Very Light Jet (VLJ) Operational Impact Analysis: ATC Workload Implications

Work in progress

Presented to: NAS Performance Workshop, Asilomar

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Date: 16 March 2006
Acknowledgements

• Doug Baart, FAA/ATO-P/Tech Ctr
  – Completion of datasets, augmentation of 2015 scenario with VLJ flights

• Dan Citrenbaum, FAA/ATO-P
  – Design and methodology development, ORLab assistance

• Sutesh Malhan, CTR Tech Ctr
  – Supporting Doug Baart

• Norm Watts, FAA/ATO-P/Tech Ctr
  – Creation of NCPS output files from AERALIB®

• Toni Trani, NEXTOR-Virginia Tech
  – Forecast information and flight profiles based on TSAM model

• Andrzej Wrotniak, Aerospace, Inc.
  – AwSim™ simulation model dataset development
Contents

• Motivation
• Approach
  – Design, datasets, etc.
• Results
• Summary
  – Observations, next steps

Image source: adamaircraft.com
Motivation

• **How will VLJs impact the NAS operationally?**
  – So far, rhetoric about “sky black with dentists”
  – Industry financial impact, ATO financial impact, but not NAS operational impact

• **Overtaking conflicts, traffic flow management**
  – Slower cruise speed may create unexpected increase in conflicts, workload

• **Analogy: tractors on the interstate**
Approach

• Run flight plan set in 4-D simulation tool (AwSim™) to measure conflicts
• Compare conflicts in baseline with future scenarios
• Conflicts are a proxy for ATC workload
  – Although not all ATC workload is associated with conflict resolution; e.g. sector loads are another component
• Examine airspace >18,000ft
  – Including cruise and transitioning aircraft
Experimental Design


<table>
<thead>
<tr>
<th></th>
<th>Low FL</th>
<th>High FL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>On-demand</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Success</td>
<td>Treatment A</td>
<td>Treatment B</td>
</tr>
<tr>
<td>Failure</td>
<td>Treatment C</td>
<td>Treatment D</td>
</tr>
</tbody>
</table>

- Additional hypothetical control (2015)

Initial results
Pending
Two VLJ flight profiles

- TSAM = Transportation Systems Analysis Model
- SATS = Small Aircraft Transportation System

<table>
<thead>
<tr>
<th></th>
<th>TSAM flight set</th>
<th>SATS flight set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average cruise altitude (FL)</td>
<td>248</td>
<td>286</td>
</tr>
<tr>
<td>Average flight time (min)</td>
<td>43</td>
<td>78</td>
</tr>
</tbody>
</table>
Forecast parameters (2015)

<table>
<thead>
<tr>
<th></th>
<th>On-demand success</th>
<th>On-demand failure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VLJ fleet</strong></td>
<td>5000</td>
<td>3000</td>
</tr>
<tr>
<td><strong>Utilization</strong></td>
<td>70%@1400 hrs/yr</td>
<td>all@400 hrs/yr</td>
</tr>
<tr>
<td></td>
<td>30%@400 hrs/yr</td>
<td></td>
</tr>
<tr>
<td><strong>Total VLJ hrs flown</strong></td>
<td>5.5M hrs/yr</td>
<td>1.2M hrs/yr</td>
</tr>
</tbody>
</table>
Flights derived from flight time

- Total flight hrs / avg. flight time = daily flights

<table>
<thead>
<tr>
<th>Flight time</th>
<th>TSAM FS: 43 min</th>
<th>SATS FS: 78 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-demand Success: 5.5M hrs/yr</td>
<td>Treatment A: 19,111 flights</td>
<td>Treatment B: 11,977 flights</td>
</tr>
<tr>
<td>On-demand Failure: 1.2M hrs/yr</td>
<td>Treatment C: 4170 flights</td>
<td>Treatment D: 2613 flights</td>
</tr>
</tbody>
</table>
Data source (baseline)

- April 20, 2005
  - High volume, good weather
- ETMS FZ messages
  - Flight plans

- Flight plans
- Pref routes → trajectories → filtering
- Waypoints
Data augmentation

• 2005 $\rightarrow$ FDG $\rightarrow$ +VLJ
  – 16 AC type classes
  – VLJ is 17th AC type class created from Eclipse 500 performance

• Conflicts: loss of separation
  – 1000 ft vertical
  – 5 nmi radius

Image source: eclipseaviation.com
Run the simulations in AwSim™
## Results I: overall comparison

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>nonVLJ Flights</strong></td>
<td>47,208</td>
<td>53,533</td>
<td>53,533</td>
<td>53,533</td>
</tr>
<tr>
<td><strong>VLJ Flights</strong></td>
<td>0</td>
<td>0</td>
<td>19,111</td>
<td>11,977</td>
</tr>
<tr>
<td><strong>Total flights</strong></td>
<td>47,208</td>
<td>53,533</td>
<td>72,644</td>
<td>65,510</td>
</tr>
<tr>
<td><strong>Total conflicts</strong></td>
<td>6032</td>
<td>8711</td>
<td>11,284 (16%/fl)</td>
<td>12,367 (19%/fl)</td>
</tr>
</tbody>
</table>
Results IIa: by FL

Conflicts by FL, A

Altitude (FL)

# Conflicts

VLJ Operational Impact Analysis
Asilomar 2006

Federal Aviation Administration
Results IIb: by FL (continued)
Results IIC: by FL (continued)

Conflict comparison: B-A

Altitude (FL)

# Conflicts

Federal Aviation Administration
Asilomar 2006
## Results IIIa: by conflict direction

![Conflict Direction Diagram](image)

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</thead>
<tbody>
<tr>
<td>Total conflicts</td>
<td>6032</td>
<td>8711</td>
<td>11,284</td>
<td>12,367</td>
</tr>
<tr>
<td>head-on/crossing/overtaking</td>
<td>1914 (32%)/2506 (42%)/1612 (27%)</td>
<td>2570 (30%)/3295 (38%)/2846 (33%)</td>
<td>3580 (32%)/4479 (40%)/3225 (29%)</td>
<td>3929 (32%)/5266 (43%)/3172 (26%)</td>
</tr>
</tbody>
</table>
## Results IIIb: overtaking by AC type class

- VLJ-other AC type overtaking conflicts as a percentage of total conflicts

<table>
<thead>
<tr>
<th>AC type</th>
<th>Treatment A</th>
<th>Treatment B</th>
</tr>
</thead>
<tbody>
<tr>
<td>HJet</td>
<td>11%</td>
<td>10%</td>
</tr>
<tr>
<td>LJet</td>
<td>12%</td>
<td>10%</td>
</tr>
<tr>
<td>SJet</td>
<td>13%</td>
<td>9%</td>
</tr>
<tr>
<td>VLJ</td>
<td>18%</td>
<td>7%</td>
</tr>
<tr>
<td>LTP</td>
<td>22%</td>
<td>36%</td>
</tr>
<tr>
<td>STP</td>
<td>23%</td>
<td>14%</td>
</tr>
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</table>
Preliminary observations

• VLJ contributes to overall workload increase
  – But not unexpectedly
  – Workload increase may have been much more without DRVSM

• VLJ impact highly dependent on FL choice
  – Higher FL trajectory set has more conflicts

• Seems like no great increase in overtaking conflicts
  – Perhaps not enough speed difference
  – Greater % overtaking VLJ-turboprop
Next steps

• Finalize Treatment A & B results
• Treatments C, and D
  – On-demand flop scenarios
• Corroboration of results with other models
• Other workload measures
  – TFM, sector load,
• Terminal phase of flight
  – Not just airport demand, or OD market demand
Ask now or email later:

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FAA,
ATO,
Operations Planning,
Office of Strategy

Image source: embraer.com

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