4TH USA / Europe
Air Traffic Management
R&D Seminar
ATM2001

EUROCONTROL

Improving Traffic Flow

Optimization and Demand Management

Five Sessions, Common Themes

- Impact of uncertainty on decision making
- Modeling economic effects
- Rerouting as an operational solution
- Mathematical modeling for optimal allocation
- Demand management

Impact of uncertainty on decision making

- **Len Wojcik: Agent Based Model (IMPACT) and decision analysis to model strategies to deal with imperfect weather forecast**
  - **Modeled both ATM and Airline agents**
  - **Incorporated decision analysis perspective**
- **Mike Ball: Studied effects of demand uncertainty on Ground Delay programs**
  - **Integer Programming model to assign airport arrival rates**

Impact of uncertainty on decision making

- Results
  - Both Papers suggest more dynamic decision making
    - IMPACT model using decision analysis perspective suggests that waiting for better information, to a point, can be better
    - Transparency of information does not automatically imply efficiency.
  - IP model suggests that during a GDP, varying airport arrival rate over the ground delay will better use airport capacity while managing delays

Modeling Economic Impacts of Decision Making

- **John Falker: What are effects of closing special use airspace on traffic flows**
  - **Analytic model leads to logarithmic increase in the number of aircraft conflicts**
  - **Simple model is applicable toweather rerouting impacts**
- **Jean-Claude Hustache: System dynamics model to model:**

Effects of Staffing Sectors on Productivity Capacity Delays

  - **Economic/operational model of European en-route system shows that it will be difficult to cope with increased demand by hiring controllers alone—new technology will be required.**

Modeling Economic Impacts of Decision Making

Celine Verlhac: Determination of opening schemes to match demand

3 Models: 1) Match time slot in 1 center
2) Accommodate overflow from prior slots
3) Accommodate multiple centers

Results: Approach 2 works as well as 3—Local optimization is often as good as global optimization for this problem!



Rerouting as an operational solution

Joe Sherry: Extensions to collaborative rerouting tools to:

- Identify flights by convective weather
- Define reroute corridors
- Automate assignment to reroute corridors based on delay, sector volume, equitability
- Maximize time for human planning / collaboration, use automation to do mechanics



Rerouting as an operational solution

Thierry Champougny Antoine Joubert: Strategic optimization for global ATM system

- Phase 1: Optimal use of existing capacity in a given airspace structure.
- Phase 2: Optimal use of available capacity using alternate routings

Results show potential for benefits in the Core area of Europe from dynamic allocation of alternate routes



Mathematical modeling for slot allocation

Stefano Elefante: Using probability density functions of arrival time distributions to set schedules that result in reduced probability of conflict or reduced schedule variance

Nicolas Barnier: Slot allocation using constraint programming

- 3 models using constraint programming to assign slots—fixed window, sliding window, sorting approach
- basic problem: respect the capacity constraints over time
- result: sliding window approach is an improvement over fixed window, but sorting approach will meet the allocation constraints.

Demand Management

Terrance Fan:

- **Discussed principles of demand management, situation at LGA, and application of demand management in US**
- **Works best at select airports**
  - **high demand / capacity ratio**
  - **many operations**
  - **diverse aircraft types**

Stephanie Stoltz:

- **Simulation Model assessment of demand management at three airports**
- **Small deviations from ATFM plan leads to large spikes in delay Hub-spoke system have large impact.**
- **Possible mismatch between plan accuracy and operational implementation**

Demand Management

Peter Kostiuk:

- Queuing and econometric model assessment of US NAS Options.
- Delay metrics do not capture true economic benefits of ATM investments.
- Demand management shifts costs around—true costs are not known.

Conclusions

- Making progress on understanding how to model uncertainties in the ATM system:
  - demand
  - capacity
  - weather
  - execution of strategies
  - economics
- TFM is a very non-linear problem at/near saturation
- Results suggest a more dynamic approach to managing system to improve capacity
  - Right information to the right people at the right time.
- However, How to integrate with aircraft operator needs is a challenge.

Topics for the Future

- Limits to system capacity
- Probabilistic treatment of optimization strategies
- Impact of non-linearities in the ATM system
- Better data
  - Consistent accurate data across various systems
  - Cost data in particular
  - Aircraft operator intent data
- Cost/Benefit/economic assessment of technologies and/or solutions must be incorporated more fully in their descriptions