Dynamics of Air Transportation System Transition

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and
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Need for System Transition

- Existing US ATM system is not sufficient to meet future demands
- Need for major transformation has been recognized
  - Reflected in NextGen plans for system change
- Magnitude of planned changes is unprecedented
- Ability to achieve system transition is a key future core competency in the air transportation systems
Feedback Model of System Change

- Model developed based on 20 case studies (successful and unsuccessful) of past changes in the US Air Transportation System, control theoretic approaches, and agenda setting literature.
Past System Changes Have Been Driven by Safety Catalytic Events

<table>
<thead>
<tr>
<th>Catalytic Event</th>
<th>Casualties</th>
<th>New System Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grand Canyon, AZ (June 30, 1956)</strong>&lt;br&gt;Midair collision between two commercial aircraft in uncontrolled airspace over the Grand Canyon.</td>
<td>120</td>
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<td><strong>Los Cerritos, CA (August 31, 1986)</strong>&lt;br&gt;Midair collision between a commercial and general aviation (GA) aircraft occurred above a residential neighborhood.</td>
<td>82</td>
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<td><strong>Dulles, VA (December 1, 1974)</strong>&lt;br&gt;A Controlled Flight into Terrain (CFIT) accident of a Trans World Airlines jet occurred near Berryvilla VA while on approach to Dulles International Airport.</td>
<td>92</td>
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<td><strong>Cali, Colombia (December 20, 1995)</strong>&lt;br&gt;A CFIT crash of an American Airlines jet near Buga Columbia while on approach to an airport in Cali Columbia.</td>
<td>159</td>
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<tr>
<td><strong>New York, NY (June 24, 1975)</strong>&lt;br&gt;A rapidly evolving weather phenomenon called a microburst caused an Eastern Airlines jet to crash during a thunderstorm while on approach to John F. Kennedy International airport.</td>
<td>113</td>
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<tr>
<td><strong>Charlotte, NC (July 2, 1994)</strong>&lt;br&gt;A USAir jet crashed after encountering a microburst while attempting to land at Charlotte-Douglas International Airport.</td>
<td>37</td>
<td></td>
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</tbody>
</table>
Opportunities for Safety Driven Change Have Decreased

U.S. and Canadian Operators Accident Rates by Year

Source: Boeing
New Transition Drivers

- Capacity
- Environmental Constraints

How will the system respond to capacity and environmental transition drivers?

Traffic Source: Sage Analysis courtesy Prof Ian Waitz
Multi-Stakeholder Nature of System Makes Transition Difficult

- **Demand** → **System Capability** (NAS)
- **System Behavior** → **Catalytic Event**
- **Implementation Process**
  - Safety and Environmental Approval Processes
- **Awareness Building Process**
  - Capability Options
  - Public Awareness
  - Stakeholder Awareness
- **Change Process**
  - **Solution Refinement Loop**
  - **Selected Actions**
  - **Objective Formation**
  - **Negotiation Loop**
  - **Stakeholder Preferences**
  - **Collective Decision Making**

- Stakeholder Values, Context
Stakeholder Objectives Driven by Perceived Costs and Benefits

- Asymmetrical cost and benefits distribution

Adapted from: (Dr. Karen Marias & Prof. Annalisa Weigel (MIT)
Increasing Airport Infrastructure to Increase System Capacity

- Current FAA OEP airports with ongoing or planned projects
  - Philadelphia
  - Los Angeles
  - Seattle
  - Washington Dulles
  - Chicago O’Hare
  - Charlotte
  - Atlanta
  - Dallas-Ft. Worth
  - Fort Lauderdale
  - Portland
  - Las Vegas
Asymmetrical Costs and Benefits lead to Disenfranchised Stakeholders

- Runway Expansion Example

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Airlines</th>
<th>Airport Authority/FAA</th>
<th>Flying Public</th>
<th>Commerce</th>
<th>Local Communities</th>
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<tbody>
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<td></td>
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<td>Reduced delays</td>
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<td>Economic growth</td>
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<table>
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<tr>
<th>Costs</th>
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<td></td>
<td>Financial Costs</td>
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<td></td>
<td>Increased noise and pollution</td>
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<td>Increased health risks</td>
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<td></td>
<td></td>
<td></td>
<td>Decreased property value</td>
</tr>
</tbody>
</table>

Legend

<table>
<thead>
<tr>
<th>Level of Benefit/Cost</th>
<th>Significant</th>
<th>Some/Indirect</th>
<th>None/Insignificant</th>
</tr>
</thead>
<tbody>
<tr>
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</table>
Environmental process provides a mechanism for disenfranchised stakeholders to block implementation.
Expansion Projects May not be Realized in Time to meet Demand

Top 30 Congested Airports in 2005

- SEA: ~24 years
- BOS: 37 years
- ATL: 15 years
- ORD: ~10 years
- IAD: ~12 years
- PHL
- STL: 10 years
- LAX: ~10 years
- ORG

Note: Figure adapted from www.fly.faa.gov

Pending Expansion Projects

Completed Expansion Projects
Airspace Redesign Projects are also Facing Environmental Barriers

- NY Airspace is one of the busiest in the world
- Planned changes would allow for more efficient use of resources
- Lawsuits threaten to delay or derail changes
Role of Capacity Catalytic Events

- Demand
- System Capability
- Solution Refinement Loop
- Selected Actions
- Collective Decision Making
- Negotiation Loop
- Objective Formation
- Stakeholder Preferences
- Awareness Building Process
- Capability Options
- Public Awareness
- Stakeholder Values, Context
- Implementation Process
- Safety and Environmental Approval Processes
- Change Process
- System Behavior
- Catalytic Event
- NAS
Demand Management is the Only Rapid Alternative

Demand Management

System Capability

Safety and Environmental Approval Processes

Implementation Process

Solution Refinement Loop

NAS

System Behavior

Catalytic Event

Awareness Building Process

Capability Options

Stakeholder Awareness

Public Awareness

Change Process

Negotiation Loop

Stakeholder Preferences

Collective Decision Making

Stakeholder Values, Context
Stakeholder Objectives also Driven by Timing of Benefits

Adapted from: (Dr. Karen Marias & Prof. Annalisa Weigel (MIT)
Temporal Distribution of Costs and Benefits

- Stakeholder objectives modeled using net present value (NPV)
Delays in Timing of Operational Capability Reduces Benefits

- Accelerating delivery of benefits has significant value
- Concerns about implementation will degrade perceived value of a change
- Trust and confidence in benefits delivery is critical
Many Planned Changes Require Stakeholder Equipage

- Required Navigation Performance (RNP)
- Area Navigation Routes (RNAV)
- Automatic Dependent Surveillance Broadcast System (ADS-B)
Delivery of benefits can be dependent upon the actions of other stakeholders.
Safety Certification and Approval Processes Delay Implementation

- **Demand**
- **System Capability**
- **NAS**

**Implementation Process**
- **Safety and Environmental Approval Processes**

**Awareness Building Process**
- **Catalytic Event**
- **Capability Options**
- **Stakeholder Awareness**
- **Public Awareness**

**Change Process**
- **Delay Loop**
- **Negotiation Loop**
- **Objective Formation**
- **Stakeholder Preferences**

- **FAA Infrastructure Decisions**
- **Stakeholder Equipage Decisions**
- **Stakeholder Values, Context**
- Complexity of safety certification and approval process poses a challenge to the approval of new capabilities

- There is a need to improve the efficiency and speed of these processes
Questions