Noise Abatement Arrival Procedures at Louisville International Airport

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The Team

- Noise Abatement Procedures Working Group (NAPWG) has the following members:
  - MIT (lead) -> Georgia Tech (lead)
  - Boeing
  - FAA
  - NASA
  - Louisville Regional Airport Authority
  - UPS

- Gets assistance from others as appropriate
Introduction

- Operational procedures are a cost effective means of achieving near- and medium-term noise and emissions reductions
  - Especially true in the case of arrivals

- The ideal arrival procedure is one where the aircraft descends continually at idle thrust from cruise to landing

- However, because the airplane is a glider in this situation, its future trajectory is very susceptible to variances in FMS logic, pilot technique, aircraft weight, and wind
Therefore, the challenges in developing such procedures are to:

- Develop procedures that positively leverage on the capabilities of the FMS
- Determine the initial separation that ensures (for a given variation in pilot technique, aircraft weight, and wind) that the separation will not fall below the minimum throughout the arrival

In this presentation, I will present the results of two flight tests at Louisville Airport that were conducted to address these challenges
2002 Flight Test: Overview

- **Objectives:**
  - Design CDA procedure for SDF TRACON
  - Measure “real-world” benefits of CDA procedure
  - Identify FMS issues that limit benefits or introduction

- **Research Approach:**
  - Fly two consecutive B767-300 aircraft along the same lateral path each night over a two-week period
    - First aircraft using conventional approach
    - Second aircraft using CDA approach
  - Measure noise and archive flight data
  - Determine noise, emissions, fuel burn, time savings
2002 Flight Test: “Design” Profile

Descent with 2 FPA
1st week of testing

Idle thrust descent
2nd week of testing

3 GS

Distance along ground track (nm)

MSL (ft)
2002 Flight Test: Waypoints

Latitude (deg)

Longitude (deg)

CHERI

BOBBIE

JIMME

WOODI

BLGRS

CHRCL

RW-17R
2002 Flight Test: Noise Reduction

Peak dBA (dB)

Locations

N4  P1  N3  N2  P2  P3  N1

CDA
Conventional
2002 Flight Test: Summary

- **Environmental and economic benefits:**
  - Up to 6 dB noise reduction (7.5 to 15 NM)
  - 30% reduction in NOx (below 3,000 ft.)
  - 500 lb. fuel burn reduction
  - 100 sec. flight time reduction

- **FMS issues:**
  - Auto-throttle engages (with high thrust) if pilots are tardy in extending flaps/gear or if unexpected wind caused aircraft to slow more quickly than expected
  - Auto-pilot responds by decreasing descent rate to arrest acceleration thus taking aircraft off desired path
2004 Flight Test: Overview

Objectives:

- Design CDA procedures for 17R and 35L that:
  - Begin at cruise altitude
  - May be used in daily operation
  - Are FMS operational procedures
  - Correct FMS issues identified in 2002

- Conduct flight test to:
  - Validate new design tools
  - Demonstrate consistency of procedure
  - Provide data required for operational acceptance
  - Validate noise, emissions, fuel burn and time savings
2004 Flight Test: Overview

- **Research Approach:**
  - Determine waypoints, corresponding altitude and speed restrictions, and pilot procedures
    - Analytical analysis
    - Simulator studies (at Boeing, NASA and UPS)
    - Beta flight tests (conducted by management pilots)
  - Determine initial separation required to ensure that the minimum separation is never violated
    - Monte-Carlo simulator studies (at MIT)
  - Conduct flight test over two-week period in September with 12 to 14 aircraft each night
    - Measure noise and archive flight data
  - Determine noise, emissions, fuel burn, time savings
Flight test successfully completed

- 126 aircraft planned over 10-nights
  - 125 aircraft performed as (or close to) expected
    - 2 of 125 aircraft given short vectors to improve spacing
  - 1 aircraft performed a visual approach

- Noise data collected on 9 of the 10 nights;
  - Late switch in direction of operation prevented noise measurement team moving to other side of airport.

- CDA and non-CDA aircraft successfully mixed on one night.
Demonstrated (for the first time at the aggregate level) the environmental benefits of CDA in real-world operations:

- Noise impact significantly reduced
  - Lower per aircraft noise levels
  - Impact concentrated in narrow corridors

- Local emissions significantly reduced
  - CO below 3,000 ft reduced by 12.7% (B-767) and 20.1% (B-757)
  - HC below 3,000 ft reduced by 11.0% (B-767) and 25.1% (B-757)
  - NOx below 3,000 ft reduced by 34.3% (B-767) and 34.4% (B-757)
Demonstrated (for the first time at the aggregate level) the economic benefits of CDA in real-world operations:

- Economic costs significantly reduced
  - Fuel to fly last 180 nm to runway reduced by 364 lbs/flight (B-767) and 118 lbs/flight (B-757)
  - Time to fly last 180 nm to runway reduced by 147 secs/flight (B-767) and 118 secs/flight (B-757)

- Demonstrated CDA use in realistic nighttime operations

- Report available!
Next Steps

- **Get Louisville procedure approved for daily use with West Coast arrivals**
  - UPS currently developing package for submission

- **Develop guidelines for procedure design**
  - Leverage insights from 2004 flight test

- **Develop criteria and determine priority for wider implementation of CDA**
  - Analyze noise impact data, radar data and structure of airspace to determine airports where introduction of CDA will provide greatest benefits
Next Steps

- Develop controller tools required for implementation in higher traffic
  - Develop rule-based algorithm (using MIT Monte-Carlo Simulator) for setting initial separation
    - Based on current aircraft types and weight, and wind
  - Design and test algorithms and displays that help controllers estimate the future state of CDA aircraft
    - Results of preliminary subjective study indicates that graphical display of velocity history improves prediction capabilities of test subjects

- Evaluate controller tools
  - Conduct controller-in-the-loop study