ICA 2016
30th Congress of the International Council of the Aeronautical Sciences

A350 XWB
The Xtra that makes the difference

An Exercise in Global Co-Operation

Didier EVRARD
Gordon MCCONNELL
The Airbus reaction:… A350XWB a clean sheet design!

Didier EVRARD appointed new head of A350 XWB Programme

... with immediate effect

PRESS RELEASE

10 January 2007

Fabrice BREGIER and Louis GALLOIS
Dec 1st 2006

Airbus wants the 350 to compete with Boeing's "Dreamliner"

Le Bourget 2007 80 A/C for QATAR
Akbar al Baker
CEO Qatar Airways

Louis Gallois
CEO Airbus
1. Benchmark lead time

- As is:
  - Pre-development: 2 to 3 years
  - Development: 5 to 6 years
  - Ramp-up: 2 years

- To be:
  - Pre-development: 2 years
  - Development to maturity: 4 to 4.5 years
  - Ramp-up: FIS

2. Faster ramp-up

- Nb of A/C vs Time
- Target: 220 A/C
- 200 A/C
- 80 A/C
- 130 A/C
- A320

3. Fully Maturity at Entry into service

- High reliability
- Low maintenance costs
- High availability

3 clear and simple programme targets

- Faster
- More
- Better
A350 XWB
This time, customers like it!

810
Firm orders

43
Customers

End August 2016
Integrated & co-located multi-disciplinary teams in the best location

From TRL2* ...

- Program
- Research
- Materials & Processes
- Design & Trades
- Sizing
- Procurement
- Architects
- Specimens manufacturing
- Tests
- Quality
- Risk Share Partners

... to TRL6*

*TRL: Technology Readiness Level

Plateau team in Toulouse
Cabin Definition Centre in Hamburg
Competitive Product
- Technology maturity
- Design maturity

Develop Faster
- Programme risks anticipation
- Tools & processes

Produce Faster
- Ramp-up drivers
- Customisation

An Extended Enterprise Team
- Transparency and trust
- Communication

Customer First

Shaping efficiency
Fewer but larger workpackages

Systems Suppliers as Integrators

And a partnership mindset
Extended
Entreprise

A Global
Industrial
Footprint

Tier 1 and tier 2 suppliers
A common toolset

- Full 3D DMU
- Design & Sizing tools
- Route Book & Unified Planning
- TRL & MRL management
The Xtra that makes the difference
A family based on a single type with a common engine

Some very challenging technical objectives…

- 25% lower fuel burn than existing aluminium competitors
- 25% lower operating cost per seat than existing aluminium competitors
- Reliable aircraft with shortest development time and fastest ramp-up
- Most advanced technology:
  - Aerodynamics
  - Structure
  - Systems

Highest levels:
- Passenger comfort
- Amenities
A350 XWB Family

One new generation family

vs

two different generation families

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Seats</th>
<th>Configuration</th>
</tr>
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<tbody>
<tr>
<td>777-9</td>
<td>398 seats</td>
<td>10 abreast, 17”</td>
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<td>777-300ER</td>
<td>352 seats</td>
<td>10 abreast, 17”</td>
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<td>787-10</td>
<td>324 seats</td>
<td>9 abreast, 17”</td>
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<td>787-9</td>
<td>283 seats</td>
<td>9 abreast, 17”</td>
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<tr>
<td>A350-1000</td>
<td>366 seats</td>
<td>9 abreast, 18”</td>
</tr>
<tr>
<td>A350-900</td>
<td>325 seats</td>
<td>9 abreast, 18”</td>
</tr>
</tbody>
</table>
A350 XWB Cabin

Comfort
18" Y-class seat width
Wide panoramic windows

Efficiency
Largest overhead bins on the market
Space-efficient monuments

Technology
4th generation IFE
Unique flat floor
Full LED moodlighting

Well being
Quietest cabin in its class
Optimal cabin environment
Huge 25% less fuel burn

- Lightweight materials
- Latest generation engines
- State-of-the-art aerodynamics
- Highly integrated systems
A350 XWB
the new technology journey

- Advanced aerodynamics and high lift system
- Natural laminar flow air inlet
- Enhanced load alleviation functions
- CFRP primary structure
- Advanced cockpit and connectivity
- Highly integrated avionics
- 240V electrical system
- Electrical network and systems installation
Titanium
• High load frames
• Door surroundings
• Landing gear
• Pylons
No corrosion tasks

CFRP
• Wings
• Centre wing box and keel beam
• Tail cone (Section 19)
• Skin panels
• Frames, stringers and doublers
• Doors (Passenger & Cargo)
No corrosion or fatigue tasks

The right material in the right place:
• Reduced weight
• Significantly lower maintenance costs
Major contribution from research centers

- Aerodynamics and load alleviation
- CFRP and metallic materials development
- Lighting and EMI protection
- Simulation and FEM modelling
- Aircraft systems development (electrical network, avionics, …)

Research & Test Centers:
DGA, LCEO, NLR, ONERA, DLR
CFRP primary structure – New challenges

- Design and engineering tools
- Materials and process development
- Thermal and acoustic performance
- New factories and partnerships
- Tooling and industrialisation
- Repair technologies
- Lightning protection
- Electrical bonding and current return
Design Component demonstrators

Sub-assembly demonstrators

Full-scale airframe testing

Flight test

A350 XWB structure test pyramid

Unprecedented intensive test campaigns to ensure

• Development of design allowables
• Validation of methods and tools
• Proof of design features
• Robust manufacturing process
A350 XWB
Virtual full scale test model (VIFST)

Full non-linear FEM - allows real time simulation of the test specimen

- Reduction of risk during static test
- Excellent correlation between model and test strains
- Test programme on time
A350 XWB Airframe development

- Finite Element VIFST model compared to actual test deflections
Electro magnetic hazards

Electrical Network Modelling validated by full-scale test

12 full scale fuselage EMH tests for Development and Certification

- Validate Simulation
- Protection means → Verify efficiency
- Anticipate manufacturing issues
Demonstration by flight testing ILDAS

• 5 Icing exposure tests
  - 75 lightning flashes
  - 500 airframe damage sites
• No system disruptions
• No CFRP delamination only minor surface damage
• Excellent damage corellation
Systems simulation and testing

- Virtual Systems simulation platforms
- Functional Integration benches
- Aircraft simulators, iron bird and full-scale testing
Flight test and certification

• Unprecedented timescale for a successful flight test campaign:
  • 15 months
  • 5 test aircraft operated in “airline” conditions
  • Over 2,500 flight hours
  • 370 min. ETOPS granted at certification by EASA
Water ingestion

High Altitude

Function & Reliability

Testing in all environments

Cold trials

Hot trials
In service – 37 aircraft already delivered to all corners of the globe

Qatar Airways
11 A/C in service
first commercial flight
15 January 2015

Vietnam Airlines
4 A/C in service
First commercial flight
3 July 2015

Finnair
6 A/C in service
first commercial flight
9 October 2015

LAN/TAM
4 A/C in service
first commercial flight
25 January 2016

Singapore Airlines
5 A/C in service
first commercial flight
8 March 2016

Cathay Pacific
4 A/C in service
first commercial flight
1 June 2016

Ethiopian Airlines
2 A/C in service
first commercial flight
1 July 2016

Thai Airways
1 A/C in service
first commercial flight
September 2016

Next to come before year end, China Airlines and Lufthansa
A350 XWB – Expanding the Family

A350-1000: ~100 A/C in service
9 customers

A350-900: ~400 A/C in service
30 customers

A substantial fleet by 2020

Over

500 A350s

In service with

39 customers
Summary

• A350 XWB was a step change in Airbus for Integrated Programme and Technical management
  • New Technologies, New Ways of Working, Innovation in development methods and tools, Transparency

• Collaborative team work across Partners and Nations has always prevailed and enabled to achieve very tough targets:
  • A Human adventure beyond the technical achievements
  • Jointly we can have great pride for what has been achieved in the spirit of Professor Von Karman’s vision
Efficiently Yours