy, uncertainty, and workload.

5:15 Adjourn

April 22, 2016

8:30 Coffee

9:00– 10:00 Ohio University – Briefings

Introduction*:* *Chris G. Bartone*

Bird Strike Mitigation for Aviation
Christopher Drummond
This research investigates taking avian radar target detections and producing target reports that are suitable for distribution to the airport Air Traffic Control (ATC) tower and aircraft users within the operational range of the airport. Formatting the filtered bird detections as avian target reports within the Traffic Information Service-Broadcast (TIS-B) and Flight Information System – Broadcast (FIS-B) message structure are under investigation and will be presented. These TIS-B and/or FIS-B avian target reports will be broadcast using 1090 Extended Squitter (1090ES) and UAT.

Single-aperture Patch Antenna with Pattern Control for Civil Aviation
Levi Moore

Microstrip patch antennas are common for GNSS applications due to their low profile, small size, ease of fabrication, and low cost. Typically, the radiation characteristics of a single-element patch antenna are fixed with an inability to electronically control the radiation characteristics in azimuth and elevation. This paper presents a single-aperture (i.e., single-element) GNSS patch antenna that can electronically control the radiation characteristic. Here, the performance of a circular four-probe-fed GPS L5 patch antenna over a circular ground plane is illustrated. The fabrication of the antenna is illustrated and the measured results at the component level and anechoic chamber radiation characteristics are presented that illustrate the pattern control aspects of the antenna. This control has a major advantage by controlling the radiation characteristic to allow for isolation of interfering signals.

10:00– 10:15 Break

10:15– 11:15 Princeton University – Briefings

Introduction: Clancy Rowley, Luigi Martinelli

Continuing progress of high-order accurate simulation tool for cargo hold fires
Mark W. Lohry

Accurate prediction of heat and particulate transfer in fire-induced flow is necessary for predicting the performance of aircraft cargo hold fire detection systems. Past investigations of cargo hold fires include full-scale experiments and simulations using traditional 2nd order accurate finite volume CFD methods. In previous meetings, we have identified several inadequacies in available simulation tools. As a result, we are continuing development of a new flow solver using the discontinuous Galerkin method for discretization, which allows for arbitrarily high order accuracy and geometric flexibility.

In this talk, we present the current state of development of this new tool. Buoyancy driven flow simulations will be demonstrated in cargo hold geometries with varying order of accuracy. We will also present fundamental 2D and 3D flow validation cases to assess the performance of the code. We will also show preliminary examples for validating this tool with available experimental data for cargo hold fires.

Uncertainty Quantification for Airfoil and Wing Icing
Anthony DeGennaro
Ice accumulation on the surface of a wing can be detrimental to aircraft performance -- it can drastically reduce the lift, increase the drag, lead to stalling at lower angles of attack, and change the control performance of the airplane. Furthermore, there is a wide range of geometric shapes and properties of the ice that are possible, which depends on a large number of physical parameters. This results in a large amount of uncertainty in the ice shape. Hence, our goal is to quantify how simple measures of aerodynamic performance are affected by uncertainty in the icing process. In this talk, we discuss

research aimed at addressing this issue using two approaches. First, we treat the uncertainty in the icing problem as existing only in the form of several ice shape parameters, which are identified using existing data on ice shapes. In particular, we present new results that demonstrate how the techniques of cluster modeling and graph partitioning may be used to segregate a large database of ice shapes into classifications of similar shapes. This approach provides an empirical classification scheme and makes subsequent UQ studies more tractable. Second, we discuss current efforts to treat the uncertainty in the icing problem from a physical standpoint, as opposed to the databased approach. This necessitates obtaining a wing icing code and then doing modeling and UQ on it. We review recent and on-going progress towards developing, testing, and verifying a 2D icing code, and discuss uncertainty quantification studies that may be conducted once this code is completed.

11:30 PI Meeting