Presented by
Alain Joselzon

for the COPAC Convention on Air Transport and Environment

Reducing Noise, Fuel Consumption and Emissions

A vision, turned into reality, projecting towards the future

Madrid, 14 February 2008
Contents & Summary

• Introduction
• Aviation is Technology…partly…
• Technology: source of environmental progress…
• …even if interdependencies and trade-offs exist
• …and Aviation is Operations
• Global vision, integration, and cooperation of all actors are key to prepare the future
• Conclusion
• Introduction

• Aviation *is* Technology…partly…

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Introduction - Aviation today

• A worldwide safe, highly performing mass transportation system.
  ‣ Accessible, affordable and used by an increasing majority,
  ‣ Indispensable vector of multiple economic and social activities
• An easy target
  ‣ Despite unmatched improvement records, resulting from the sector’s continuous quest for perfection (safety, reliability, cost and performance – including fuel burn reduction)
    – Every achievement is taken for granted
    – High expectations of technology-related progress
      • Extensive R&D programmes that require huge investments to support needed technology and product development
      • Environmental dimension at the top of company and product requirements, to meet to-day’s & to-morrow’s challenges
  ‣ A high traffic growth sector, making it more visible
• Airbus is on its way towards an eco-efficient enterprise through its full range of activities – ISO14001 certified (sites and products throughout the whole life cycle)
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Aviation is Technology…partly…

- **Strong Technology incentive resulting from high requirements**
  - Complex technical products - very high reliability and safety standards
  - Multi-disciplinary technical domains, multiple criteria to integrate, sophisticated design & optimisation tools, test & validation processes
  - Relying on top expertise in all domains and very resource-intensive R&D activities (time, expertise, costs)

- **Very sensitive to operations**
  - Meteorological and flight conditions - Operational procedures
  - Air traffic management - Infrastructure and Land use Planning

- **Very dependent on socio-economic context**
  - Fuel price, high competition among manufacturers and airlines, small profit margins

⇒ every new product only worth developing if it brings a significant improvement step: mature technologies selected and integrated in line with product requirements and overall optimisation
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Propulsion System high performance design prospects

Innovative Turbofan Architecture
• Geared Turbo Fan
• Counter-Rotating Fans

Counter-Rotating Propfan Engines
By Pass Ratio up to 80 ↔ open Rotor technology
Structural Weight Reductions: a considerable progress story

1990 (10-12% *)

1990 (10-12% *)

2005 (20-25%*)

2005 (20-25%*)

2010-2015 (50+%*)

2010-2015 (50+%*)

Composite wing and fuselage

est. structural weight saving ~ 15%

Composite wing and fuselage

est. structural weight saving ~ 8%

Composite + Advanced Materials

* Percentage of composites in structural weight

Composite + Advanced Materials

* Percentage of composites in structural weight

GFRP (Glass)
QFRP (Quartz)
CFRP (Carbon)
Metal
Glare

« Materials Baseline »

« Materials Baseline »

est. structural weight saving ~ 8%
Achievements: 70% reduction in fuel burn
Aircraft Fleet Fuel Efficiency Recent Trend

- ~70% Fuel Efficiency improvement up to 1990 at product level
- Continuing improvement reflected at fleet level (average > 1.5%/year)
- IATA goal to improve fuel efficiency by at least 25% by 2020 from 2005
- Driven by strong & efficient market forces, combined with inherent fast-evolving high technology, improved operational practices & ATM
- Needs sustained research & technology funding from Industry & Governments
ACARE Vision on CO₂ Reduction

<table>
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<th>2000</th>
<th>2020</th>
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<tr>
<td>ATM</td>
<td>5-10%</td>
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<tr>
<td>Aircraft</td>
<td></td>
<td>20-25%</td>
</tr>
<tr>
<td>Engine</td>
<td></td>
<td>15-20%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
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<td>50%</td>
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Potential for fast broad-based solutions to be taken into account!
Capacity growth without noise increase

Illustration: A380 and London QC departure noise

Capacity doubled at constant departure noise noise
Some Technology Advances in Acoustics

- Low noise Nacelle (Air Intake)
- Low noise Nozzle
- Low noise Landing Gear
- 0-Splice Air Intake Liner
Breakthroughs for fuel burn & emissions reduction are possible...
Fuel Saving is part of aircraft manufacturer’s core business
Synergies and Architectures: Energy generation

**FUEL CELLS**

Expected ~ Next Decade

- H2 Bottle Replacement
- RAT Replacement
- APU Replacement
- Kerosene
- Primary Power Supply
- Alt. fuel

Step by Step approach

TIME

Primary Power Supply

Fuel Cell System
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Interdependencies & Trade-offs: a permanent challenge

- Low CO₂
- Low fuel burn
- Low fuel consumption
- Low Noise
- Big
- Light
- Small
- Big
- Hot
- Cold
- Cold
- Low NOₓ
- Low Maintenance Costs
Technology & Design drivers

SAFETY

Performance
Operability
Reliability
Maintainability
Durability

Product Development & Optimization

Interdependencies

Technologies

Design architectures configurations

Fuel Efficiency
Emissions
Noise
Comfort
Capacity

Environmental requirements need to be balanced with multiple other aircraft design requirements
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Operational aspects are a major element in aviation environmental effects

• Operational improvements are crucial to environmental efficiency
  ‣ Important potential gains from operational procedures optimisation (ground, flight, maintenance)
  ‣ Important potential gains from traffic management optimisation
  ‣ Some impacts are by essence operational-dependent

• Operational improvements are often combined with / dependent on / technology developments
Operations can bring important environmental benefits, often combined with Technology - Full analysis needed

**Motored Gear**
- Reduced noise
- Autonomy, but …
- Not a fuel burn reduction technology (benefit on ground compensated by penalty in flight)

**High Speed Towing**
- Significant fuel burn benefit potential (tractor vehicle more efficient than aircraft engines at idle)

**Source**: WheelTug 2007

High-Speed Towing may save up to 10,000 tonnes fuel per aircraft over a 20 year A320 lifetime!
Operation: Noise abatement procedures

Major Stakes with respect to Operations, Noise & Environmental footprint

- Noise gains & rapidity of optimisation process, TOW, mission, FLEX-TOFF, traffic growth, airport capacity, airborne systems, procedure automation & crew workload, fuel burn & emissions

What Airbus is doing

- High achievements in enabling optimised and automated procedures, maximised environmental benefits and aircraft operability, minimised operator and crew workload, while maintaining or enhancing safety level

- Leading or actively involved in further research & development for enhanced optimisation capability & benefits

- Very active in international efforts to stimulate & frame progress through ICAO/CAEP
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Aircraft Life Cycle: a manufacturer challenge, and a global environmental vision

Airbus fully committed & operational, with ISO 14001, Environmental Management System, Eco-Efficiency concept & policy in place.
Airbus is deeply involved in Clean Sky JTI

- Will demonstrate & validate technological breakthroughs needed to reach ACARE environmental goals for 2020 *
  - Mega-project = 1.6 Bn € - 86 partners - 7 years - Ambitious objectives - Wide scope (engines, aircraft, rotorcraft, operations, eco-design) - Actual Demonstrators to be tested - Technology Evaluator to assess realistic technological integrations/combinations
- Launched 5 February 2008
- Airbus, founding member, plays a leading role (Integrated Technology Demonstrator)

*-50% CO2 emissions, -80% NOx emissions, -50% perceived noise compared to aircraft in service in 2000
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CONCLUSION

In summary, Airbus:

- strives to leave no stone unturned, and rationally assess what is underneath,
- works with thorough determination, full strength, and in close cooperation with all other actors, to:
  - maximise its eco-efficiency,
  - help the Industry prosper responsibly, with less and less impact on the environment, and
  - contribute to the eco-efficiency of the whole aviation sector.
As for the future, you do not have to foretell it, but to enable it.

No debes prever el porvenir sino permitirlo

*Autors de Saint Exupéry*

**Muchas Gracias**
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