Aviation
A Journey to 2050

31st Congress of the
International Council of the Aeronautical Sciences
Aviation in figures

3.6 billion
Passengers

51.2 million
Tonnes of freight

$2.7 trillion
Global GDP* annually

62.7 million
Jobs supported

*GDP: Gross Domestic Product

Source: ATAG 2016
Air Traffic will Double in the Next 15 Years

Air Transport is a Growth Market
over the last 10 years
More than double since 2001

Source: ICAO, Airbus GMF 2017

*RPK: Revenue Passenger Kilometres
The Challenge for Aviation: Sustainable Growth

European Union’s Flightpath 2050

-75% CO2
-90% NOx
-65% Noise

Reference year: 2000
History of a Continuous Fuel Burn Reduction

80% Fuel Burn & CO₂ Reduction per seat since the dawn of the jet age
History of a Continuous Noise Reduction

Noise Reduction since the dawn of the jet age

75%
Aviation Challenges

- Sustainable growth & traffic doubling every 15 years
- Commitment to the Flightpath 2050 technology targets
- Safety & Security
- This is what is expected from YOU!
AVIATION CHALLENGES

A JOURNEY To 2050
The Eco-Efficiency & Performance Levers

Aerodynamic
Energy
Weight
Operations
Challenges related to Aircraft lifecycles

- Software cycle: 6 to 12 months
- Hardware cycle: 3 to 5 years
- A/C upgrades: 6 to 15 years
- A/C production: 30 to 50 years

32 years ago the A320 first Fly By Wire airliner still alive and kicking!

32 years from now…2050!
Challenges related to Increasing Complexity – the example of Automatic Control

Managing Complexity needs a Paradigm Shift: Architecture, Agile Methods, Artificial Intelligence… and Certification rules
Road to the Future

Enhance existing platforms & preparing for new configurations

On the track of improving

Towards new configurations & Urban Air Mobility

Through better integration & architecture
On the track of improving 23rd ISABE Conference

Aerodynamic
Fuel
Operations
Towards new configurations & Urban Air Mobility

Road to the Future
Enhance existing platforms & preparing for new configurations

- New Engines on existing products
- Advanced composites
- Additive Layer Manufacturing
- Systems for Safety
- Predictive maintenance

Through better integration & architecture

On the track of improving
New engines on existing products

Benefits from the continuous technology progress allow engine configuration changes
Improving aircraft platform capabilities

BPR: Bypass ratio

- **A300**: CF6-50, 1972
- **A310**: CF6-80, 1983
- **A310-300**: PW4000, 1987
- **A340**: CFM56-5C, 1993
- **A340-600**: Trent500, 2000
- **A380-800**: GP7000, 2008
- **A320neo**: PW1100, 2016
- **A320neo**: LEAP-1A, 2016
- **A350-900**: TrentXWB, 2016
- **A330neo**: Trent7000, 2017

**R&D target**
BPR > 15

&

new technos far beyond

Constantly enhance performance of our flying platforms
Build future & disruptive technologies
The neo story

Aircraft changes mainly contained at engine level

-20% fuel burn per seat

A320, a commercial success!

60% NEO market share

13,000 orders from 300 customers

A321 high demand

-50% Noise & NOx emissions

Source: AIRBUS
Advanced Composites

Lighter & Stronger by Design

Maximise weight reduction & fuel efficiency

CFRP* Structural Weight

A350XWB 90% of the wet surface is in Carbon

*CFRP: Carbon Fiber Reinforced Polymere
Design for Additive Layer Manufacturing

3D-printing: a strong asset for the future

only 5% waste material

up to 50% potential weight saving

Weight
Saftey – the Runway Overrun Protection System as an example

Enhance Safety by preventing runway overrun at landing

Principle
- Alerting system based on continuous real-time calculation of stopping distance vs. remaining runway length
Predictive Maintenance

- Give prior indication of a component/system failure
- Thanks to systematic transmission of massive data & data analytics
- Allow anticipation & planning of the maintenance
- Prevent unexpected failures & operational interruptions

skywise
An Open Digital platform for the aviation industry
Road to the Future

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On the track of improving

Towards new configurations & Urban Air Mobility

Through better integration & architecture
Road to the Future

Enhance existing platforms & preparing for new configurations

- More Electrical Aircraft
- Laminar Flow
- Flightpath Optimisation

On the track of improving

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Towards new configurations & Urban Air Mobility

Through better integration & architecture

Operations

Weight

Fuel

Aerodynamic
Electrical technologies have to be further explored.

Move from technology bricks development to aircraft architecture & integration.

More Electrical Aircraft

Architecture & Integration challenges

- E-ECS
- Propulsion Offtake & Starting
- Ice Protection
- Electrical Network

E-ECS: Electrical - Environmental Cabin System
Breakthrough Laminar Aircraft Demonstrator in Europe (BLADE)

Minimised drag with laminar flow

-5% fuel burn expected

2014 – 2015
Wind tunnel tests
Laminar wing & Krueger flap demonstrator

2016
First aircraft parts

2017
Flight tests on Airbus A340

A CleanSky program
Optimized Operations: 4D trajectory exchange

Enhance ground trajectory prediction

Solve conflicting trajectories upfront

& Reduce traffic congestion
Enhance existing platforms & preparing for new configurations

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- Laminar Flow
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Towards new configurations & Urban Air Mobility

On the track of improving

Through better integration & architecture
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Towards new configurations & Urban Air Mobility

- Boundary Layer Ingestion
- Open Rotor
- Distributed propulsion
- Hybrid propulsion
- Formation Flight

On the track of improving

Through better integration & architecture

Road to the Future
Towards new aircraft configurations

Boundary Layer Ingestion

- Benefit from slower moving air at the boundary layer
- Minimises propulsor effort & reduce total drag
- Define optimum inlet distortion & fan reinforcement
- Address propulsion integration in unusual location
- Analyse & solve integration effects

~10% fuel burn reduction
Open Rotor

Push propulsive efficiency to the limit

~6% Fuel burn saving vs. advanced UHBR

Lower cruise speed
Position propulsion system for safety and comfort
Noise challenge

UHBR: Ultra High Bypass Ratio
Towards new aircraft configurations

Distributed Propulsion

- Reduce control surface needs
- Reduce total drag

3-4% fuel burn reduction

Size propulsion needs for aircraft mission & control

Propulsive architecture and sizing to ensure failure cases

Propulsion integration for Low speed benefits and minimum drag penalty in cruise
Hybrid Electric Propulsion

Explore new configurations

From electrical power boost

To full electrical power

Develop technology bricks to investigate higher levels of hybridation & distributed propulsion

Develop integration technologies and operational solutions

Define certification basis with authorities
Formation Flight

Reduce CO2 emission and fuel burn by 7 up to 12%

**Principle**
- The leading Aircraft creates two vortices
- Following aircraft can ‘surf’ those vortices & benefits from extra lift, reduce engine setting whilst flying at the same speed
- New specific & automated control laws & sensors to optimize and maintain the position within the vortex
Towards Urban Air Mobility

Airbus is taking a pioneering role in opening the market, while developing and exploring new vehicle concepts, systems and business models
Time to conclude our Journey….

Yes we will fly even more in 2050…
But only if we meet our Environmental Challenges while improving even further Safety and Security.

Advanced Materials, Aerodynamics, Systems…
…are a Must!
But only more integration within the Aircraft, between the Aircraft and the Engine and within the overall Air Traffic system will allow reaching our Goals.

Will we still need air breathing engines in 2050? Definitely more Electricity!
Time to conclude our Journey…

Advances from other areas will accelerate our evolution even faster
- Batteries and Sensors from mass production
- Low cost very high bandwidth connectivity
- Data Analysis and Artificial Intelligence…

Increasing complexity requires a Paradigm Shift in the way we introduce technology…
- Agile methods, Fast Iterations
- Digital end to end continuity
- Open Innovation, “Coopetition”
- …and address Certification Rules

2050… A world of Opportunities…

Are you Ready?
Thank You