

David Hills

**Flight Physics Centre of Competence,
Engineering,
Airbus**



The Airbus Challenge

- Products & Technologies



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.

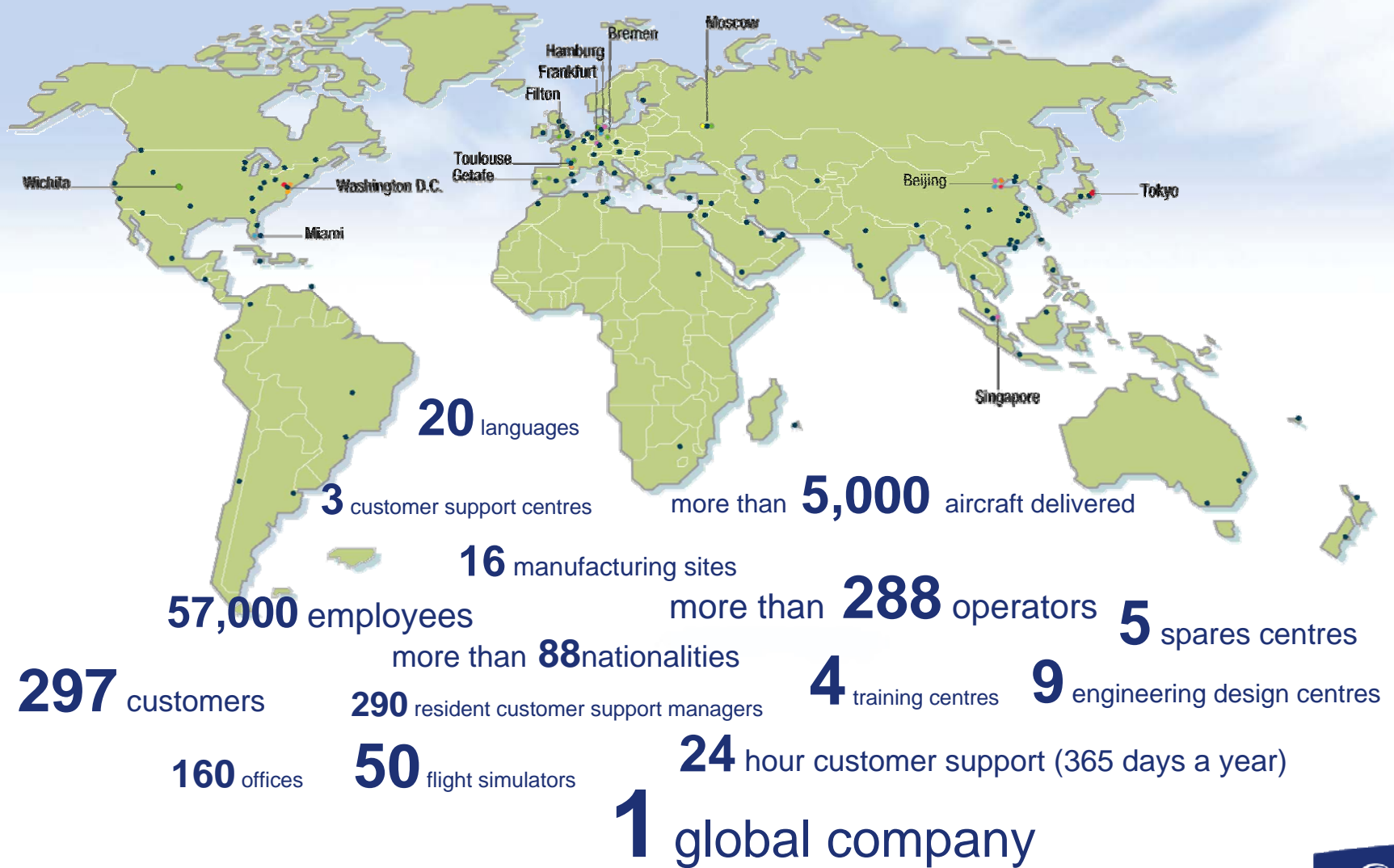
Welcome to the world of Airbus

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



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



Passengers at heart. Airlines in mind.

Welcome to the world of Airbus

Airbus' achievements by the end of 2007 included

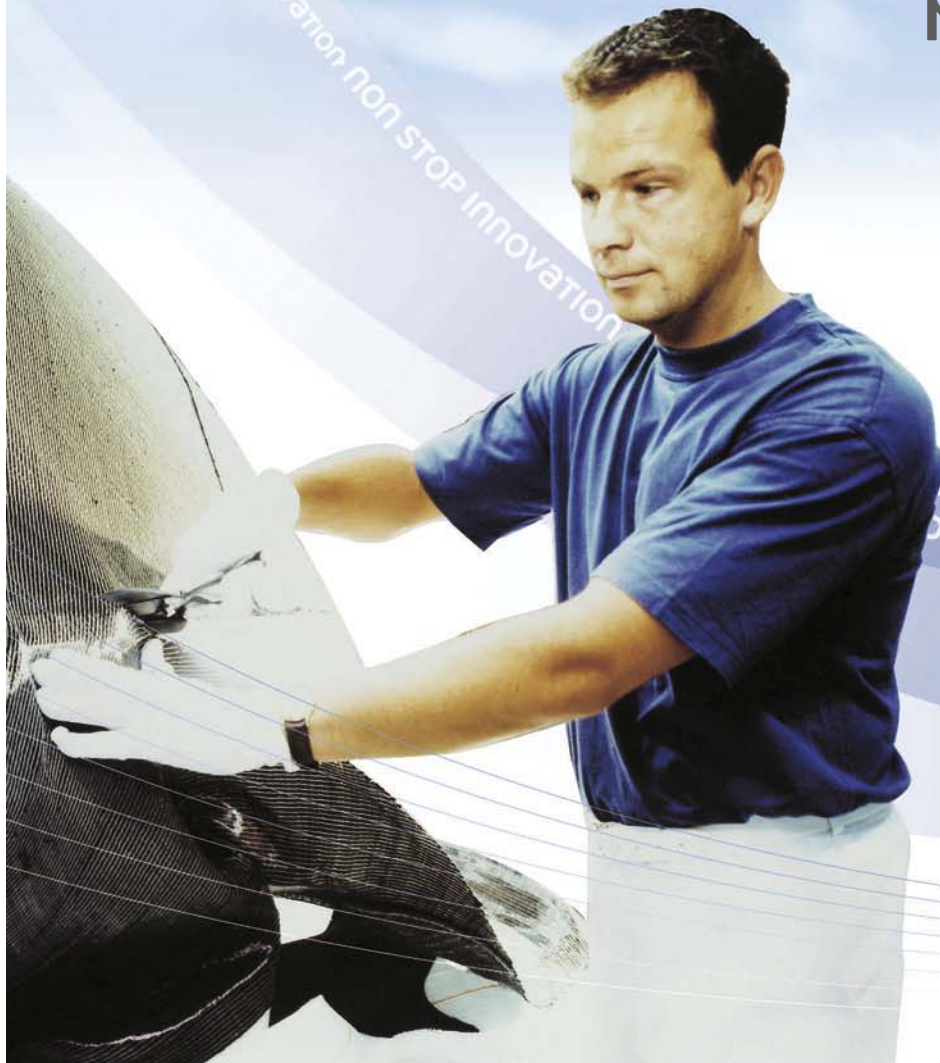
- ▣ A stable annual turnover of approximately 26b€
- ▣ A gross market share (units) of 51 %
- ▣ Delivering 453 aircraft and selling 1,341 in 2007
- ▣ Surpassing 8,000 aircraft ordered by 297 customers
- ▣ Supporting 5,000 aircraft in service with 288 operators
- ▣ Regularly achieving over 50% of large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



Data to end Dec 2007



A world of product innovation



Evolution of the Airbus family

a world of innovation

📈 **8,833 orders**

📈 **297 customers**



📈 **5,140 delivered to date**

📈 **453 delivered in 2007**

Data to end Mar 2008



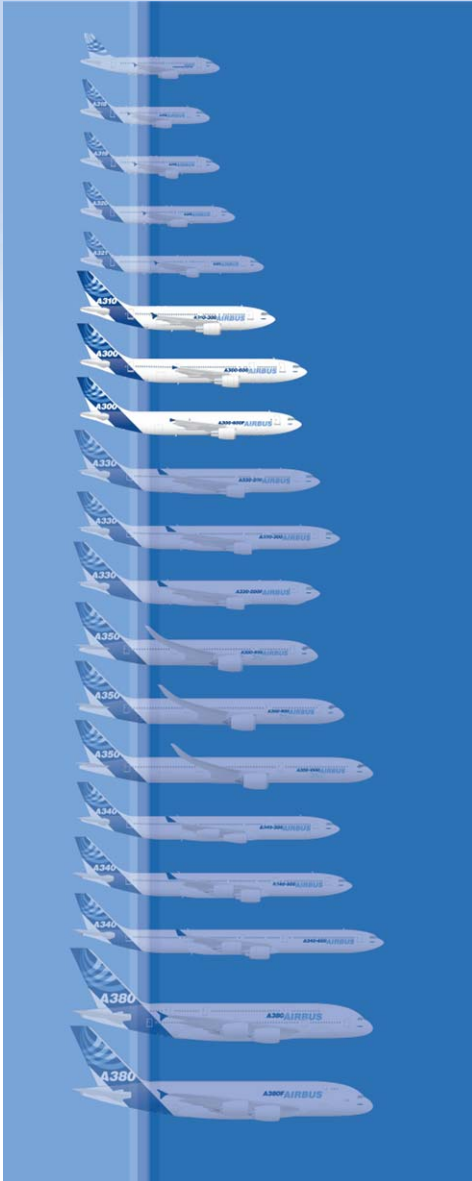
Evolution of the Airbus family

a world of product innovation

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



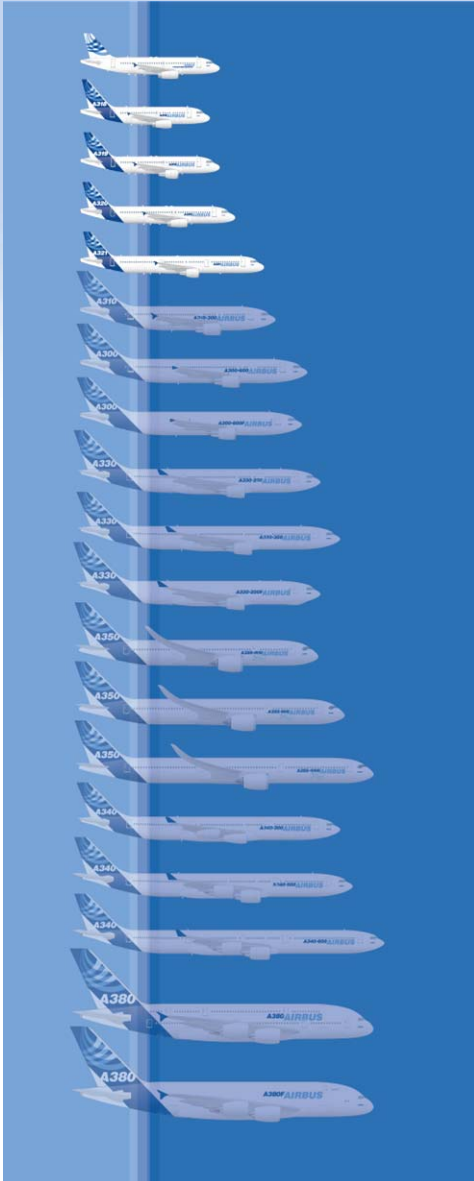
Evolution of the Airbus family

a world of product innovation

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



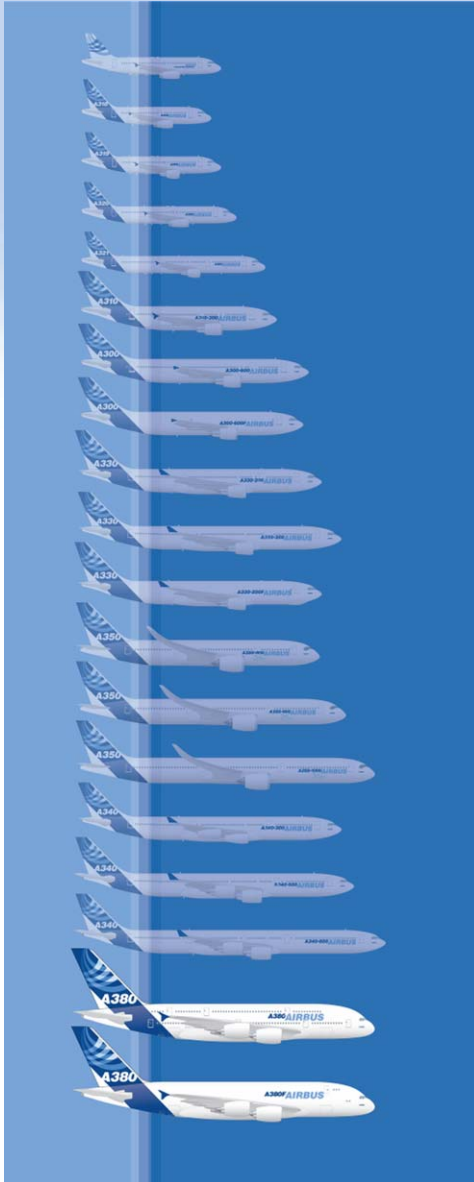
Evolution of the Airbus family

a world of product innovation

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

A world of technical excellence

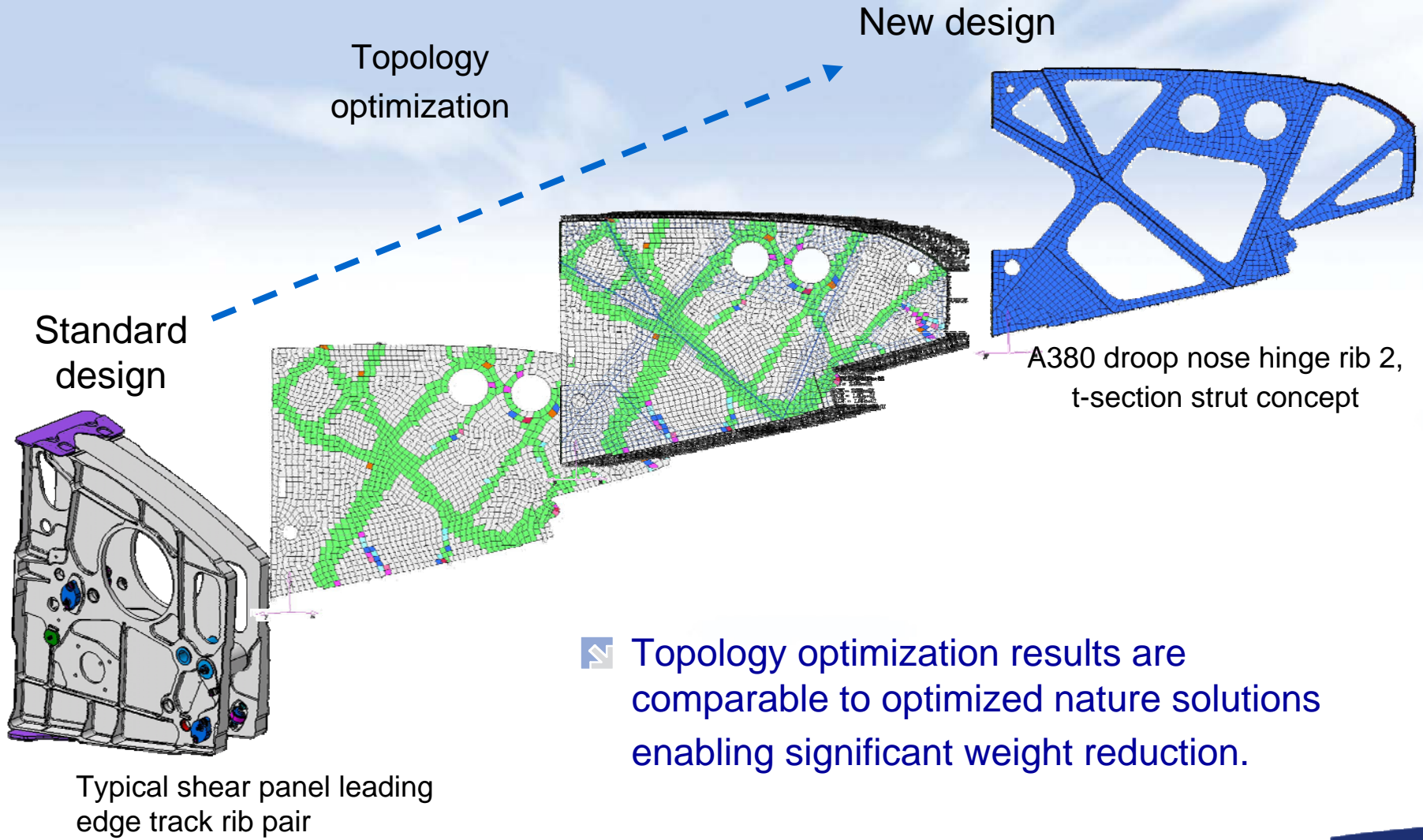


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A380 Structural Topology optimization

A world of technical excellence





A350XWB - Aerodynamics Technologies

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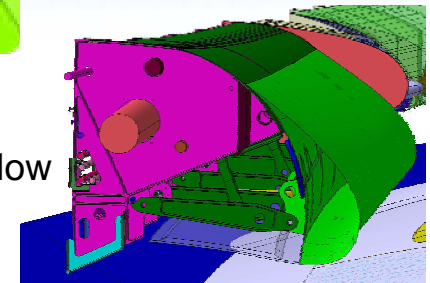
▣ Rationale

- Reduce operational cost
- Reduce local and global environmental impact
- Reduce development time and cost



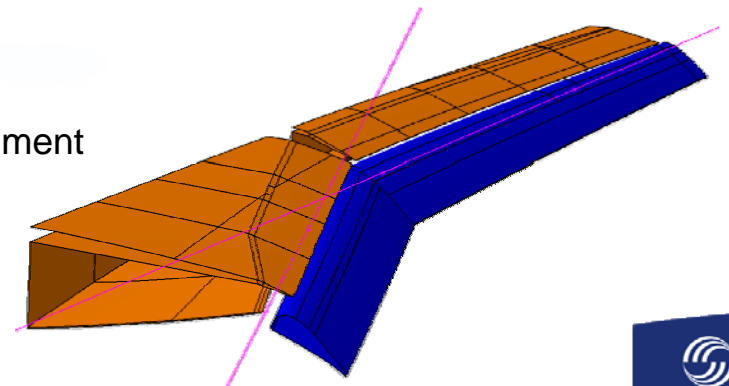
▣ Solution

- 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

A world of technical excellence



Rolls-Royce Trent XWB



Rationale

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



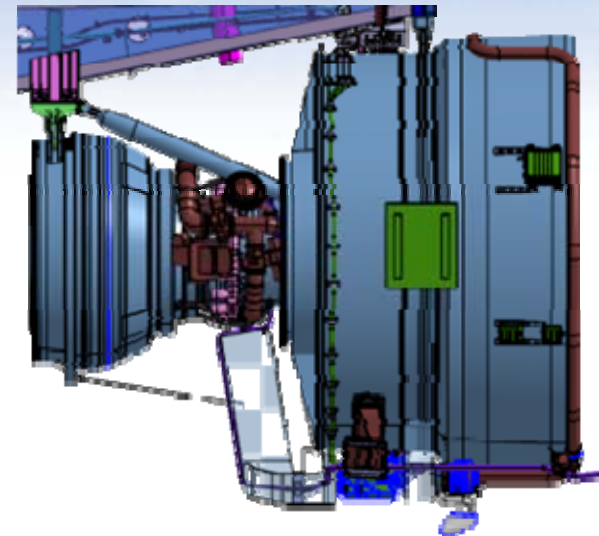
Solution

Most modern jet engine: Rolls-Royce Trent XWB



Benefit

- Low SFC: low fuel-burn
- Low maintenance costs
- Low emissions
- Low noise



A350-1000

A350-900

A350-800

74Klbs

83Klbs

92Klbs

A350XWB - New Material Fuselage

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Rationale

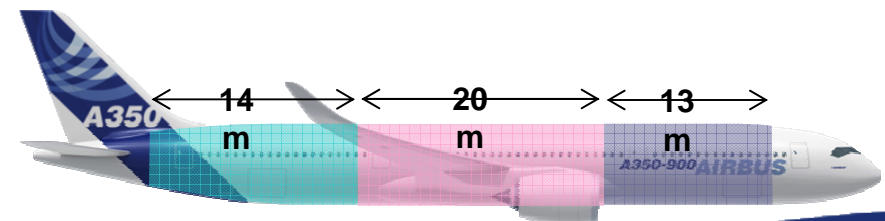
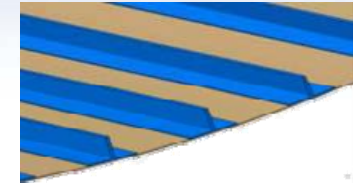
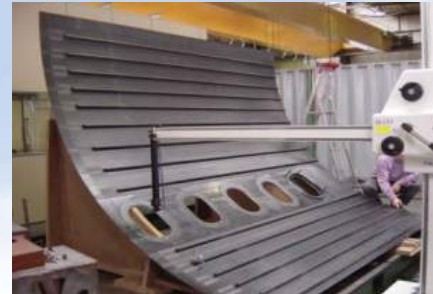
- Reduce operational cost
- Reduce global environmental impact

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



A350XWB - New Material Wing

A world of technical excellence

▣ Rationale

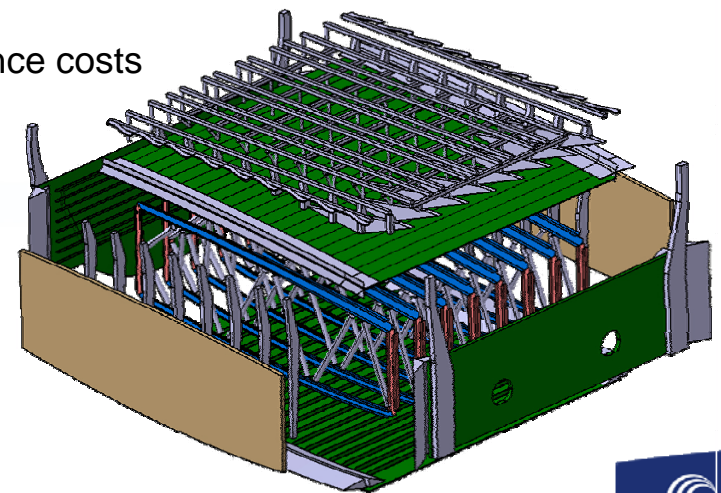
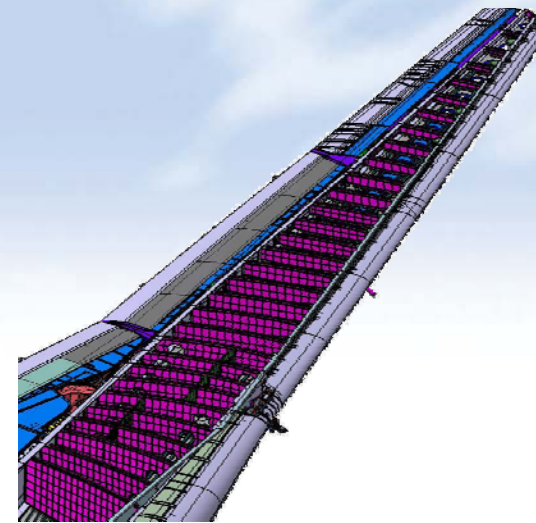
- Reduce operational cost
- Reduce global environmental impact

▣ 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

A world of challenge & opportunity



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 companies 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 (CO_2 , NO_x , ...) for the same fuel burn



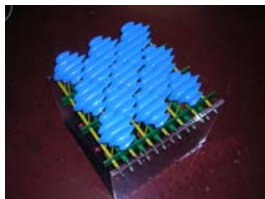
✚ *"...by 2020 all new Airbus aircraft entering the market would produce 50 per cent less CO_2 and 80 per cent less NO_x than levels in 2000!"*



Louis Galois, 2007 International Paris Air Show Le Bourget, based on ACARE Vision 2020

Technology Drivers & Solutions

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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

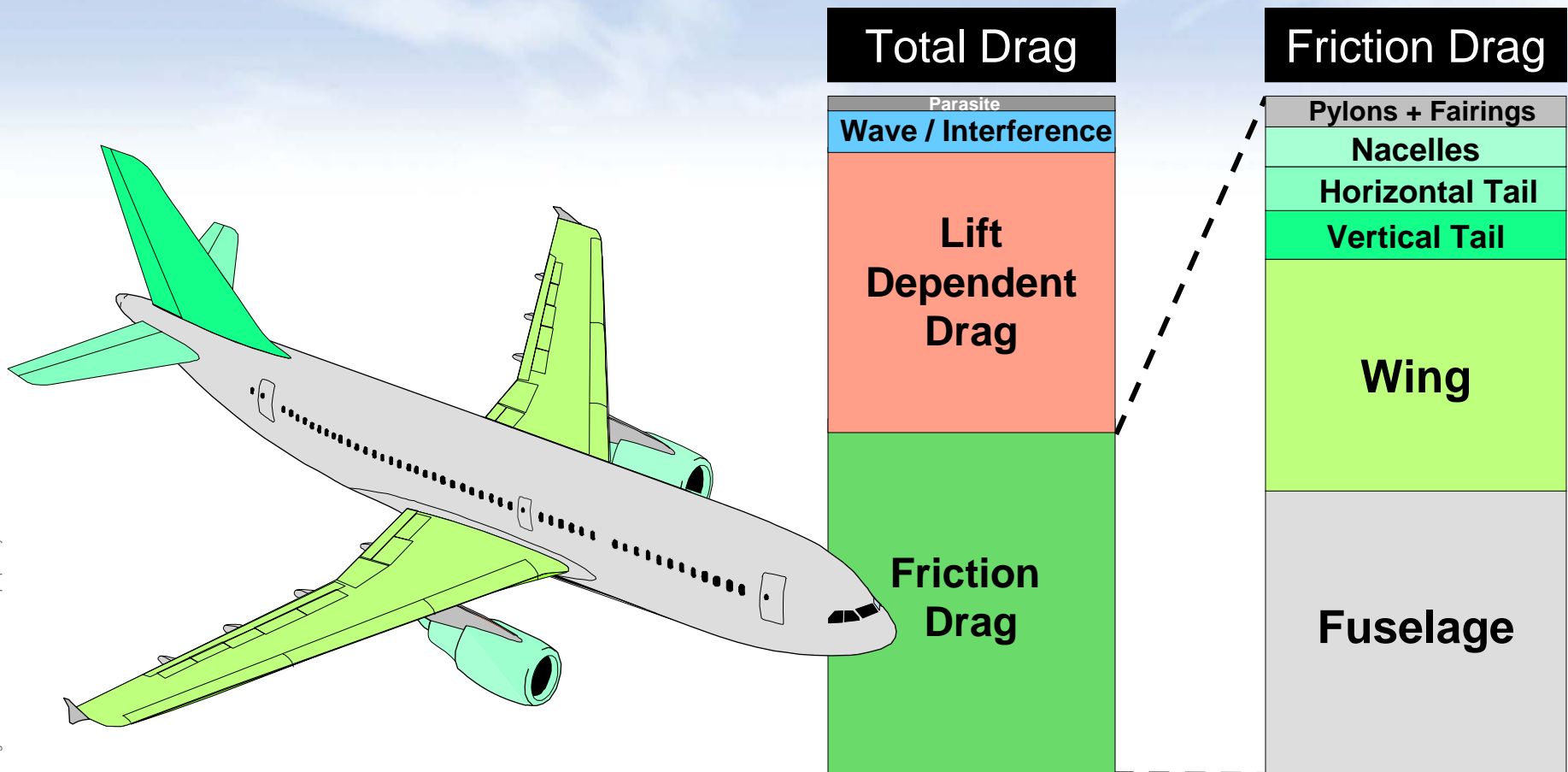
Improve engine technologies

**Focus For the
Rest of This
Presentation**

A Brief Diversion Into Aircraft Drag

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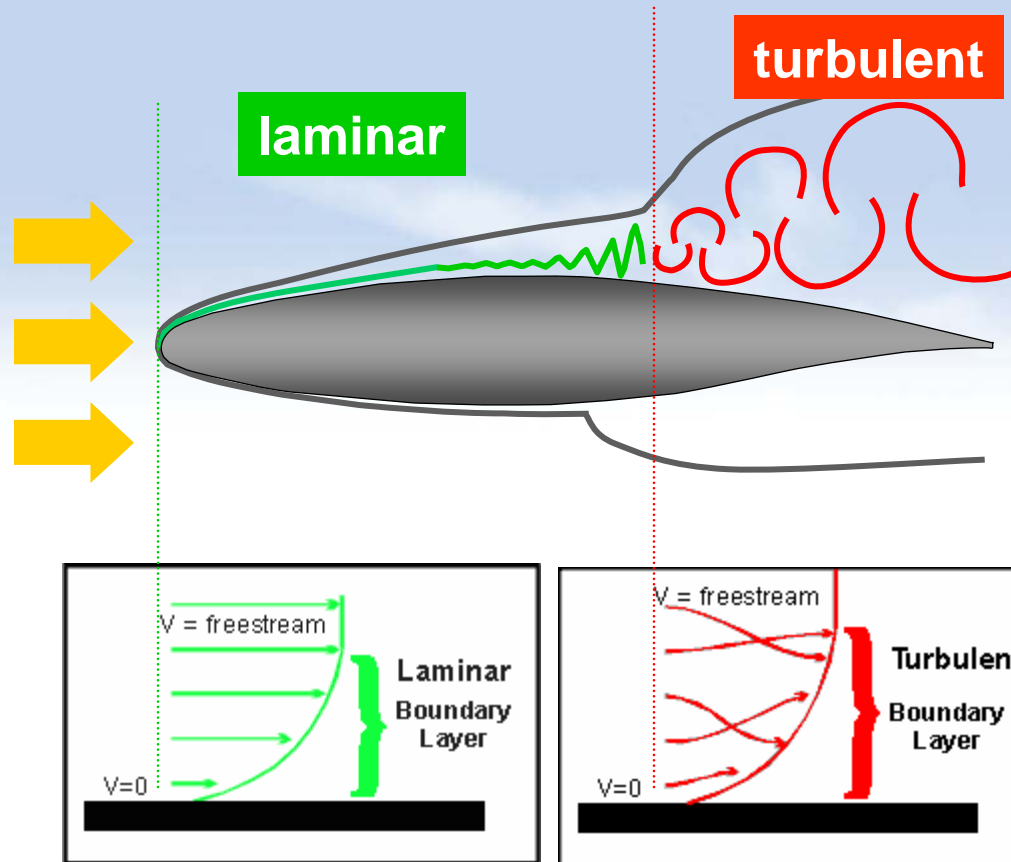
☒ Typical break down of overall aircraft[†] drag by form & component



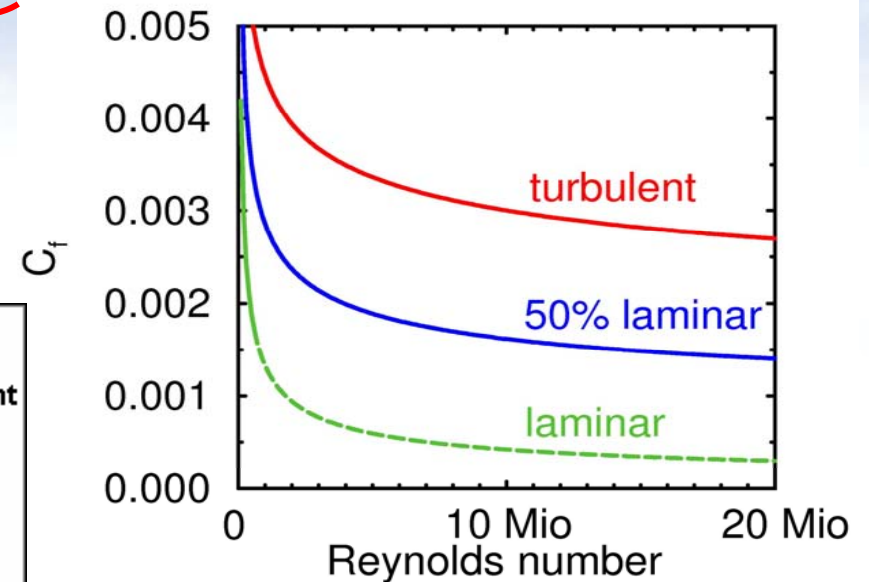
† = Based on a typical A320

Laminar & Turbulent Flows

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Drag Coefficient
(skin friction drag)



➤ Laminar boundary layer has much lower friction drag

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

Drag Reduction Potential

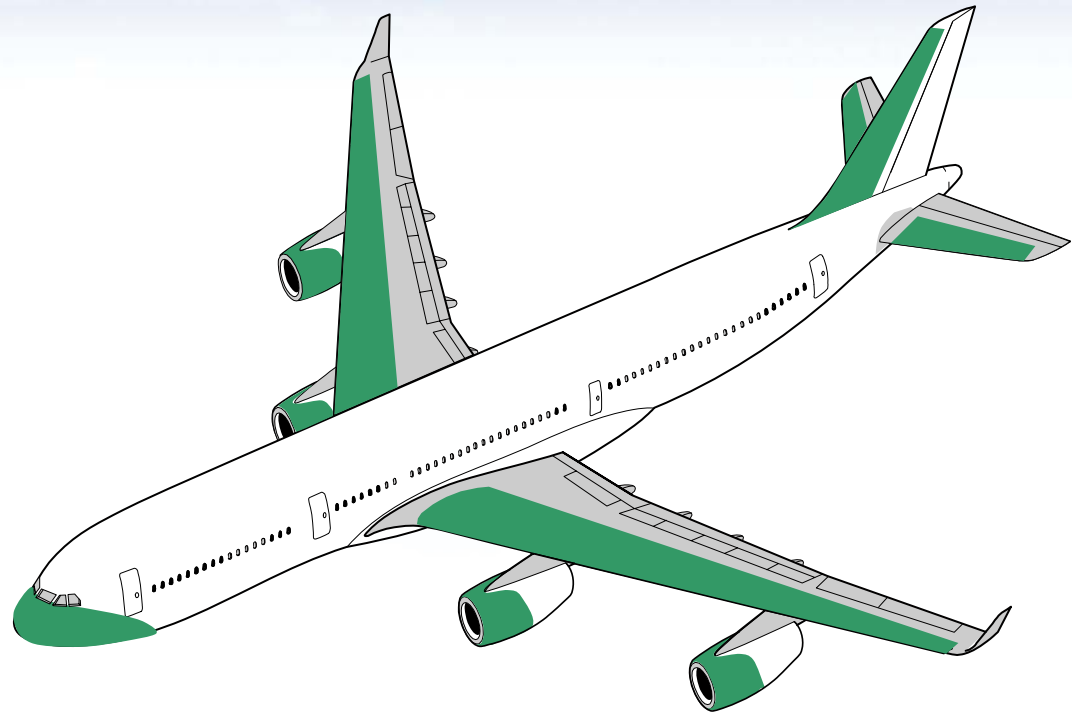
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▣ Potential Drag Savings (aircraft level) of at least 10%

- Wing
- Tail
- Nacelles

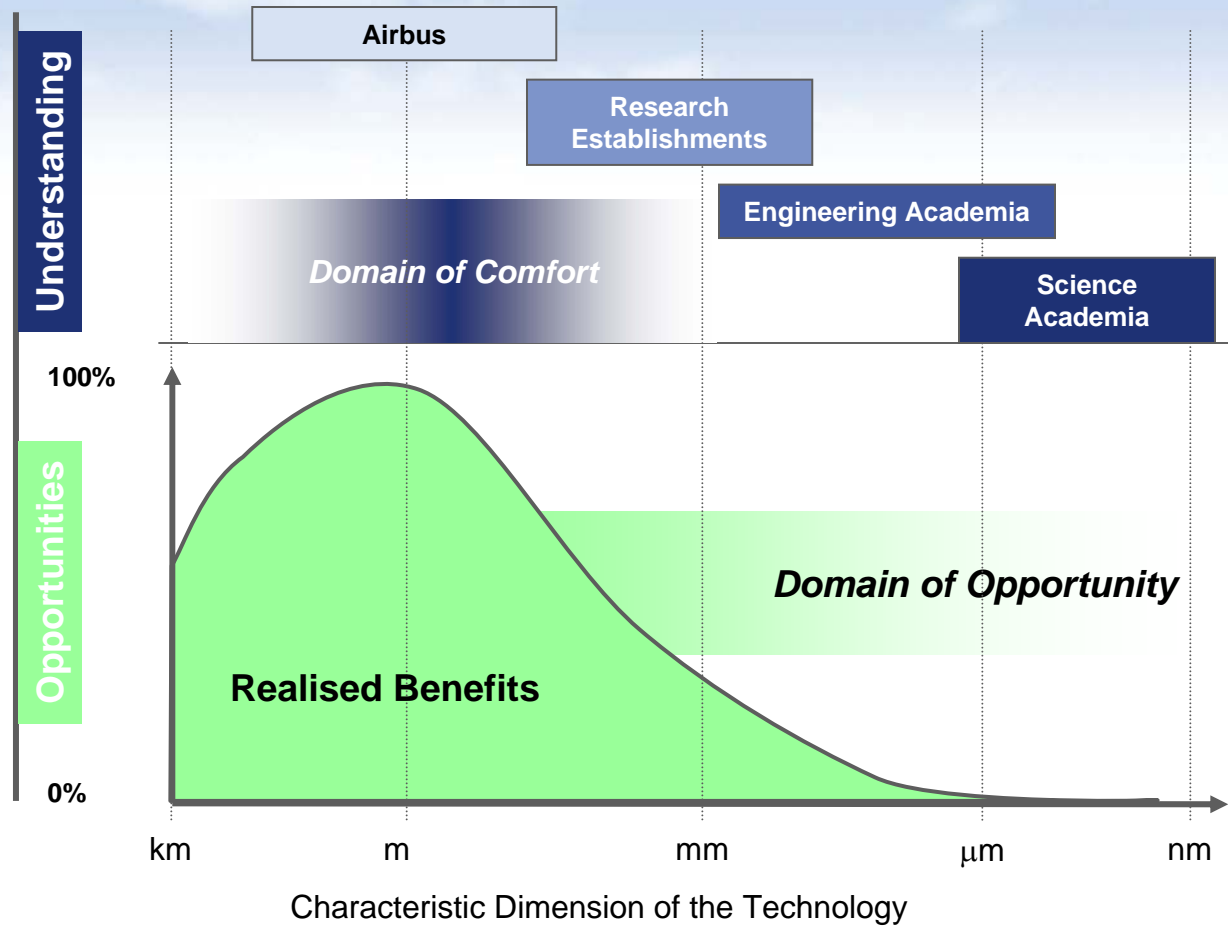
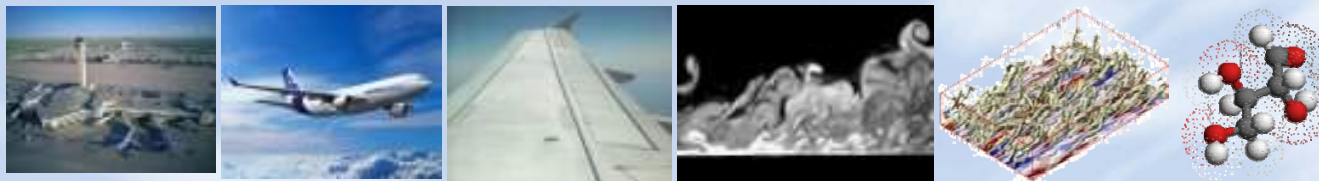
▣ Benefits: Lower fuel burn

- Decreased pollution
- Decreased CO₂
- Range extension
- Reduced operating costs

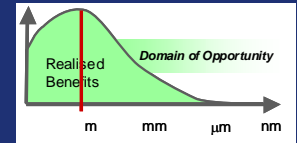


Framework for Preparing Breakthrough Technologies

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Stirring up Aircraft Concepts



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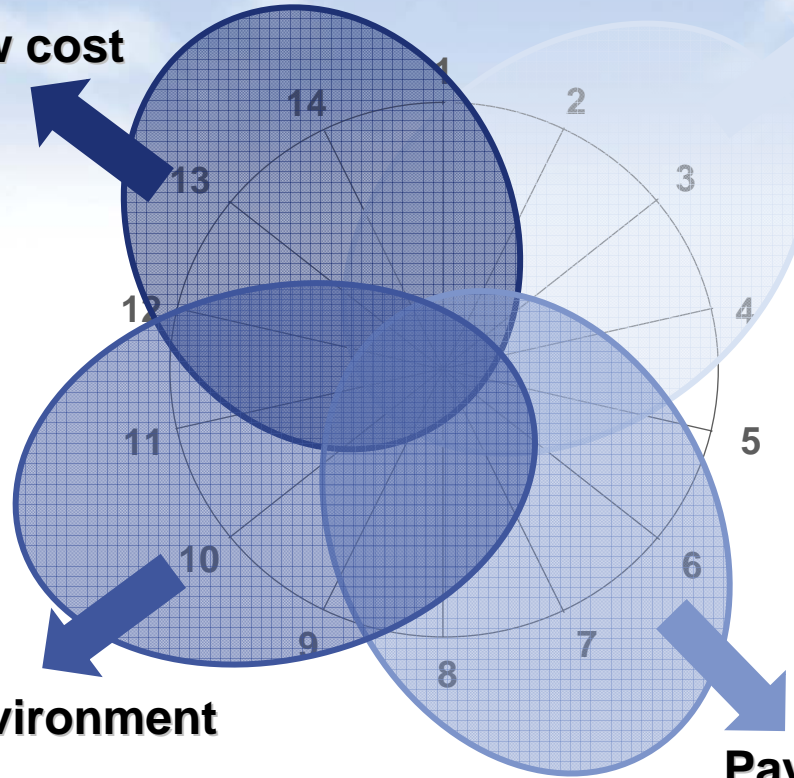
Low cost

Design requirements

Speed



Environment

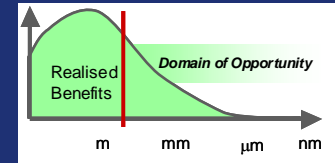


Payload



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.

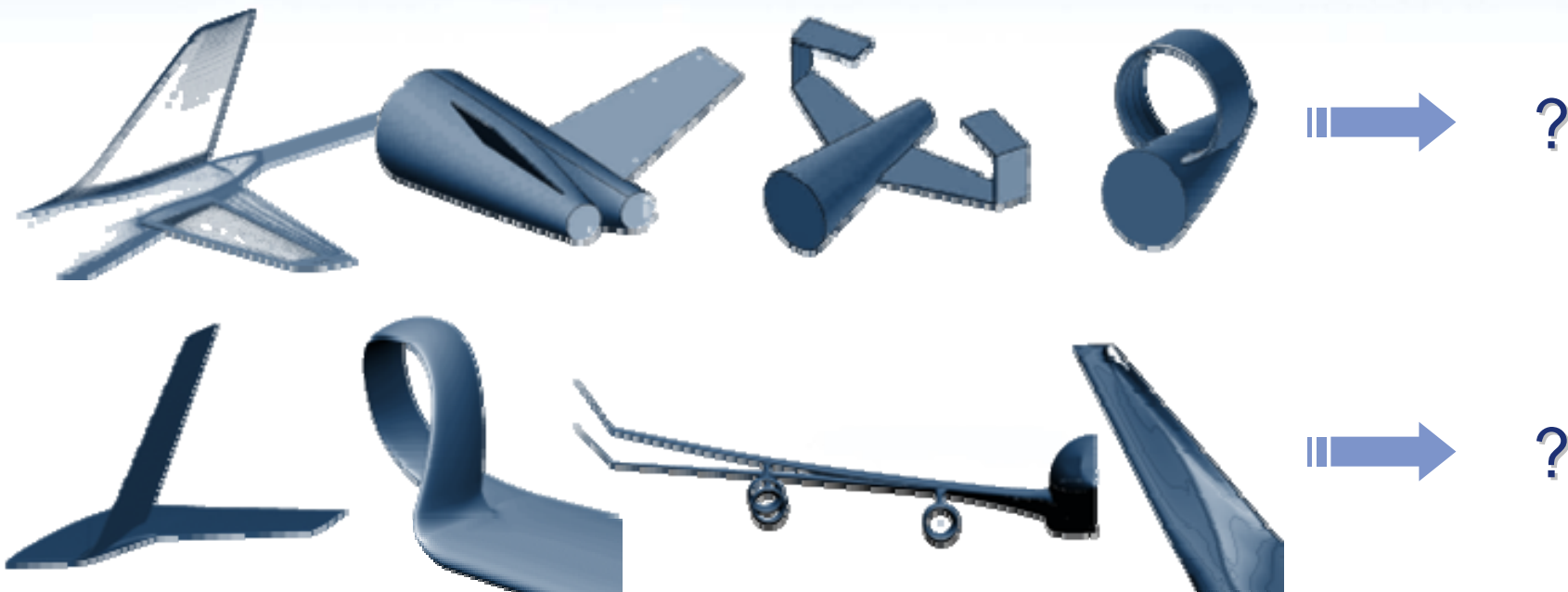
Innovative Components



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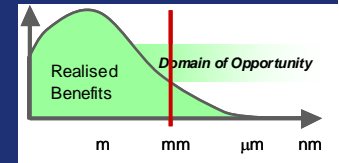
“Think out of the Box”

Extended domain of opportunity by rethinking standard component concepts



Assessment, Optimisation and Down Selection is carried out through Multi-disciplinary parametric investigations

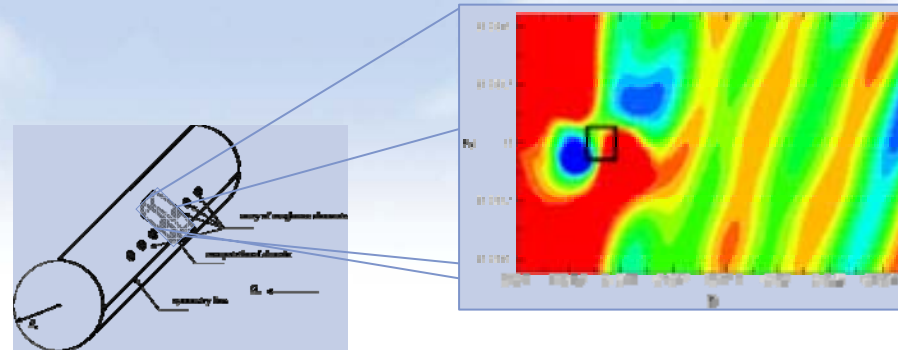
Promotion of Laminar Flow



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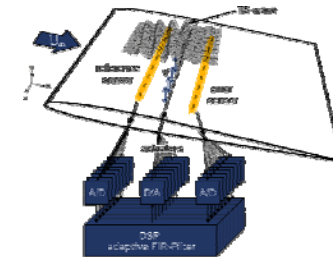
Passive Laminar Flow

- Natural Laminar Flow
- Micro Roughness Elements

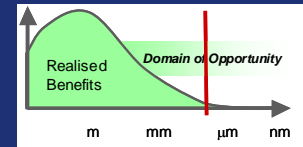


Active Laminar Flow

- Closed-Loop Tollmien-Schlichting Wave Control
- Heating
- Suction



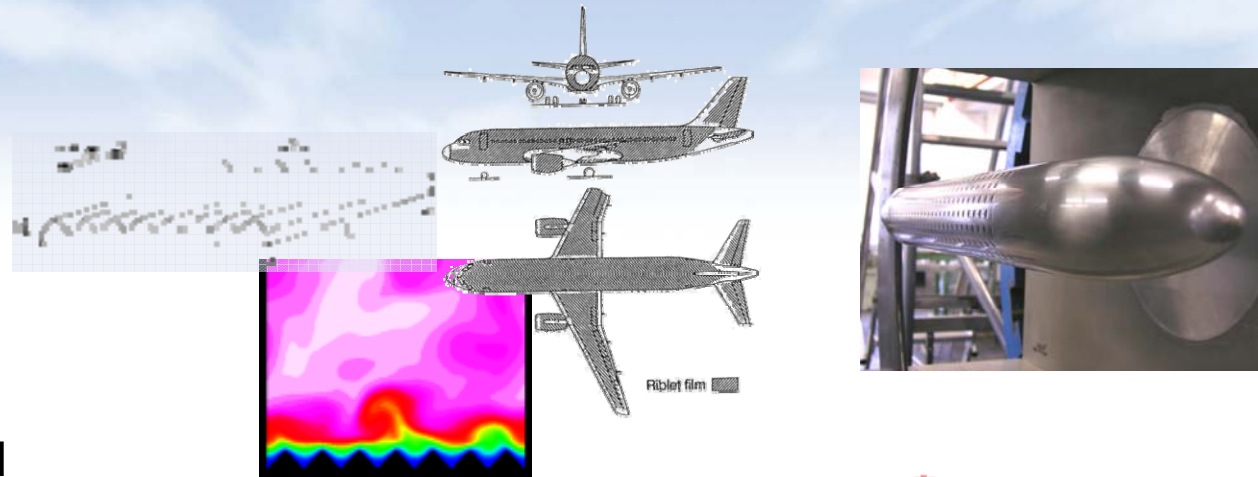
Flow Control



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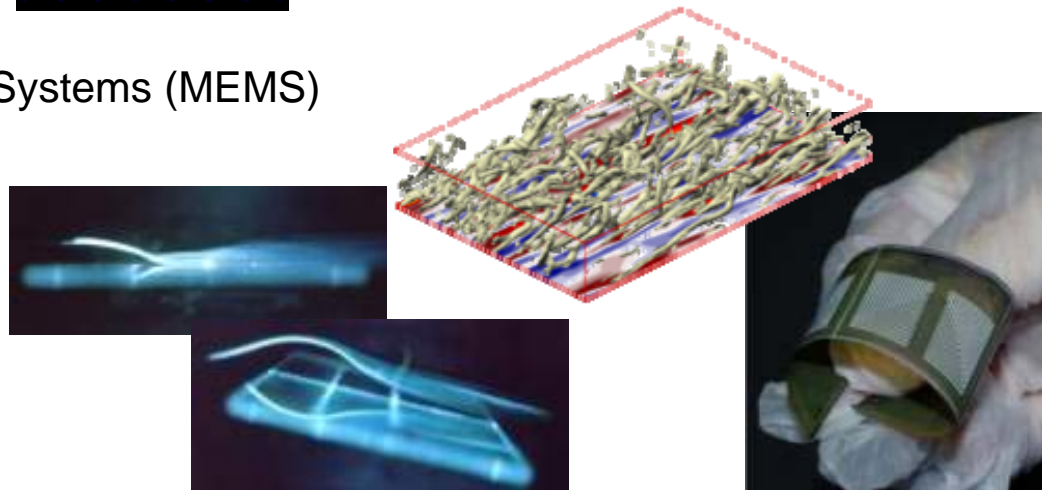
Passive Control

- ▣ Riblets
- ▣ Dimples

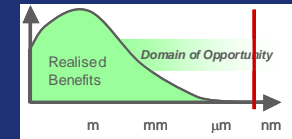


Active Control

- ▣ Micro Electro-Mechanical Systems (MEMS)
 - Actuators & Sensors
- ▣ Low Energy Plasmas
- ▣ Micro-Blowing/Suction



Toward Smaller Scales: Surface Coatings



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Purpose

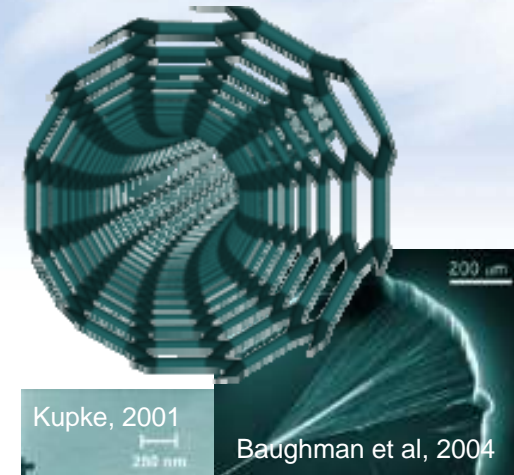
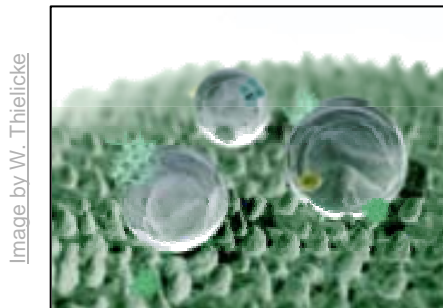
- Use of nano-coatings for their Self-Cleaning and Self-De-icing properties.

Benefits

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

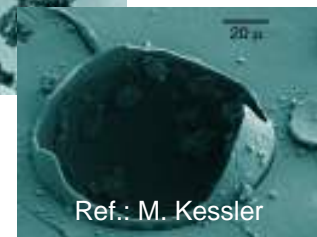
Examples

- Nano-structures on coatings allow to mimic the **Lotus effect** / Hydrophobic Surfaces



Kupke, 2001
250 nm

Baughman et al, 2004



Ref.: M. Kessler

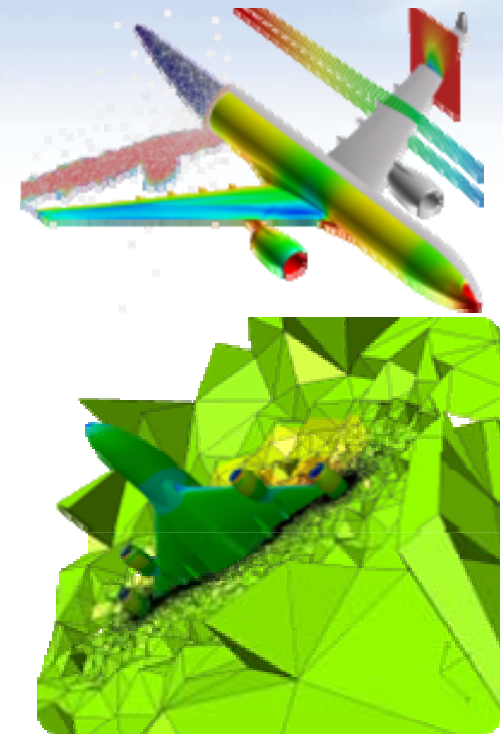
Future Simulation Concept

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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
- A Critical Enabler for the Design With New Technologies



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

A world of challenge & opportunity

CFMS - Filton/Bristol

- 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 10⁶

DOVRES - Getafe/Madrid

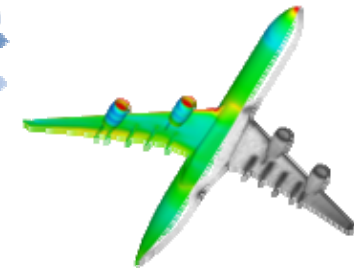
- Virtual Reality for Design
- Field Programmable Processors
- CFD Specific Hardware

C²A²S²E - 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



Conclusions

- ✚ Airbus Is a European Success Story, Demonstrating Its Ability to Compete With the American Giants.
- ✚ The Future of Airbus, and the Rest of the Civil Aerospace Community, Rests on Its Ability to Continue to Meet the Demanding Expectations of Its Customers and Society.
- ✚ 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

Antoine de Saint Exupery



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for your attention

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