Hochschule für Angewandte Wissenschaften Hamburg

Aircraft and Technology Drivers for 21st Century Air Transportation Systems

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Eric Schwartz
Director
Boeing International
Berlin, Germany
Otto Lilienthal (ca. 1894)
Agenda

• Boeing Today
• 787 Dreamliner
• 21\textsuperscript{st} Century Geopolitical/Environment Drivers
• 21\textsuperscript{st} Century Owners
• 21\textsuperscript{st} Century Operators
• 21\textsuperscript{st} Century Customers
• Commercial Aircraft
• Aviation Services
• Defense Systems
• Network Systems
• Satellites and Launch Vehicles
• Financial Services
• Technology
Major Business Units

- Boeing Capital Corporation
- Shared Services Group
- Integrated Defense Systems
- Boeing Technology Organization
- Commercial Airplanes
- Major Business Units
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• 21st Century Owners
• 21st Century Operators
• 21st Century Customers
The Boeing 787 Dreamliner

- 787 Overview
- Market Drivers
- Technology Summary
- Program Status
The 787 Is a Complete, Flexible, Efficient Family

787-8
210-250 passengers (three-class)
8,000 – 8,500 nmi | 14,800 – 15,700 km

787-9
250-290 passengers (three-class)
8,600 – 8,800 nmi | 15,700 - 16,300 km

787-3
290-330 passengers (two-class)
3,000 – 3,500 nmi | 5,500 – 6,500 km
Configured for Success
787-8 Design Features

- Advanced wing design
- Composite primary structure
- Large cargo capacity
- Innovative systems technologies
- Breakthrough passenger cabin
- Overhead crew rests
- Enhanced flight deck
- Advanced engines and nacelles
Efficiency for Medium- and Long-Haul Markets

Dual-Class
Short Medium Range Rules

Twin Aisle
787-3

Single Aisle
787-3
737-600
737-700W
737-800W
737-900W
767-300
757-300
767-400ER
767-400ER
777-200ER
777-300ER
777-300
787-8
787-9

Tri-Class
Long Range Rules

747-200
787-3
787-400ER
777-200LR
(3 aux fuel tanks)

In Service
Launched
Study

Range (nmi)
Seats

1500 2500 3500 4500
100 150 200 250 300 350 400

Same Speed and Range - 747, 777, 787
Addressing the Market’s Needs (2006-2025)

- **61%** Regional jets
- **13%** Single-aisle
- **23%** Twin-aisle
- **4%** 747 and larger

- **27,200** airplanes
- **2.6 trillion delivery dollars***

*In year 2005 dollars
Fragmentation Is Happening

2005 International Scheduled Flights

Proposed Flights
Creating New Non-Stop Routes

The 787 can efficiently connect more than 450 new city pairs

Possible New Airport Pairs

- Vancouver - Sao Paulo
- Seattle - Shanghai
- San Francisco - Manchester
- Boston - Athens
- Tel Aviv - Montreal
- Munich - Nairobi
- Geneva - Singapore
- Dubai - Taipei
- Madrid - Manila
- Auckland - Beijing
Compatible with Today’s Infrastructure

- 787-8
- 767-300
- 787-9
- A340-300
Advanced Technology Contributions to 787 Efficiencies

- Engines
- Aerodynamics
- Materials
- Systems
Composite Solutions Applied Throughout the 787

- Carbon laminate
- Carbon sandwich
- Fiberglass
- Aluminum
- Aluminum/steel/titanium pylons

- Composites: 50%
- Aluminum: 20%
- Titanium: 15%
- Steel: 10%
- Other: 5%
Propulsion Systems Feature
Key Technologies

- Higher bypass ratio
- No-engine-bleed systems architecture
- Low-noise nacelles with chevrons
- Laminar flow nacelles
- Interchangeable (at the wing)
Advanced Systems Technologies Provide Value

Common Core
Open Systems Architecture

More Electric
Systems Architecture

Advanced Flight Controls

Integrated Health Management

e-Enabled Systems

Wireless IFE

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Improving the Flying Experience

787 is 15” (38 cm) wider

226.5 in (5.75 m)

A300/A310
A330/A340

Higher Humidity

Bigger Windows

15” (38cm) Wider

Better Air Quality

More Head Room

Lower Cabin Altitude

Smotherer Ride

Wider Seats and Aisles

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Quiet for Airport Communities

- Quieter for communities, crews, and passengers
- Less fuel used
- Lower emissions
- Fewer hazardous materials
- Less waste in production

60% less area affected than the A330 and A340

787 noise footprint stays in the airport property

85 dBA contours
3,000 nmi mission

London Heathrow

Source MS Mappoint, (c) Microsoft, Inc.
Structures Progress
Large Cargo Freighter First Flight
## 787 Dreamliner:

### Progressing on Schedule

<table>
<thead>
<tr>
<th>Event</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airplane Announcement</td>
<td>2002</td>
</tr>
<tr>
<td>Authority to Offer</td>
<td>2003</td>
</tr>
<tr>
<td>Program Launch</td>
<td>2004</td>
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<tr>
<td>Firm Configuration</td>
<td>2005</td>
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<tr>
<td>Start of Major Assembly</td>
<td>2006</td>
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<tr>
<td>787-8 First Flight</td>
<td>2007</td>
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<tr>
<td>787-8 Enters Service</td>
<td>2008</td>
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<tr>
<td>787-3 Enters Service</td>
<td>2009</td>
</tr>
<tr>
<td>787-9 Enters Service</td>
<td>2010</td>
</tr>
</tbody>
</table>

*Image of Boeing 787 Dreamliner*
Worldwide Market Interest Strong

36 customers, 455 announced orders and commitments. 432 Firm orders. (October 11, 2006)

* Leasing Operator
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Geopolitical and Environmental Drivers

Urban congestion and population growth
- drive transportation integration and new modes of travel

Globalization and leisure travel growth require safety and efficiency
- Breakthroughs in speed, range, and comfort
- New passenger convenience
- Safe and affordable

Dwindling natural resources and environmental concerns
- Cleaner alternative fuels
- Reduced emissions

Hydrogen Fuel Airplane
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• 21\textsuperscript{st} Century Geopolitical/Environment Drivers
• 21\textsuperscript{st} Century Owners
  – New Missions and Configurations
  – Enabling Technologies
• 21\textsuperscript{st} Century Operators
• 21\textsuperscript{st} Century Customers
Future Missions in the Next 20+ Years

- **Super/hypersonic airplanes** flying on the edge of space to meet the needs of intercontinental business travelers.

- **Ultra-quiet VTOL air taxis** will move people from local parking lots to urban multi-modal transportation centers.

- **Personal air vehicles** capable of landing on the owner’s driveway could emerge over the next 100 years.

- **Autonomous systems** will enable new defense missions and commercial services such as satellite repair.
Super-Efficient Platform Technologies

Technologies being developed today for the aircraft of tomorrow

- Nanotube fibers
- Integrally stiffened composite panels
- Nanotech materials
- Joining processes that eliminate fasteners
- New metallic alloys
- Smart coatings
- Fire retardant foam w/Nano-composites
- Multifunctional structures with embedded systems
Clean Platform Enabled
Future Operational Environment

Clean/Safe Multi-modal Transportation Systems

- More Electric Technologies support no-bleed engines power; ultra-capacitors, Li-Ion Batteries
- Photonics - Control/Power By Light
- Component Cooling by electron tunneling devices
- Fuel Cell Auxiliary Power Unit (APU)
Technologies Required to Realize the Morphing Aircraft of the Future

Advanced Structures

New metallic alloys and flexible skins

Active Aeroelastic Wing Research

Imbedded Actuation and Thermal Control

Small, Low Cost Actuators

Nastic Structures

Real-time Flight Control Systems
Mission Adaptive, Multi-ship Flight Control

Intelligent and “learning” flight control systems will ensure safe and reliable aircraft

- Provide optimal use of all flight controls and effectors
- Optimize performance and trajectory, for normal or abnormal conditions
- Key enabler for autonomous flight in national airspace systems

Piloted and autonomous air vehicles operate together in common controlled airspace

- Heterogeneous vehicle operations
- Autonomous deconfliction
- Managed formations of multiple aircraft – vortex drag reduction, air refueling, etc.
- Autonomous comm/surveillance platforms in near-term. Autonomous cargo in 10-20 years
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  • Super-Efficient Flight Crews
  • Integrated Vehicle, Fleet and System Health Management
• 21st Century Customers
Super-Efficient Flight Crews

Key Operational Challenges

- Demand for increased capacity & efficiency
- Need for improved system safety and security
- Need to minimize operations & support costs
- Integration of manned & unmanned vehicles

Enabling Technologies

Advanced vision & visualization devices
- Synthetic/enhanced vision
- Holographic/immersive interfaces
- Seamless real-time collaboration

Multi modality interfaces
- Robust head and eye tracking devices
- Touch sensitive/responsive interfaces
- Spatial auditory cueing/discrimination
- Speech synthesis/recognition

Advanced automation and decision support
- Intelligent/adaptive flight controls
- Dynamic human-machine task allocation
- Predictive models of human performance
Integrated Vehicle, Fleet and System Health Management

On and off board predictive health management

Integrated system architecture

Ubiquitous sensing

Self-awareness

Network centric system health and maintenance services
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Passenger Flow Services

Integrated travel data (land, sea, air)

Profile-based, location-enabled information push

Mobile collaboration

Virtual private network

Role-based access control

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Creating the Future of Aerospace

Questions?