MITRE’s Center for Advanced Aviation System Development (CAASD): Wake Turbulence R&D – Past, Present, and Planned

Clark Lunsford
April 3, 2007
Outline

• CAASD background
• CAASD’s wake turbulence R&D
• R&D challenges
• What wake turbulence R&D can CAASD best contribute to
• WakeNet observations
CAASD’s Mission

To serve the public interest by advancing the safety, security, effectiveness, and efficiency of aviation in the United States and around the world by conducting a continuing program of research, development, and engineering in collaboration with the aviation community.

- FAA’s only Federal Funded Research and Development Center
  - Line item in DOT appropriations
- Focused on the modernization of ATM systems and operations to add capacity and efficiency, safety and security
- Works closely with stakeholder community
  - Government agencies, airlines, cargo, GA, airports, pilots, controllers, OEMs, suppliers, standards bodies
- Works in partnership with FAA, NASA, DoD, and International Civil Aviation and Airport Authorities
- Long-track record of contributions; over 45 years of ATM involvement
CAASD’s Wake Turbulence R&D
CAASD Initial Role

• Understand potential impact of future wake turbulence related terminal procedures
  – Approach and work program evolved from a two-year CAASD Sponsored Research project

• CAASD proposed a top-down look
  – Spectrum of procedures (about 30) explored: single runway and Closely Spaced Parallel Runways (CSPR) arrivals, single runway and CSPR departures, etc.
    • Procedures assessed for data, technology, development, coordination, implementation risk and benefits
    • Single runway arrivals require significantly more technology and were eliminated from near-term deployment; part of the overall long term plan with NASA
  – CSPR arrivals selected by FAA in 2002 (with significant CAASD help) as candidate for procedural solution with low technology and significant benefits
    • STL Waiver and potential extension to additional airports
CAASD Role

FAA Near-Term Procedure

• Developed Joint FAA/NASA Wake Turbulence Program Plan
• Conducted Human in the Loop (HITL) simulations with STL operational staff
  – Developed and refined initial STL operational procedures
  – Assessed Operational ATC feasibility of proposed rule change
  – Validated expected benefits, including arrival/departure interaction
  – Identified operational issues and potential mitigation strategies for wake safety analysis
  – Presented and discussed results with ALPA to frame proposed procedure and elicit operational issues (key drivers of wake program objectives)
• Identified safety issues and structured safety assessments, based on initial set of procedures
CAASD Role

FAA Near-Term Procedure (concluded)

• Worked with the FAA and Volpe to enhance the STL wake data collection plan and analysis tasks
  – Ensured operational relevance and stakeholder perspective
  – Ensured adequate foundation for proposed rule change
• Established and led FAA/Stakeholder Issues Roundtable Group* to identify, prioritize, and address operational issues
  – Conducted relevant analyses of operational issues, alternatives assessments and mitigation strategies
  – Developed scenarios for use in AFS safety analyses of procedure
  – Worked with ATP in developing the roadmap, waiver, and rule change
• Developed Safety Risk Management Document (SRMD) and coordinated inputs from FAA and stakeholders
• Coordinated with key players in the wake turbulence community and with other FAA initiatives

* ALPA, NATCA, ATB, AFS, ATP, Volpe
Efforts Supporting Mid-Term CSPR Departures

- Initial Concept of Operations*
- Wind/Wake Data Collection and Analysis at other CSPR Airports as needed*
- Prepare SRMD* and Final Safety Assessment
- Change to FAA Order 7110.65*

- Development and Refinement of Concept of Operations* & wind algorithms

- Operational Hazard Assessment and Mitigation*
- Refine Benefits Analysis of Procedure & Airports*
- Wind Algorithms & DST Requirements* Definition
- Architecture Development*
- DST & Integration Development and Test
- Key Site Implementation

- HITL Simulation – Assess Feasibility and Info Requirements*

- Initial Benefits Assessment*

Key:
Blue = Done
Green = Currently Ongoing
Gray = Future Activities

* CAASD Role
ATM Lab Tower Simulation Supporting Operational Feasibility and Information Requirements Research

- ASDE-X Display with WTMD Field
- Tower BRITE Display
- Tower “Out The Window” Display
- Local Controller ACE-IDS Display with WTMD Runway Status Indicator
- Tower Local Control Positions
CAASD Role in Joint FAA & NASA Research (Beyond CSPR Departures)

• Developing operationally realistic options for farther-term wake procedures utilizing wake monitoring and prediction technologies
  – Developed phased approach versus “big bang” to future technology
  – Leveraging CAASD knowledge of ATC, Pilot Operations, and FAA culture
  – Utilizing CAASD assets to fully explore multiple scenarios and to identify potential hazards to be included in safety analysis
  – Describing current operations through simulation and analyses of recorded ATC data to provide realistic bounds for new procedures
  – Simulating capacity/delay benefit for multiple procedure options
  – Assessing development and deployment risks

• Coordinating with key players
Wake Turbulence R&D Challenges
Wake Turbulence R&D Research Challenges

• Continuing to perform targeted research that leads to feasible solutions that will be implemented and used
  – Very easy to slip into doing interesting research, for research sake, that does not lead to any operationally useful capability

• Continuing to filter candidate solutions by feasibility, benefit, and technical risk considering the entire operational environment
  – Avoid the trap of focusing on an interesting technology and force-fitting an application to make use of it
Wake Turbulence R&D Research Challenges (continued)

• Establishing a wake hazard definition that
  – Maintains or improves the current safety record
  – Is accepted by the stakeholders
  – Can be used with measurable data in an operational ATC system
CAASD Strengths
CAASD Understands Complex ATM/CNS Interrelationships

ATM/CNS Systems

Controller

Airlines

Airports

General Aviation and Air Taxi

Passengers
Integrated ATM Laboratory –
Enables Effective Concept Exploration Through Real-Time, Human-In-The-Loop (HITL) Experimentation

En route

Traffic Flow Management

CRCT in Field

URET in field

TACT

URET

En route

URET

Cockpit

TFM

Surface

Terminal

Cockpit

Terminal
Investigating Operational Feasibility and Benefits with Modeling, Simulation, and Analysis

Visualization

Modeling & Simulation
- Airport
- Terminal
- En Route
- NAS
- Global
- Policy Impact Analysis
- Human-In-The-Loop

Data Processing
- CAASD
- ORACLE
- MRALD
- COLDFUSION
- Linux

Data Sources
- Radar data
- Live feeds
- ETMS

© 2007 The MITRE Corporation. All rights reserved.
WakeNet Observations
WakeNet Observations

- WakeNet venue helped to foster information sharing and involvement by stakeholders
- Can’t be, and has not been, the only time when stakeholders are involved
  - Additional input/involvement is needed during research activities that desire stakeholder buy-in, such as safety analysis, operational feasibility, airport/procedure selection, review of wind and wake data and analyses
- Has been one element that helped build a cohesive, cooperative, and productive team that spans many organizations
- CAASD’s role has been the same as that of other partner organizations: To share information and analysis results freely and accurately, toward the goal of safe and successful implementation of new wake solutions