Aircraft Technology

Impact on Airport Capacity

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Chief Engineer Boeing Enabling Technology & Research
Agenda

- Traffic Growth
  - Airplane size
  - Flight frequency
- Fuel Supply
- Community Noise Reduction
- Adverse Weather
Priorities

• Safety
  – Precision approaches
  – Runway condition
  – Ground De-icing
  – Runway incursions

• Traffic Growth
The 767 Now Dominates the North Atlantic Market

- ETOPS enabled twins to fly over the Atlantic
- Low trip cost—twin-engine economics
- Point-to-point service
- Widebody comfort level
- Matches frequency/capacity to market demand
Traffic Growth

• Between Airports
  – Build an CNS/ATM web that can support the traffic without delays

• At Airports
  – Build more runways to deal with the volume, or
  – Get more passengers through the existing runways
    • Make bigger airplanes
    • Increase operations frequency
Airplane size

- Rough order of size
  - Runway / overpass / bridge strength
  - Span - Gate width (Folding wings)
  - Length - Dock size (Two deck loading)
The requirement

To make money -- for the airlines

Strategies

- Halve Fuel costs -- 6% rev  (3x profit)
- Halve Maintenance  4+%rev  (2x profit)
- Halve Ownership -- 15% rev  (7x profit)
  - Halve Purchase Price
  - Double Utilization

April 20, 2000
The Blended Wing Body

… to address Fuel Burn
A Different Solution

... to address utilization
Flight Frequency

• Limiting factor is often airplane spacing due to wing wake vortex
  – Eliminate the vortex
  – Avoid the encounter
    • FAA / ICAO separation standards
    • AVOS, Socrates, etc
  – Deal with an encounter
Video of Boeing Invention
Fuel Supply

• Conventional fuels - at least 80 year supply
• Wide range of alternatives but
  – infrastructure
  – airplane changes not always retrofitable
The selling price of alternative fuels will have to produce excellent profits to attract venture capital.
Effect of Alternate Fuels

- LH2
  - Better fuel burn for greater than transcon flights
  - Fueling losses are significant
  - Need infrastructure
- Liquid Methane
  - Like LH2

Change in Energy Consumption with LH2

<table>
<thead>
<tr>
<th>Flight Distance (nm)</th>
<th>Delta rel to Jet A</th>
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<tbody>
<tr>
<td>1750</td>
<td>-40%</td>
</tr>
<tr>
<td>3000</td>
<td>-20%</td>
</tr>
<tr>
<td>5500</td>
<td>0%</td>
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</table>

April 20, 2000
Community Noise Reductions

• Stage III minus 8 to 10 dB
  – Probably doable on new airplanes
  – Sometimes retrofitable
• May be problems with preferential runways and cross winds.
• Remote area cruise noise will still be heard
dBA

Now

- CUT-OFF SAW
- PNEUMATIC PEEN HAMMER

100

- TEXTILE WEAVING PLANT
- SUBWAY TRAIN (20')

90

- PNEUMATIC DRILL (50')

80

- FREIGHT TRAIN (100')
- VACUUM CLEANER (10')
- SPEECH (1')

70

2020

- ELECTRIC FURNACE AREA
- BOILER ROOM
- PRINTING PRESS PLANT

60

- TABULATING ROOM
- INSIDE SPORT CAR (50 MPH)

50

- NEAR FREEWAY (AUTO TRAFFIC)
- LARGE STORE
- ACCOUNTING OFFICE

40

- PRIVATE BUSINESS OFFICE
- LIGHT TRAFFIC (100')
- AVERAGE RESIDENCE
# Engine Noise Reduction Forecast

<table>
<thead>
<tr>
<th>Component</th>
<th>Year</th>
<th>Component ΔdB</th>
<th>Engine ΔdB</th>
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<tbody>
<tr>
<td>Lip Liner</td>
<td>2005</td>
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<td>0.6</td>
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<tr>
<td>Scarf Inlet</td>
<td>2003</td>
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<tr>
<td>Advanced Rotor</td>
<td>2006</td>
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<td>0.6</td>
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<tr>
<td>Adaptive Liners</td>
<td>2012</td>
<td>5.0</td>
<td>2.0</td>
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<tr>
<td>A-Max Lining</td>
<td>2003</td>
<td>5.0</td>
<td>2.0</td>
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</tbody>
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**Forecast Graph:**

- **Engine Noise Reduction Forecast**

![Graph showing engine noise reduction forecast](image)

File: 2015 Forecast
**Airframe Noise Reduction**

*Forecast*

### FLAP EDGE TREATMENTS

<table>
<thead>
<tr>
<th>EIS</th>
<th>2008</th>
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<tbody>
<tr>
<td>COMPONENT ΔdB</td>
<td>3.0</td>
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<tr>
<td>AIRFRAME NOISE ΔdB</td>
<td>0.8</td>
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</table>

### SLAT TREATMENTS

<table>
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<th>2008</th>
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<td>COMPONENT ΔdB</td>
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</tr>
<tr>
<td>AIRFRAME NOISE ΔdB</td>
<td>0.8</td>
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### SEALED SLAT AT LANDING

<table>
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<tr>
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<th>2008</th>
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<tbody>
<tr>
<td>COMPONENT ΔdB</td>
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<td>AIRFRAME NOISE ΔdB</td>
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### UNIFORM SPANWISE LIFT

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<tr>
<td>AIRFRAME NOISE ΔdB</td>
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### “CLEANER” LANDING GEAR

<table>
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<th>EIS</th>
<th>2010</th>
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<tbody>
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<td>COMPONENT ΔdB</td>
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<tr>
<td>AIRFRAME NOISE ΔdB</td>
<td>1.0</td>
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</tbody>
</table>

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April 20, 2000

File: 2015 Forecast
Airplane Design Choice Driven by Noise

Superior low speed L/D

Highly efficient engines and wing for low takeoff weight leading to lower takeoff thrust and noise

Engines over wing to shield inlet noise completely

Engines forward of trailing edge to shield aft engine noise

Low noise flap and slat designs or innovative quiet highlift designs

But ...
Adverse Weather

• Runway Conditions
  – Cart results not always helpful
  – Grooves

• Ground De-ice
  – Type IV fluids
  – Condition monitoring cameras