Reflections on the First Year of NEXTOR

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Outline

- National Center of EXcellence for AviaTION Operations Research
- First-year projects
- Some fundamental research issues for NEXTOR
- A brief assessment
A university-industry-government partnership aimed at developing capabilities for

- modeling, designing and evaluating the performance and safety of

- partially decentralized, more flexible, advanced technology concepts

for air traffic management and airports
First Year Projects

- Applied basic research primarily at universities
  - Human factors support to FAA Office of System Safety
  - World aviation safety data analysis
  - Modeling for establishing separation standards and computing associated collision risk
  - Positive Passenger Baggage Matching
  - Advanced concepts for Collaborative Decision Making
  - Integration of Reusable Launch Vehicles into ATM system
First Year Projects (2)

- Shorter term issues mostly addressed jointly with industry partners
  - SIMMOD improvements and maintenance
  - Impact of AATT technologies on ATM concept definition
  - Center Sector Tools Descent Advisor Research
  - Investigation of Integrated Alert Systems concepts
  - Analysis of critical portions of CTAS
  - Development of a Project Management Information system
First Year Projects (3)

- Industry-sponsored joint projects in areas of specific mutual interest:
  - Distributed environment for simulating weather events (TASC)
  - SIMMOD-based airport gate planning (Massport)
  - Terminal area automation in partially decentralized ATM (Draper)
  - Macroscopic queueing model of NAS (airports and en route) (LMI)
Aviation infrastructure (ATM and airport system) in US:

- Vital and extremely successful
- Excellent levels of safety

BUT:

- Approaching (selectively) its limits in terms of capacity and efficiency
- Becoming highly resistant to change
A complex system

- ATM system has become extremely complex
- Technological / technical, economic, institutional, legal and human factors
- Increasingly constrained operating environment deepens complexity
- “NAS as CAS” (complex adaptive system)
To cope with complexity and to change, fundamental research needed on:

- Current system’s characteristics
- Uncertainty, variability, nonlinearity
- Computer-based models
- Objectives, behavior and interactions of stakeholders (“agents”)
- Safety and human factors/automation
Current system: Delays

- Magnitude of current delays
- Cause-and-effect relationships
- Average delay vs. delay variability vs. “system flexibility” in delay assignment
- Airline tactics (short-term) vis-a-vis delays
- Airline strategies (long-term) vis-a-vis delays
Need for systematic analysis and evaluation of existing system’s performance:

- gigabytes of data daily (ETMS, ACARS, airlines)
- completeness? adequate level of resolution?
- automated gathering and processing of data
- visual and statistical presentation of key selected metrics

Potentially invaluable insights!
Uncertainty, variability, nonlinearity are pervasive in ATM system
- Capacity and delays
- Aircraft position predictability
- Agent behavior and public perceptions

Concepts and programs based on “deterministic and linear” assumptions are usually doomed to failure
“Existing and Required Modeling Capabilities for Evaluating ATM Systems and Concepts”

- Reviews 27 fast-time models (2-6 pages)
- State-of-the-art assessments in 5 areas
- General and model-specific recom’dns
General Findings: Existing Models

1. Flow, capacity and delay: Most advanced.
2. Conflicts: Scattered features/capabilities; no one model adequate for a complete analysis.
3. Humans and automation: Early stages; urgent attention / resources needed.
4. Cost-benefit: Formative stages; little knowledge of valuations; very hard to quantify some impacts of advanced ATM concepts.
5. Airline (AOC) and other user behavior: Major new area of basic research.
“Agents”

- Studies of the behavior of NAS Agents
  - understand (“fuzzy”) goals of users
  - responses to changes, e.g., capacity enhancements and decentralization

- Development of Modeling Tools
  - infer behavior of users

- Macroscopic Models of the NAS System Behavior and Performance
  - network competition
  - metrics
Difficulties

- Funding constraints impose a short-term orientation on FAA R&D
- No FAA precedent for NEXTOR-like arrangements
- “Time constants” of university research are long
- Limited resources mean underutilization of affiliated universities and of some industry partners
Fundamentally sound concept

- Enormous need for applied basic research on fundamental aspects of ATM and airport operations
- NEXTOR can complement in important ways the capabilities of other major loci of NAS R&D activity (Hughes Center, NASA, MITRE CAASD, MIT Lincoln Labs, et al.)
- A unique partnership of academic talent and industry expertise and resources