Project 023 Analytical Approach for Quantifying Noise from Advanced Operational Procedures

Massachusetts Institute of Technology

Project Lead Investigator

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University Participants

Massachusetts Institute of Technology (MIT)

- P.I.: R. John Hansman
- FAA Award Number: 13-C-AJFE-MIT, Amendment Nos. 008, 015, 022, 031, 046, and 051
- Period of Performance: October 1, 2024, to September 30, 2025
- Tasks:
  1. Evaluate factors limiting the ability to develop and utilize low-environmental-impact flight procedures.
  2. Review current and proposed air traffic management (ATM) modernization plans for potential environmental impact benefits.
  3. Identify potential opportunities for incorporating operational environmental optimization.
  4. Propose a path forward for high-potential opportunities.

Project Funding Level

The Federal Aviation Administration (FAA) provided $860,000 in funding, and matching funds totaling $860,000 were provided by MIT (approximately $80,000) and the Massachusetts Port Authority (Massport) (approximately $780,000).

Investigation Team

Prof. R. John Hansman (P.I.), All Tasks
Sandro Salgueiro (graduate student), All Tasks
Clement Li (graduate student), All Tasks
Zhishen Wang (graduate student), All Tasks
Mina Cezairli (graduate student), All Tasks

Project Overview

In this project, the team is evaluating the noise reduction potential of advanced operational procedures in the terminal (arrival and departure) phases of flight. The noise impact of these procedures is not well understood or modeled in current environmental analysis tools, presenting an opportunity for further research to facilitate ATM system modernization. This project leverages a noise analysis framework previously developed at MIT under ASCENT Project 023 to evaluate a variety of sample procedures. In conjunction, this project contributes to the memorandum of understanding between the FAA and Massport to identify, analyze, and recommend procedure modifications at Boston Logan International Airport (BOS).

Task 1 - Evaluate Factors Limiting the Ability to Develop and Utilize Low-environmental-impact Flight Procedures

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Objectives

The objective of this task is to identify factors driving operational stakeholder acceptance constraints, which limit when low-environmental-impact procedures may be utilized and, consequently, also impact the feasibility of their implementation. Interviews with stakeholders may be conducted to better understand the operational requirements that different stakeholders have in the context of procedure acceptance.

Research Approach

- Review relevant literature, including prior human-in-the-loop studies, to identify the effects of novel performance-based navigation (PBN) flight procedure concepts on air traffic control (ATC) and pilot tasks.
- Identify the relationship between operational stakeholder concerns and safety, in the context of the implementation of advanced low-noise flight procedure concepts.

Major Accomplishments

- Identified potential mechanisms to mitigate stakeholder concerns, including new merging and spacing tools and collision mitigation capabilities.
- At BOS, monitored the use of overlay RNAV (Area Navigation) GPS approach procedures throughout the year using flight trajectory data, and identified usage rates for different aircraft and airlines.

Task 2 - Review Current and Proposed ATM Modernization Plans for Potential Environmental Impact Benefits

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Objectives

This task involves the review of historical, current, and proposed ATM capabilities that influence how operational stakeholders perceive the acceptance of new flight procedure concepts. Examples of capabilities to be analyzed include ATC decision support tools (including merging and spacing tools), trajectory-based operations (TBO), and aircraft navigation capabilities. Both United States and international capabilities are to be reviewed.

Research Approach

- Review relevant literature on both existing and proposed ATM modernization plans, including ATC and pilot decision support tools.
- Analyze noise monitor data from BOS to evaluate noise benefits achieved with the implementation of new low-noise procedures that were developed as part of prior work.

Major Accomplishments

- Identified a legacy set of ATC decision support tools used for merging and spacing of aircraft on final approach.
- Identified current efforts towards deployment of new merging and spacing tools, including the Terminal Sequencing and Spacing (TSAS) tool in the United States and Point Merge in Europe.
- Obtained a large set of noise monitor and aircraft trajectory data for a full year of operations at BOS, enabling new quantitative analyses on the noise effects of procedure changes.
- Analyzed raw noise monitor data for a new overwater required-navigation-performance (RNP AR) approach implemented at BOS (runway 33L).
    - Preliminary results show a significant noise reduction associated with the new procedure as measured at a highly impacted area, matching prior modeling results.
- Analyzed raw noise monitor data and flight trajectory data for new departure procedures serving runways 15R, 22L, and 22R at BOS.

- Preliminary results showed noise reduction associated with the new procedures as measured in a highly impacted area.
- Analyzed raw noise monitor data and flight trajectory data for the new arrival procedure serving runway 22L at BOS, which started to be flown in July 2025.

Task 3 - Identify Potential Opportunities for Incorporating Operational Environmental Optimization

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Objectives

The objective of this task is to consider the potential of the ATM modernization capabilities identified in Task 2 to address the limitations identified in Task 1 or to enable environmentally desirable trajectories. Potential enhancements or additional capabilities will be identified.

Research Approach

Review potential effects of ATC and pilot support tools identified in Task 2 towards mitigating the operational stakeholder concerns identified in Task 1.

Major Accomplishments

- Leveraged flight trajectory data to compare track miles between the old procedures and the new overwater RNP AR approach implemented at BOS (runway 33L)
  - Preliminary results showed a reduction in track miles flown, leading to fuel burn benefits for the RNP AR procedure.
- Leveraged flight trajectory data to compare track miles between old and new procedures for new departure procedures serving runways 15R, 22L, and 22R at BOS.
  - Preliminary results revealed a reduction in track miles flown in all three of the new departure procedures, leading to fuel burn benefits.

Task 4 - Propose a Path Forward for High-potential Opportunities

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Objectives

The objective of this task is to synthesize findings from Tasks 1, 2, and 3 to identify key capability development paths that could enable concepts of low-environmental-impact flight procedures. Areas of investigation will include requirements for each capability, functions served by it, and what changes it may drive in the roles and training of operational stakeholders (controllers and pilots).

Research Approach

- Synthesize findings from Tasks 1, 2, and 3 and identify development paths for future low-noise capabilities.

Major Accomplishments

- Not applicable, pending conclusion of Tasks 1, 2, and 3

Publications

Cezairli, M., Salgueiro, S., & Hansman, R. J. (2025). Implementation Analysis of Low-Noise Performance-Based Navigation Flight Procedures at Boston Logan Airport. *Journal of Air Transportation, 33*(3), 274-284. https://doi.org/10.2514/1.D0475

Cezairli, M., Salgueiro, S., & Hansman, R. J. (2024) Analysis of the Implementation of Low-Noise PBN Flight Procedures at Boston Logan Airport. [Conference presentation.] AIAA Aviation 2024 Forum, Las Vegas, Nevada. https://doi.org/10.2514/6.2024-3856

Hansman, R. J., Salgueiro, S., Huynh, J., Li, C., Jansson, M., Mahseredjian, A., & Zimmer, K. (2021). *Block 2 procedure recommendations for Logan Airport community noise reduction*. MIT international Center of Air Transportation. https://hdl.handle.net/1721.1/131242

Hansman, R. J., Jensen, L., Huynh, J., O'Neill, G., & Yu, A. (2017). *Block 1 procedure recommendations for Logan Airport community noise reduction*. MIT international Center of Air Transportation. http://hdl.handle.net/1721.1/114038

Salgueiro, S., & Hansman, R. J. (2023). *Identifying, Visualizing, and Communicating Constraints in PBN Flight Procedure Design* [Conference presentation]. AIAA Aviation 2023 Forum, San Diego, California. https://doi.org/10.2514/6.2023-3968

Salgueiro, S., Thomas, J., Li, C., & Hansman, R. J. (2021, January 11-21). *Operational noise abatement through control of climb profile on departure* [Conference presentation]. AIAA SciTech 2021 Forum, virtual. https://doi.org/10.2514/6.2021-0007

Thomas, J, & Hansman, J. (2019). Framework for analyzing aircraft community noise impacts of advanced operational flight procedures. *Journal of Aircraft*, 6(4). https://doi.org/10.2514/1.C035100

Thomas, J., Yu, A., Li, C., Toscano, P., & Hansman, R. J. (2019, June 17-21). *Advanced operational procedure design concepts for noise abatement* [Seminar presentation.] Thirteenth USA/Europe Air Traffic Management Research and Development Seminar, Vienna, Austria.

Yu, A., & Hansman, R. J. (2019, January 7-11). *Approach for representing the aircraft noise impacts of concentrated flight tracks*. [Conference presentation.] AIAA Aviation Forum, Dallas, Texas.

Outreach Efforts

- September 27, 2017: Poster to the ASCENT Advisory Board
- December 5, 2017: Call with Boeing to discuss procedure noise impact validity
- March 16, 2018: Discussion with Minneapolis-Saint Paul International Airport about metrics
- April 4, 2018: Poster to the ASCENT Advisory Board
- May 7, 2018: Presentation to the FAA 7100.41 PBN Working Group
- June 24, 2018: Discussion with air traffic controllers about dispersion concepts
- July 23, 2018: Briefing at the FAA Joint University Program research update meeting
- October 9, 2018: Poster to the ASCENT Advisory Board
- November 8, 2018: Presentation to the Airline Industry Consortium
- March 3, 2019: Presentation at the Aviation Noise and Emissions Symposium
- October 15, 2019: Presentation to the ASCENT Advisory Board
- November 12, 2019: Presentation to the Airline Industry Consortium
- May 21, 2020: Meeting with operational stakeholders from the FAA 7100.41 process to discuss Block 2 concepts
- September 23, 2021: Public hearing to present Block 2 procedure recommendations for BOS
- Numerous community meetings
- Numerous briefings to politicians representing eastern Massachusetts (local, state, and federal)
- Briefing to the FAA Management Advisory Council
- In-person outreach and collaboration with Massport, an operator at Boston Logan Airport, and an ASCENT Advisory Board member
- April 1, 2022: Presentation of a summary of lessons learned from the Boston project to an audience of FAA, Massport, and HMMH stakeholders
- August 16, 2022: Presentation of work on flight procedure constraints at the FAA Technical Center in Atlantic City, New Jersey, as part of the Joint University Program
- September 20–21, 2022: 7100.41 Working Group meeting at the Boston terminal radar approach control facilities (ASCENT Project 090); presentation to air traffic and airline stakeholders on flight procedures proposed for BOS as part of Block 2; approval received for all presented procedures for further implementation work
- April 9–10, 2024: Presentation to the ASCENT Advisory Board
- October 29–31, 2024: Poster to the ASCENT Advisory Board
- April 14–15, 2025: Presentation to the ASCENT Advisory Board

Awards

- 2018 Department of Transportation/FAA Centers of Excellence Outstanding Student of the Year Award to Jacqueline Thomas
- 2021 Massachusetts Port Authority Logan Stars Award to the MIT International Center for Air Transportation research group

- 2023 American Institute of Aeronautics and Astronautics Orville and Wilbur Wright Graduate Award to Sandro Salgueiro

Student Involvement

Graduate students have been involved in all aspects of this research in terms of analysis, documentation, and presentation.

Plans for Next Period

The next phase of this project will focus on the continuation of all tasks, with a particular focus on the analysis of ATM modernization plans and the identification of potential noise benefits enabled by future capabilities. Current efforts include the analysis of noise monitor data from BOS, which will be used to quantify the change in noise impacts due to the implementation of Block 1 and Block 2 procedures.