Airbus Aircraft Acoustic Abatement
Initiatives to Reduce Perceived Aircraft Noise

Daniel Carnelly
Technical Marketing Director
Aircraft Performance & Environment
The value of aviation

2.97 billion passengers

$2.2 trillion of global economic impact

34,765 city-pair routes

3.5% of global GDP supported
A global industry supporting global jobs

56.6 million jobs supported by aviation worldwide

8.36 million directly employed in air transport industry

51% of international tourists by air

Oxford Economics report 2012

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Comparing aviation and High-Speed Trains

Compared to High-Speed Trains in the EU,

4 times fewer people are exposed to aircraft noise

4 times more people are transported by air

*European Commission - DG Environment – April 2006
“Development of a methodology to assess population exposed to high levels of noise and air pollution close to major transport infrastructure”
Aviation’s noise reduction achievements

Cumulative Noise relative to Chapter 4 (EPNdB)

1st generation turbofans
Low bypass ratio

2nd generation turbofans
High bypass ratio

High bypass ratio plus component noise reductions

Very-high bypass ratio

A300b2/b4
A320
A340-600
A350 XWB

BPR: less than 2
BPR: 2 to 7
BPR: greater than 7
A positive track-record in reducing noise

Over the last 40 years
20dB airport noise reduction

<table>
<thead>
<tr>
<th>Airport</th>
<th>Number of Aircraft Movements</th>
<th>Area of 57dBA contour (km²)</th>
<th>Population within 57dBA</th>
<th>Number of Aircraft Movements</th>
<th>Area of 57dBA contour (km²)</th>
<th>Population within 57dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heathrow</td>
<td>350 000</td>
<td>330</td>
<td>590 000</td>
<td>454 800</td>
<td>108.3</td>
<td>228 700</td>
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<tr>
<td>Gatwick</td>
<td>198 000</td>
<td>235</td>
<td>47 500</td>
<td>240 500</td>
<td>39.6</td>
<td>2 850</td>
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<tr>
<td>Stansted</td>
<td>47 000</td>
<td>30</td>
<td>1 100</td>
<td>155 100</td>
<td>22.5</td>
<td>1 400</td>
</tr>
<tr>
<td>TOTAL</td>
<td>595 000</td>
<td>595</td>
<td>638 600</td>
<td>850 400</td>
<td>170</td>
<td>232 950</td>
</tr>
</tbody>
</table>

Source: CAA Annual Noise Exposure Contour reports

60% less people impacted in the UK over 20 years
Aircraft design balances numerous criteria
Taking a balanced approach to aircraft noise
ICAO resolution A33-7, voted in October 2001
Noise emissions are caused by airframe & engines.

- At Takeoff (high thrust) engine noise dominates (especially fan and jet noise).
- At Approach (low thrust) engine and airframe noise are equally important.
The A380 double-whammy

1. The capacity effect
   - With 40% more capacity than the 747-400, the A380 allows airlines to cater for growth while keeping the number of flights constant.

2. The technology effect
   - The A380 is an all new design benefiting from technological advancements in noise reduction.
Technology for lower noise

**Engines**
- New high pass ratio engines

**Performance**
- Better take off and climb performance, lower approach speed
- Automated and customised noise abatement procedure for take off for further noise reduction

**Airframe/Nacelles**
- Optimisation of high lift systems
- Innovative acoustic treatment of nacelles

Giving half the noise energy of a 747-400
A380: the quietest long haul aircraft

The A380 is quieter than much smaller aircraft

The A380 is quieter than much smaller aircraft
Noise abatement departure procedure (NADP)

Constant altitude over communities means lower thrust setting can be used while overhead & thrust directed away from populated communities.

1. Take-off and rapid climb to lower initial altitude
2. Constant altitude & thrust setting whilst overflying community
3. Once the community is cleared, continue to climb to cruise altitude

Less community noise
ADAS – further reducing noise at departure

ADAS enables additional 2dB of noise reduction

Optimized NADP1 = lower noise in close airport environment

NADP1 optimised

NADP1 normal

Distance from brake release (km)

Airport specific noise constraints
Aircraft data
Airbus Departure Analysis Software (ADAS)
Optimised NADP in Flight Management System
Noise footprint from LHR: departure

85 dbA contour at London Heathrow - 5,000 nm mission

Less than half the noise footprint on departure...

with 40% more passengers

*Airbus marketing rules: 525 seat layout, Max Pax Payload, JAR 3% profile, 200nm alternate
A380 Arrival noise footprint at LHR

85 dB(A) contour to runway threshold, max landing weights for both aircraft

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Length from runway threshold</th>
<th>Maximum width</th>
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<tbody>
<tr>
<td>A380-800</td>
<td>2,480 m</td>
<td>272 m</td>
</tr>
<tr>
<td>747-400</td>
<td>4,740 m</td>
<td>450 m</td>
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</table>

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A380 wins 2012 Noise Abatement Society Award

Who we are

The objective of the Noise Abatement Society is to raise awareness of and find solutions to, noise pollution and pollutants related to solving noise issues, for example light disturbance and air pollution.

Our work helps to relieve the physical and mental distress and ill health which noise and related pollutants cause and which profoundly affect public health, profoundly, the quality of human and wildlife.

Now celebrating its 50th year, the Society was established in 1959 by John Connell GBE who successfully lobbied the Noise Abatement Act through Parliament in 1960, establishing noise as a statutory nuisance for the first time in the UK.

Our work helps to relieve the physical and mental distress and ill health caused by noise and other pollutants.

Gloria Elliott, Chief Executive
Noise Abatement Society
Cutting-edge aircraft architecture
A320neo - A320 Family efficiency improvement package

**Sharklets:**
- Fuel burn saving on long sectors
- Improved field performance

**New engines:**
- Bypass ratio 9 to 12
- Up to 81 inch fan diameter
- Lower SFC
- Lower noise levels

**Minimum change aircraft**
- 15% overall fuel burn reduction
The improved take-off and climb performance lead to improved trajectory for noise:

Higher fly-over altitude
Lower fly-over thrust

Benefit vs. in-service SA family (with current wing tip fence):

Up to -1 EPNdB in operational take-off conditions
Geared Turbofan enables:

• Double digit lower fuel burn
• Significant reduction in noise and emissions
• Decouples fan from turbine shafts
• Allows slower rotation of fan
• Suppresses noise from high-speed blade tips

PurePower® PW1100G engine by Pratt & Whitney
A320neo brings noise benefits from 2015

neo noise benefit compared to current A320 Family

Average of -4 EPNdB at take-off

Average -2 EPNdB in the approach
A320 neo Noise margin improvement

- Target cumulative noise margin vs. Chapter IV (EPNdB)

<table>
<thead>
<tr>
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<th>A319</th>
<th>A319neo</th>
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<table>
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<table>
<thead>
<tr>
<th></th>
<th>A321</th>
<th>A321neo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Margin</td>
<td>-2.8</td>
<td>-10</td>
</tr>
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Margin for future regulation

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A350 XWB brings noise benefits from 2014

Noise benefit compared to A340-300:

About -7 EPNdB at take-off with 35 additional passengers

(*) conditions for comparison:
- Same mission (4000NM, 310/275 pax)
- Standard noise abatement departure
- Flyover (9200m from brake release)

On 1st flight, nicknamed ‘Hushliner’ by press
A350 XWB – Low noise & emissions

A350 XWB minimizes environmental impact

Data for A350-900, Trent XWB-84 engines, 268 tonnes MTOW

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Reduction of RNP to 0.1nm

Latest standard of RNP allows operations in very constrained environments

- Must demonstrate no lateral deviation from approach path by more than 0.1nm
- Requires specific upgrade to aircraft systems
- A320 & A330 both RNP 0.1nm capable

Allowing access to more airports and more alternates
RNP used by A321 to reduce noise

Precision flying between villages to approach Stockholm Arlanda
Continuous Descent Approach (CDA)

CDA offers simpler, more optimised, descent profiles

Continuous descent approach profile

Conventional approach path
Stepped descent with holding pattern
Track length reduction, A320s into Brisbane

Reduced track length and avoidance of noise-sensitive communities using an RNP CDA to Brisbane

45.8nm

23.2nm
TaxiBot

- Airbus JV with IAI
- Semi-robotic towbarless tractor tows aircraft from/to gate
- Flight-deck controlled
- Engine start near runway end; engine shutdown after landing

Reducing aircraft ground noise and emissions
eTaxi

An A320 spends 15% of its time taxiing...

Innovative on-board solution to dispatch/taxi the aircraft
Electric motors on landing gear for ground movements

eTaxi saves fuel where there are long taxi & ground hold times
Hydrogen Fuel cells – reducing fuel burn, CO₂ & noise

Alternative energy generation system which can replace:

- APU
- ground and in-flight engine start
- air conditioning
- electrical power back-up
- generates water

Potential development for aircraft taxiing

- zero-emission ground operation
- saves weight

Flight test on A320

Potential for zero-noise ground ops
Engine research for fuel & emissions reduction

Working with engine manufacturers to investigate next steps in engine technology to reduce fuel consumption & noise

Maturity (and acceptable reliability) of OR expected around 2030
Progressive environmental regulation will have an impact on aircraft design in the long-term.
Airbus committed to ambitious technology goals:

- Develop technologies and procedures to allow a 75% reduction in CO2 emissions per passenger kilometre and a 90% reduction in NOx emissions by 2050.

- Perceived noise emissions to be reduced by 65% compared 2000 level.

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Aerodynamic landing gear
Airbus eGenius research

Ultimately, aviation should get away from dependence on kerosene (whether fossil or biofuel)

Airbus sponsors the ‘eGenius’ electrically powered concept aircraft
Only engine noise comes from the prop

Scaling-up might take a bit of time!
Conclusions

- Aircraft noise improvements have already been remarkable
- A combination of technology & operations will see continued improvements: Manufacturers, ATC and government together
- Noise is not the only emission – a balanced approach is needed
- Airbus continues to invest in low-noise technologies

Fewer communities then ever before impacted by aircraft noise