The Airbus Challenge

- Products & Technologies

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Engineering,
Airbus
Welcome
to the world of Airbus
Airbus at a glance

Welcome to the world of Airbus

- A world of product innovation
- A world of technical excellence
- A world of challenge & opportunity
Passengers at heart. Airlines in mind.

Airbus designs, sells, builds and supports the most modern and comprehensive aircraft family in the world thanks to:

- Unrivalled flexibility across four aircraft families, all of which have been developed in response to customer needs
- 57,000 employees around the world, including France, Germany, Spain, the UK, North America, China, Japan and Russia
- A global network of over 297 customers and 288 operators
- Close working relationships with its shareholder EADS
Numbers of a culturally diverse, global company

- 57,000 employees
- 20 languages
- 3 customer support centres
- 50 flight simulators
- 160 offices
- 297 customers
- 4 training centres
- 290 resident customer support managers
- 16 manufacturing sites
- more than 88 nationalities
- more than 5,000 aircraft delivered
- 5 spares centres
- 9 engineering design centres
- more than 288 operators
- 24 hour customer support (365 days a year)
- 1 global company
Growing together

- The cultural diversity of 57,000 employees from 88 nations gives Airbus a strong competitive advantage.

- Airbus recruits an increasing number of women in traditionally male roles such as engineering.

- Airbus’ people strategy, Growing Together, encourages better performance, higher quality and job dedication.

- Responsibility and initiative are fostered at all levels, with strong support for current and future leaders.

- Airbus promotes an open dialogue with employees and employee representatives.

- Airbus celebrates and rewards employee achievements through national and company-wide award schemes.
Airbus’ achievements by the end of 2007 included

- A stable annual turnover of approximately 26b€
- A gross market share (units) of 51 %
- Delivering 453 aircraft and selling 1,341 in 2007
- Surpassing 8,000 aircraft ordered by 297 customers
- Supporting 5,000 aircraft in service with 288 operators
- Regularly achieving over 50% of large civil aircraft orders and deliveries

Data to end Dec 2007
A world of product innovation
Evolution of the Airbus family

- **8,833 orders**
- **297 customers**
- **5,140 delivered to date**
- **453 delivered in 2007**

Data to end Mar 2008
Evolution of the Airbus family

The A300/A310 Family
Strong foundations from which to grow

- The first Airbus aircraft
- The first twin engine widebody
- The first civil aircraft with a forward-facing two man cockpit
- The first civil aircraft with composites in secondary, and then primary structures
- The first civil aircraft to feature drag reducing wing tip devices
Evolution of the Airbus family

The A320 Family
The versatile answer for profitability

- The world’s best selling aircraft family
- The widest single-aisle aircraft
- The first civil aircraft with full fly-by-wire and side stick control
- The lowest operating cost and highest residual values in its class
- The only business jet certified for public transport
- The first civil aircraft to have a composite tailplane and flaps
Evolution of the Airbus family

The A330/A340/A350 Family

The most comfortable cabin in the sky

- The most technologically advanced and fuel efficient civil aircraft on the market
- The most spacious and quiet cabins
- The first civil aircraft with a composite rear pressure bulkhead and keel beam (A340)
- 60% advanced materials (A350 XWB)
Evolution of the Airbus family

The A380 Family
The flagship of the 21st century

- Airbus’ response to growing demands on transport
- The most spacious and comfortable cabin available
- The most technologically advanced aircraft in commercial production today
- The first civil aircraft structure to incorporate 25% composites
- The highest level of environmental performance in its class
- New hydraulic electric system
A world of technical excellence
Commitment to technological leadership

A world of technical excellence

- The Airbus family has pushed the boundaries of technology, through design techniques, the development and application of new materials and innovative production processes.

- The majority of Airbus’ research targets safety, efficiency and performance.

- Airbus believes in investing in partnerships, research, new technology and training that benefits not only Airbus, but the wider industry and emerging economies.

- Airbus has a central role in a range of industry-wide research actions including Vision 2020, VIVACE, AWIATOR and CLEANSKY.
Continuous Product Development

A320 - Determined to drive down cost

Lower drag fuel surge-tank vent
New shaped engine pylon
Engine upgrades
- CFM & IAE
Redesign of upper wing-to-fuselage fairing
Winglet research testing

A340-500/600 new optional 380t MTOW

New cabin with innovative customisation options
New flight deck avionics
- Advanced Fly-by-Wire
Revised wing
Upgraded, e-enabled systems
New structural materials
New Generation engines

A world of technical excellence
A380 Structural Topology optimization

Topology optimization results are comparable to optimized nature solutions enabling significant weight reduction.

Typical shear panel leading edge track rib pair

New design

A380 droop nose hinge rib 2, t-section strut concept
Rationale
Reduce operational cost
Reduce local and global environmental impact
Reduce development time and cost

Solution
Aerodynamic design based on overall aircraft high-fidelity CFD
Extended laminar flow nacelle with a higher proportion of natural laminar flow
Droop-nose device on inboard wing
Multifunctional trailing edge flap system: Adaptive Dropped Hinge Flap
Integrated use as high-lift device and for in-flight adaptation of cruise wing shape

Benefit
Fuel burn reduction through drag saving
Load alleviation functions and cruise efficiency enhancement
Improved design through increased prediction accuracy
Essential savings in development time and cost
A350XWB - Next Generation Engines

Rationale
- Reduce cost of operations
- Reduce local and global environmental impact

Solution
- Most modern jet engine: Rolls-Royce Trent XWB

Benefit
- Low SFC: low fuel-burn
- Low maintenance costs
- Low emissions
- Low noise
Rationale
Reduce operational cost
Reduce global environmental impact

Solution
Use of CFRP fuselage panels, doublers, joints & stringers, keel beam & typical frames
Use of panel concept for CFRP fuselage
Use of Aluminium-Lithium for cross-beams, seat-rails in dry area and cargo floor structure

Benefit
Light weight fuselage help fuel-burn savings
Fatigue- and corrosion-free composites save maintenance costs
5% density reduction for cross-beams/seat rails
Rationale
Reduce operational cost
Reduce global environmental impact

Solution
Use of Aluminium-Lithium for wing ribs
Use of CFRP spars, skins and stringers

Benefit
Light weight wing structure helps fuel-burn savings
Fatigue- and corrosion-free composites save maintenance costs
5% density reduction for wing ribs
A world of challenge & opportunity
Environmental Challenges on Future Aircraft

Airbus has implemented a joint policy to improve the environmental performance of its aircraft and the impact of production, as well as the working conditions of employees. The company’s position reflects the outcome of the ACARE group and its vision for the air-transport system of 2020.

- Less fuel burn for the same payload, same mission at lower emissions
- Less emissions (CO₂, NOₓ, …) for the same fuel burn

“...by 2020 all new Airbus aircraft entering the market would produce 50 per cent less CO₂ and 80 per cent less NOₓ than levels in 2000!”

Louis Galois, 2007 International Paris Air Show Le Bourget, based on ACARE Vision 2020
Technology Drivers & Solutions

Addressing the Environmental & Commercial concerns of our customers points us to a number of specific technical objectives.

- **Weight reduction technologies**
  - Structures & material
  - Load control & limitation

- **Drag reduction technologies**
  - Aerodynamic design
  - Surface material & quality
  - Manufacturing & maintenance

- **Improve engine technologies**
A Brief Diversion Into Aircraft Drag

A world of challenge & opportunity

Typical break down of overall aircraft† drag by form & component

<table>
<thead>
<tr>
<th>Total Drag</th>
<th>Friction Drag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parasite</td>
<td>Pylons + Fairings</td>
</tr>
<tr>
<td>Wave / Interference</td>
<td>Nacelles</td>
</tr>
<tr>
<td>Lift Dependent Drag</td>
<td>Horizontal Tail</td>
</tr>
<tr>
<td></td>
<td>Vertical Tail</td>
</tr>
<tr>
<td></td>
<td>Wing</td>
</tr>
<tr>
<td></td>
<td>Fuselage</td>
</tr>
</tbody>
</table>

† = Based on a typical A320
Laminar & Turbulent Flows

Laminar boundary layer has much lower friction drag

Large drag reduction possible, even if only part of the surface is laminar

Drag Coefficient
(skin friction drag)
Drag Reduction Potential

Potential Drag Savings (aircraft level) of at least 10%

Wing
Tail
Nacelles

Benefits: Lower fuel burn
Decreased pollution
Decreased CO₂
Range extension
Reduced operating costs
Framework for Preparing Breakthrough Technologies

A world of challenge & opportunity

Domain of Comfort

Domain of Opportunity

Realised Benefits

Characteristic Dimension of the Technology

Understanding

Opportunities

km
m
mm
μm
nm

Airbus
Research Establishments
Engineering Academia
Science Academia
The idea is to select concepts to explore the most relevant capabilities and meet the widest range of challenges. **Important:** these are not intended to be future Airbus products, but extreme configurations to develop our capabilities.
Innovative Components

“A Think out of the Box”

- Extended domain of opportunity by rethinking standard component concepts

Assessment, Optimisation and Down Selection is carried out through Multi-disciplinary parametric investigations
Promotion of Laminar Flow

Passive Laminar Flow
- Natural Laminar Flow
- Micro Roughness Elements

Active Laminar Flow
- Closed-Loop Tollmien-Schlichting Wave Control
- Heating
- Suction
Flow Control

Passive Control

- Riblets
- Dimples

Active Control

- Micro Electro-Mechanical Systems (MEMS)
  - Actuators & Sensors
- Low Energy Plasmas
- Micro-Blowing/Suction
Toward Smaller Scales: Surface Coatings

Purpose

- Use of nano-coatings for their Self-Cleaning and Self-De-icing properties.

Benefits

- Significant improvement of aircraft performance
  - Drag reduction
  - Operational Cost and Weight Saving

Examples

- Nano-structures on coatings allow to mimic the Lotus effect / Hydrophobic Surfaces
To understand and experience the impact that a substantial increase in simulation power will have upon the way future products are designed.

Objective

- To Develop Airbus Aerodynamics and Flight Physics Into a Fully New Paradigm of Simulation.
- Not Only Increase Throughput, but Will Radically Change the Design Process and the Role of the Engineer.

Advances in processor technology, increase of computer capacity and the “smart” use of High Performance Computing (HPC) power will enable an effective increase of simulation capability by up to a million times within the next decade.
Future Simulation Concept

- Innovative overall system for product design
- Change in “Engineer’s way of working“
- IT architecture impact
- Powerful HPC center

New Speed

New Tools

New Way of Working

Simulation Capability Increase by 10^6

DOVRES - Getafe/Madrid
- Virtual Reality for Design
- Field Programmable Processors
- CFD Specific Hardware

C^2A^2S^2E - Bremen/Braunschweig
- Comprehensive solutions for most relevant aircraft applications
- Technology integration
- Concentrated world expertise
- Powerful HPC center

Multi-Disciplinary Integration

FlowSimulator Software Backbone

Mosart - Toulouse/Paris
- Parallel Simulation Architecture Improvement
- CFD Components Improvement
- High Bandwidth Access to Remote Computers

A world of challenge & opportunity
Conclusions

Airbus Is a European Success Story, Demonstrating Its Ability to Compete With the American Giants.


The Key to Addressing the Challenges of the Future Lay in the Hands of Our Engineers and Their Ability to Innovate

The Skills of the Future Not Necessarily the Skills of the Past

- More Simulation Less Test
- Deeply Multi-Disciplinary / Integratory in Nature
- Focus on the “Domain of the Small”
.. A final thought

“As for the future, your task is not to foresee it, but to enable it.”
Antoine De Saint-Exupery 1900-44
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