Airbus – where are we going next (evolution or revolution)?

Neil Scott
Vice President Engineering
Airbus UK

IMechE Western Aerospace Centre 2013 Prestige Lecture
Filton provides design and support of wings for all Airbus aircraft. Half of the Filton workforce are in engineering.

The A400M wing assembly facility pioneers bespoke manufacturing techniques & the use of advanced composite materials.

Airbus in Filton also has design and supply responsibility for fuel systems and for most variants, the landing gear.

There are over £100M worth of test facilities at Filton including the fuels test centre, wind tunnel, structures and landing gear test facilities.

Customer Services teams are also based at Filton.

Aircraft design and manufacturing has taken place on this site for over 100 years.

Airbus Aerospace Park is under construction and will open next month.
Airbus family

The most modern and efficient aircraft families

Passenger aircraft: from single-aisle A320 family to the 500-seat A380
Corporate Jets: VIP and government aviation
Freighter aircraft: the freight market sector
Military aircraft: airlift and support missions
Airbus family

A380 Family
A340 Family
A350 Family
A330 Family
A320 Family

Passenger aircraft: from single-aisle A320 family to the 500-seat A380
Corporate Jets: VIP and government aviation
Freighter aircraft: the freight market sector
Military aircraft: airlift and support missions
Innovation

40 years of innovation, a driver for success

**A300B:**
First ever widebody twin-engine in the 70s forward-facing crew cockpits in the 80s

**A320 Family:**
Side-stick & electronic engine controllers
Digital auto flight system
Aerodynamic improvements (winglets, sharklets)

**A380:**
Unprecedented fuel efficiency and comfort

**A350 XWB:** a game changer
over 53% of composite material

**Environment:**
First aircraft manufacturer awarded ISO 14001 - all sites and products
A full range of market leading civil airliners

**A320 family:**
A take-off or landing every 2.5 seconds,
7 billion passengers carried since EIS in 1988

**A330 family:**
A take-off or landing every 25 seconds,
More than 800 A330s sold since 787 launch

**A350 XWB:**
First Flight mid 2013
582 firm orders from 34 customers

**A380:**
Takes-off or lands approx. every 6 minutes
125 flights per day and 1 million pax per month
Market
GLOBAL COMMERCE

JOBS
56m
JOBS SUPPORTED BY THE AIR TRAVEL INDUSTRY
SOURCE: IATA 2012

GLOBAL GDP
3.5%
AVIATION $22 TRILLION
SOURCE: IATA 2012

GLOBAL RANKING

TOURISM
35%
BY AIR
SOURCE: IATA 2012

SAME SIZE AS POLAND

#19
Airbus predict 'global air fleet will double by 2032' with two thirds of the population taking at least one flight a year

Airbus predicts 29,000 new planes needed by 2032
Traffic will double in the next 15 years

Air traffic has doubled every 15 years

Air traffic will double in the next 15 years

Source: ICAO, Airbus GMF 2013
Air travel has proved to be resilient to external shocks over the last ten years. World annual traffic (RPKs - trillions) has shown a 67% growth through multiple crises, including Oil Crises, Gulf Crisis, Asian Crisis, WTC Attack, SARS, and Financial Crisis. The trend indicates a robust recovery each time a significant shock has occurred. source: ICAO, Airbus GMF 2013
Manufacturers: An attractive market for new competitors
Evolutions
Airbus A320 family

A320 family - one type, four equally spaced models

The most efficient and comprehensive coverage of the single aisle market

Seats*

185 to 220
150 to 180
124 to 156
107 to 132

Balanced capacity

+ ~20%
+ ~20%
+ ~20%

*Typical two-class and high-density seat counts
Airbus A320 family

A320 family - evolution
Build on proven values

Efficiency

2011 2013 2015

A320neo

sharklets
A320 Family non-stop innovation

- New cabin
- Engine improvements
- GPS Landing system
- RNP 0.1
- Maintenance programme
- Extended Service Goal
- Sharklets

2007: HUD
2008: Aerodynamic improvements
2009: GPS Landing system
2010: 78t A320
2011: EFB, OANS, ROPS
2012: Improved comfort, Reduced fuel burn, Reduced DMC, Improved capability, Improved navigation

ROPS: Runway End Overrun Protection
OANS: On-board Airport Navigation System
Cash Operating Cost for Single Aisle Aircraft

CASH OPERATING COST BREAKDOWN

$65/BBL Crude Oil price
Early 2007 levels

Fuel
29%

Flight Crew
Ground Handling
Nav/Landing charges
Maintenance

$150/BBL Crude Oil price
Lower than Mid-to-late 2008 peaks

Fuel
50%

Fuel will become the dominant cost item
A320neo

- Efficient engines
  CFM56-5B featuring a 68” fan diameter
  IAE V2500 featuring a 63” fan diameter

- Wing tip fences

A320

- More efficient engines
  CFM LEAP-X featuring a 76” fan diameter
  PW1100G featuring a 81” fan diameter

- Sharklets

Low risk, minimum change aircraft ... up to 15% fuel burn reduction
Global changes on the aircraft

- Sharklets
- Local wing reinforcement
- Local CWB reinforcement
- Adapted Flight Controls Computer Software

Reinforced aircraft
PurePower® PW1100G engine by Pratt & Whitney

Geared Turbofan enables:
- Double digit lower fuel burn
- Significant reduction in noise and emissions
- Lower engine operating costs
- Wide design space for future technology insertion

Proven reliability and product maturity at A320neo EIS:
- Benefits and durability validated in engine demonstrator and core test programs
- Fan Drive Gear System matured through extensive test program
- First GTF validation and certification engine at test
- Revenue service by EIS
Sharklets design: new wing-sharklet join & sharklet device assembly

Rib 27 (wing-side)

Rib 27A (sharklet-side)
Covers:
Skin thickness increase outboard of Rib 11.
Topskin material 7449
Bottomskin material 2024HDT.
Strip milling introduced in change area.

Stringers:
Increased height outboard of Rib 11.
New material 2026.

Mid and Outer Rear Spurs:
Front spar Web thickness increase outboard of Rib 9
Flange changes outboard of Rib 25
New crack stopper outboard Rib 24

Ribs 12 to 26:
System penetrations maintained.
Thicker web features and taller stringer cut outs.
Larger cleats used to fit larger fasteners.

Fixed Leading Edge:
Bolting and rivet changes outboard of Slat 4

Fixed Trailing Edge:
Aileron Hinge bracket changes

Rib 27:
New large machined rib concept
Introduction of support straps to stringers

Systems Installation:
New looms for Sharklet, routed outside rib 27.
Centre Tank Vent Pipe Modified.
What does 15% fuel burn reduction represent?

- Reduced fuel burn
  Per aircraft per year
  - A320: 1,150 t
  - A320neo: -3,600 t

- Reduced CO₂ emissions
  Per aircraft per year
  - A320: 800 nm sector
  - 1,150 t
  - A320neo: 800 nm sector
  - 3,600 t

1585 trips per year

800 nm sector
A significant efficiency improvement package
Latest Airbus Technology

A320neo
- 15% fuel burn
- Lower noise levels – up to 17dB below ICAO Ch4 standard
- NOx emissions 50% below CAEP6 Standards

A350 XWB
- 25% fuel burn
- Lower noise levels - up to 16dB below ICAO Ch4 standard
- NOx emissions 35% below CAEP6

A380
- 20% fuel burn
- Lower noise levels – up to 17dB below ICAO Ch4 standard
Challenges
To reduce:

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

Other Challenges:

- Aircraft Cost/Price
- Air traffic and
- Airport congestion
Reduced the last 40-50 years:

- CO2 by 70%
- NOx by 90%
- Noise by 75%
The Noise Challenge

- Volume of Noise Event
- Duration of Noise Event
- Pitch and Tone of Noise Event
- Frequency of Noise Events
- Time of Day
- Individuals Reaction to Event
- Density of Population
- Level of Background Noise
- Individuals Location to Event
- Weather Conditions
- Number of People Annoyed by Aircraft Noise

Reducing ability for Aviation Industry to Control or Influence

No ability for Aviation Industry to Control or Influence
Aircraft and engine technology

- Airframe noise
- Engine/Airframe interaction
- Engine noise
- Nacelle liners effectiveness
- Aircraft performance
- Acoustic Liners
- Handling Bleed
- Jet
- Fan
- Intake
- Compressor
- Combustor
- Turbine
- Bypass Duct
- Engine Core
Main airframe noise sources
Landing gear

Noise source localization
Slat/Flap extended, LG down

MLG: Velocity Distribution in Horizontal Plane for z = -3.300 m

Flow interaction with leg/bogie beam joint

Driving parameter: aircraft airspeed
\[ \Delta \text{SPL} \sim 60 \log (V) \]
Rough Order of Magnitude
Main airframe noise sources
High lift systems

Noise source localization
Slat/Flap extended, LG down

Flow distributions
- high lifted profile
- slat cove

Driving parameter: aircraft airspeed
ΔSPL ~ 60 log (V)
Rough Order of Magnitude
The Perfect Flight

• Implementing sustainable best practices for a “Perfect Flight”...

18 June 2012: Airbus and Air Canada made North America’s first ever Perfect Flight (over 40% of CO₂ reduction compared to a similar regular flight)

14 October 2011: Airbus and Air France completed the world’s first greenest commercial flight (50% of CO₂ reduction compared to a similar regular flight)
5 MILLION HOURS EXCESS FLIGHT TIME

9 MILLION TONNES EXCESS FUEL
28 MILLION TONNES OF CO₂
Industry Commitments – CO2

Transport Action Group Source

• **Targets**

1. Improve fleet fuel efficiency by 1.5% to 2020
2. Cap net CO2 emissions through carbon-neutral growth
3. Reduce net CO2 emissions by 50% below 2005 levels by 2050

**The four pillars**
- Technology (incl. biofuels)
- Operations
- Infrastructure
- Economic measures
• Demonstration flights
• Value chains
• Commercial flights
The future
“Game Changing” technology readiness

- **Innovative structure**
  - Composites
  - Metallic technologies
  - Nano technology

- **New engines**
  - Advanced turbofan (Leap X and GTF)
  - Next Generation turbofan
  - Open rotor

- **Aerodynamic efficiency**
  - Sharklet
  - Laminar Flow & “Smart” wings

- **Alternative fuel**
  - Biofuels
  - Fuel cell technology

- **Air Traffic Management**
  - SESAR/Next Gen (ATM)
  - Green trajectories
  - Innovative cockpit

- **Timeframes**
  - 2010 to 2020
  - Beyond 2025
A long term future technology vision

- Configuration and new power plant
  - Non-conventional aircraft concept
  - New propulsion concepts

- Flow control
  - Full active flow and load control

- Airframe
  - Adaptive, intelligent structures

- Value adding cabin
  - New passenger services full wireless

- Mission management
  - Flight or ground based
  - Mission management
Drag reduction through Laminar Flow
SFWA WP3.1 BLADE

BLADE1
Breakthrough Laminar Aircraft Demonstrator in Europe

CLEANSKY 2
European Commission

FTT Group
Speculative Systems Development

DASSAULT AVIATION
ASCO
ONERA
DLR
NLR
NASA
bias
Ita
NEW
AIRBUS
Overall configuration challenge

Need to shift from single discipline asymptotic trend... thanks to capabilities and skills enabling multipoint and multidisciplinary configuration optimisation
Blended wing
The Future – Our Vision, Our Concept Plane

- U-shaped tail shield for less ground noise
- Curved fuselage to improve flight
- Ultra thin wings to better glide through the air
- Meg-quiet blended engines for less fuel burn and emissions
- Double doors for quicker and easier boarding
AIRBUS SMARTER SKIES
Assisted take off and continuous ‘eco-climb’
Aircraft in free flight and formation along ‘express skyways’
Low-noise, free-glide approaches and landings
Low emission ground operations
Main ambitions for future

Highly differentiating

- EMISSIONS
  - Fuel
    (+ Noise, Nox, CO2...)

Prepared for future

- RECURRING COST

- FUTURE PROOF
  Flexible toward Energy, Green, Growth

The technical rupture is pulled by multiple drivers