Scope

• Airbus Acoustics Engineering Activities
• Aircraft Noise Management & Regulations
• Current and Future Aircraft Noise Design
• Noise Abatement Procedures Concepts
• Demonstration of tailored operations on Heathrow
• Conclusions
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Acoustics within Airbus Design Office

Acoustic Design office missions:

Enable & support development of **competitive and innovative A/C solutions** fulfilling acoustic regulatory requirements, customer expectations and business challenges.

Three types of noise considerations:

- **Community noise**: Design, certification and operation
- **Interior noise**: cabin & cockpit
- **A/C**: Ramp noise

Acoustic activities cover the whole aircraft program lifecycle:

- **R&T; Method & Tools**
  - Predevelopment
  - Prepare our future challenges
- **Development**
  - **Prediction**
  - Drive multidisciplinary noise design
- **Certification**:
  - Verification & Validation cycle
  - Demonstrate compliance
- **Series**
  - Support In-service A/C, Cont Dev and Operations
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Balanced approach to A/C noise management

ICAO resolution A33-7, voted in October 2001

Reducing noise impact of air transport

Interdependencies
- Noise
- Emissions
- Fuel Economy

ICAO/CAEP

Noise reduction at source
- Aircraft, Engine Manufacturers

Operational procedures
- Operators, ANSP,...

Land Use Planning & Management
- Airports, national/local authorities

Aircraft operating restrictions
History of Increased ICAO Noise Stringency / Noise Reduction Achievements + trends

According to ICAO noise exposure modelling, maintaining this trend could ensure a global sustainable growth from 2020 to 2040.
Airplane Design: a Balance of Various Objectives
For take-off operation, engine noise is the major contributor to the overall aircraft signature. Quieter the engine noise will be, greater the airframe noise contribution will be.

Main engine noise sources come from jet and fan.
For *approach* operation, airframe noise is the major contributor to the overall aircraft noise signature.

High-Lift Devices and Landing Gears are the main airframe noise sources.

**Noise sources breakdown on approach flight path**

Representative Twin-engine Long Range transport aircraft

![Airframe noise](image)

**EPNdB**

<table>
<thead>
<tr>
<th>Source</th>
<th>EPNdB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airframe</td>
<td>5 dB</td>
</tr>
<tr>
<td>Engine</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
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</table>

**Slat Flap LG Airframe**

**EPNdB**

<table>
<thead>
<tr>
<th>Component</th>
<th>EPNdB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slat</td>
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</tr>
<tr>
<td>Flap</td>
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<tr>
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For approach operation, airframe noise is the major contributor to the overall aircraft noise signature.

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The double-solutions: capacity + technology
The A380 offers the biggest change yet in noise reduction technology at airports. It can carry 42% more passengers than the competing aircraft but produces half the noise energy when taking off and three to four times less noise energy when landing.

Airframe Noise
- Droop nose
- Landing gear
- Flap/slat setting

Performance
Better take off and climb performance
lower approach speed

Latest generation engine technology
- Zero-splice inlet technology for engine nacelles
- Low noise aero acoustic fan design
- Advanced acoustic liners

> 16 EPNdB below Chapter 4

Automated and customised noise abatement procedure for take off for further noise reduction
A350 XWB
The ‘Hushliner’

State of the art Aerodynamics & engine technologies for noise reduction - Unmatched quietness

21dB below ICAO Ch4 limit

Low noise design and technologies implemented on A350XWB

Stream-wise flaps deployment

Avionics enabling eco efficient operations

Low noise engine: Fan system aero-acoustic design
Swept OGV
Cut off turbomachinery
Cycle optimization

Low noise nacelle design
Zero-splice intake liner
Optimized liner design
Maximized liner areas

Air Flow Deflector for Fuel Over Pressure Protector noise cancellation

Advanced Dropped Hinge Flaps

Sealed slat

Filled flap side edge

Landing Gear Parasitic noise reduction
Benefit of Latest Airbus A/C in-Service A350-900

Noise benefit

Noise benefit compared to A340-300
About -7 EPNdB at take-off with 35 additional passengers
The new eco-efficient single-aisle

The New Engine Options for the A320 NEO offer high bypass ratio engines (PW GTF and CFM Leap 1A) with latest propulsion system acoustic design and technologies.

~ 19 EPNdB below Chapter 4

- **Sharklets**
  - Improved aerodynamic performance

- **Air Flow Deflectors**
  - Cavity noise suppression

- **New engines**
  - Bypass ratio 9 to 12
  - Up to 81 inch fan diameter
  - Lower noise levels
  - Latest nacelle liners technology
New Environmental Option

-19db
Noise level compared to Chapter 4

$10M
PV savings from saving noise charges at London Heathrow

Take-off noise NEO vs. CEO

Lp(dB) level

NEO
CEO
Serial Improvement

**Sharklets**: New wing tip devices developed to enhance low speed and high speed A/C performance.

Benefit vs. in-service SA family (with current wing tip fence):
Up to -1 EPNdBA in operational take-off conditions

**SA Fuel Over Pressure Protector Air flow Deflector**

Benefit of vortex generators in approach conditions:
Up to -9 dBA in a speed range between 180 and 240 kts, corresponding typically to a distance between 15 and 50km from the airport
Main achievements have been made on Take-off. Mainly thanks to engine / nacelle integrated aero-acoustic design.
Next Steps for Design Optimization: examples of Future Green Technologies

Slat/Flap technologies

Low-noise flap side edge technologies

Low noise landing gear design
Next Steps for Design Optimization: examples of Future Green Technologies

Novel nacelle acoustic technologies

Ultra High Bypass Ratio Turbofan

Open Rotor
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Noise efficiency

Quieter operations in development

Pool of Noise Abatement Procedures

Departure

- MCDP
- UP to 10dBmax

Arrival

- CDO/A
- Standard
- Segmented
- E-G/S
- IGS
- UP to 5dBmax
- UP to 3dBmax
**Departure optimized function**: A380 & A350 have a new automatic flight function to reliably & continuously handle NADP with optimum noise trajectories

- Ambient conditions
- Airport constraints & areas to be protected
- Actual aircraft parameters

Airbus Departure Analysis Software (ADAS)

Optimised NADP In Flight management system

- Noise Thrust: Fixed thrust
- Noise Speed: Fixed speed
- Noise End Altitude (NEA): End of acoustic procedure
- Thrust ramp: Thrust transition from noise thrust to max climb thrust

**Benefits**:
- >2dB benefit relative to standard NADP1
Optimization of Operational Procedures
Noise Abatement \textit{Approach} Concept

CDA with Increased Glide Slope (-4°)

\begin{figure}
\centering
\includegraphics[width=\textwidth]{chart.png}
\caption{A320-211 \textit{LW} = 53 t Flight path and DBA_{\text{max}} below flight path}
\end{figure}

- CDA
- Conventional approach profile
- IGS

Large area of noise benefit
Noise relief: 5dBA intermediate approach, 4dBA final approach
New ATM procedures to reduce environmental impact

➤ Without Required Navigation Performance (RNP)

116 arriving flights, RWY 34, Kelowna (Canada)
New ATM procedures to reduce environmental impact

⇒ **With Required Navigation Performance (RNP)**

⇒ Significantly less people affected with same traffic, same A/C
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Tailored Operation on Heathrow Airport with A380

• Challenge: reduce aircraft noise impact on ground around LHR airport
• Proposed solution:
  • Take advantage of A380 noise performance and capabilities to comply with tailored operations:

  ➔ Design new procedures for late departures and early arrivals

• Stakeholders involved in the project
  • Airline: British Airways (BA)
  • Airport: Heathrow (HAL)
  • Air Navigation Service Provider (NATS)
  • UK Civil aviation Authorities (CAA)

• Proposed solutions to be used on BA revenue flights
Tailored Operation on Heathrow Airport with A380 – Noise context

Heathrow noise context

Actual microphones positions

Area to be protected
As identified by HAL Environmental Division

Légende
Noise sensitive areas identified by Heathrow

Google earth

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© 2014 The OpenStreetMap Group

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Tailored Operation on Heathrow Airport with A380 – Departures

**New lateral path** designed by Airbus Prosky
- RNP procedure to ensure repeatability
- No more lateral dispersion
  ➔ Procedure coded in A/C Nav database

Vertical path optimization by customization of
- Thrust reduction and acceleration altitudes
- Intermediate speed value
- Thrust value
  ➔ Values entered in A/C FMS page during cockpit preparation

![Google Earth image of flight paths](image1.jpg)
Tailored Operation on Heathrow Airport with A380 – Departures
Noise Performance Analysis: Optimised vs. Reference flights

70dBA iso-contours

Footprint shape and surface evolution from reference flights to optimised procedures
Tailored Operation on Heathrow Airport with A380 – Departures
Noise Performance Analysis: Optimised vs. Reference flights

75dBA iso-contours

Footprint shape and surface evolution from reference flights to optimised procedures
Tailored Operation on Heathrow Airport with A380 - Outcomes

• New designed procedures have been flown on BA revenue flights.
  • Positive feedback from BA pilots
  • ATCo well received these new procedure (no impact on traffic)

→ Noise benefits expected from modelling confirmed with real flights analysis.
→ Demonstrate operations with a airlines are an efficient lever to tackle airport noise.
Thanks for your attention

Any questions?
Optimization of Operational Procedures

- Noise Abatement Departure Procedure
- Continuous Descent Approach

- NADP
- CDA

- T/O
- Climb
- Cruise
- Descent
- Approach

- Noise
- NOx
- Contrails
- CO₂
- Fuel

Multidisciplinary optimization
Benefit of Current Airbus A/C In Service
A380-800

Capacity growth without noise increase: Departure

- A340-313: EPNdB 88, 275t
- A340-642: EPNdB 92, 365t
- A380-841: EPNdB 96, 560t

Capacity doubled at constant departure noise

+90t
+285t