A Plain Person's Guide to Quieter Planes

The noise we hear doesn't just come from the planes

It is also caused by also from the way they are flown.

We will look at the operational matters in the second half of the paper

It is true that we really should be talking about ***less noisy*** planes, as aircraft remain very noisy, but in this short paper I'm going to refer to them as *quieter* simply because it makes the text flow more easily.

Have aircraft become quieter over the years?

Yes, they have. It is claimed over the past 50 years individual aircraft have reduced their noise impact by 75% and that compared with the first jet aircraft, noise from modern aircraft has been reduced by 97% on departure - a 15 decibel reduction - and 94% on arrival - a 12 decibel reduction **(1)**. But we need to be careful with this. It is based upon manufacturers' certified figures (EPNLdB) which are measured and computed as sound **pressure levels** in decibels and this is **sound energy**. People don't hear noise as **sound energy** but as degrees of **loudness** which is **sound intensity**. The two are quite different. So in the figures quoted above, a 15 decibel reduction on departure is only about a third of the reduction in loudness – not a 97% reduction. Furthermore, these measurements are taken using A-weighting. Many acousticians argue that C-weighting should be used for noise with a high low-frequency content, such as aircraft. C-weighting can increase noise levels by up to 15 decibels. The improvements, such as they were, took place between the late 1960s and the late 1990s. The improvement since 2000 has been more limited **(2)**.

Why have aircraft becoming quieter?

Aircraft noise comes from two places: the engine and the airframe. With improvements to engine design, particularly with regards to how air enters and exits the engine, noise improvements have been made. Airframes too have become cleaner and therefore quieter, but this leads to other issues like slowing the aircraft down which can in itself create noise.

Will the improvements continue?

They will. The planes which have been introduced in recent years – like the A320 neo, the Boeing 737 MAX, the A350-900 and the 787-8 – are quieter than the aircraft they replaced. Will this process continue? The CAA believes it will **(2)**: *"Assuming a standard fleet life of 25 years, in line with usual depreciation assumptions, and take the last generation of aircraft as being purchased up until 2013 we can expect to see significant noise improvements arising from normal fleet renewal exercises as airlines switch from older types to the latest aircraft until at least 2038".* The improvement, though, will be incremental. The industry puts it as no more that 0.1 or 0.2 decibels each year. Such a small amount, whilst going in the right direction, would take at least between 15 and 30 years to achieve an only just perceptible 3dB noise reduction per plane.

That's engines; what about airframe noise?

In the short to medium-term this is looking less promising. Professor Jeff Astley, Professor of Computational Aeroacoustics, University of Southampton wrote **(3)**: *"Reducing airframe noise is more challenging. The use of flaps and slats and deploying of landing gear at approach are necessary to slow the aircraft while maintaining lift, but they all create additional noise. It's hard to have one without the other. Perhaps the most effective means to ensure both will come from new, improved aerodynamic aircraft designs that can provide better low-speed performance without sacrificing fuel efficiency at cruise. In the longer term, after 2050, completely new aircraft geometries that use blended wing designs, and even aircraft that change shape will potentially lead to major reductions in airframe noise, greater efficiency and improved environmental impact."*

Why does it seem so noisy if planes are quieter?

It is to do with the increase in flight numbers. In the 1970s half the number flights used Heathrow than do today, rising to 315,753 in 1986 and 475,861 in 2019. Flights have also tended to become more concentrated over the last decade or so both on landing and departure. These days it tends to be the sheer volume of aircraft passing overhead which most disturbs people.

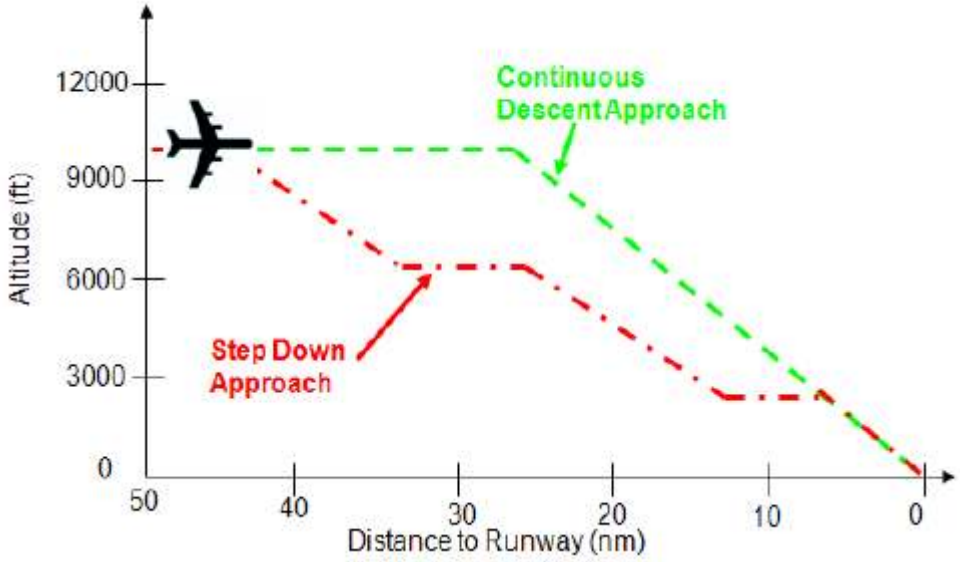
Operational practices which could cut aircraft noise

There are a number of operational practices which can reduce the noise from planes.

Arrivals

Continuous Descent Approach (CDA)

Aircraft can descend in one of two ways: either in a step-by-step fashion or using CDA. CDA can cut noise by between 2.5 and 5 decibels. On average around 89% of aircraft coming into **Heathrow** use CDA. **London City** is more problematic as arrivals need to stay below the Heathrow aircraft. It means that, for example, planes on arrival fly level at 2,000ft right across South London.



The angle of descent

International rules require aircraft to land a 3 degree angle. Some airports, such as **London City** with smaller planes and tall buildings to avoid, are permitted to land more steeply. On their final approach to London City planes land at 5.5 degrees. **Heathrow** is one of the very few large airports to try a steeper angle. It trialled a 3.2 degree approach. It was operationally possible but only had a small impact on noise levels – up to 0.5 decibel reduction. What could make more of a difference is what is known as a 'two-segment approach'. This involves planes using a steeper angle – perhaps even 5 degrees - further away from the airport before reverting to 3 or 3.2 degrees for the last few miles as the plane steadies to land on the runway. Until trials have been done it is not possible to be certain of the noise improvements but they could be significant. Heathrow has shown interest in conducting trials.

Lowering the landing gear

For modern aircraft landing gear is the dominant noise source on approach. When landing gear has been lowered noise levels increase by between 3 and 5 decibels. So, the later landing gear is lowered, the less noise. Recent CAA analysis suggests that at Heathrow 90% of arrivals had not lowered their landing gear 8nm (9 miles) from touchdown, falling to 73% at about 7 miles**(2)**. In order to get a stabilized approach landing gear needs to go down at an altitude of 1000–2000ft, about 2–3 minutes before touchdown. It is difficult for an airport to enforce the point at which landing gear is lowered but Heathrow is looking at innovative schemes to check up when individual planes lower it and possible ways of highlighting airlines and aircraft which lower it sooner than necessary.

Departures

Rate of ascent

Common sense would suggest that the faster you climb, in order to get as high as you can as soon as possible, would reduce noise levels. In essence, that's correct but it is a little more complex. If a plane uses all its power to climb steeply on leaving the runway, that will benefit most communities *directly* under the flight path. But it has four downsides:

- it will increase noise for people very close to the airport
- it will increase air pollution levels in the vicinity of the airport
- it will have a significant impact on the wear and tear of engines
- it will spread the noise so that communities living either side of the flight path up to about 4,000ft will get more noise

Will the new-type of flight paths coming in make a difference?

All airports are moving towards a new type of flight paths known as Performance Based Navigation (PBN) routes. They will be narrower flight paths. Heathrow is looking to introduce multiple PBN routes both on arrival and departure and alternate them in order to give people a break from the noise. PBN also has the potential to allow flights to ascend more quickly. At present Heathrow (and even more so London City) aircraft can be held down many miles from the airport to avoid conflict with flight paths from other airports. The intention of PBN is to design dedicated routes which avoid that conflict.

Is there a conflict between improvements to noise and climate emissions?

There is. Noise and emissions are often at odds with each other. It's a tough challenge. The aviation industry aims to develop technologies and operational practices which will reduce aircraft CO_2 emissions per passenger kilometre by 75%, noise by 65%, and NOX by 90%, by 2050 benchmarked against a typical new aircraft in 2000. The industry body Sustainable Aviation says **(4)**: *"Achievement of any one of these three targets would be challenging, but to achieve all three simultaneously will require considerable ingenuity and a clear understanding of the inter-dependencies between these three key drivers"*. The CAA summed it up like this **(2)**: *"Concerns in relation to climate change, carbon dioxide emissions, and local air quality could also have an impact on noise performance. Although there is not a direct correlation, and noise performance has previously been reduced alongside emissions reductions, as gains become more marginal in future, the potential requirement to trade off emissions and noise performance is likely to increase……the Sustainable Aviation Noise Roadmap22 for example, highlights that there are two conceivable paths for future aircraft design, low-carbon designs and low-noise designs. Whilst low-carbon designs may be quieter than existing aircraft, they may not be as quiet as low noise designs"*.

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Who will resolve any conflict?

It is likely to be driven as much by politics as by technology. The Government is under real pressure from a vibrant climate change movement to find ways to reduce CO_2 from aircraft. The challenge for noise campaigners is to match this pressure.

The CAA has said:

> ***'Policy-makers should be aware of this when considering incentives around sustainability and ensure that perverse incentives are not introduced which lead to increasing noise impacting local residents'.***

In Summary

New aircraft coming on-stream over the next 20 years or so will cut noise levels by 0.1- 0.2 decibels each year. Beyond that period, different designs which the industry is working on may well mean more significant noise reductions.

A package of operational improvements on arrival can reduce noise:

Continuous Descent Approach (CDA) can cut reduce noise by between 2.5 and 5 decibels. Adherence to CDA is already high at Heathrow at 89%. The introduction of the new PBN flight paths would enable London City planes to use CDA more if it enables separation from the Heathrow routes.

A 3.2 degree angle of descent would cut noise by up to 0.5 decibels. A two-tiered angle of descent would cut noise levels in areas further from Heathrow more significantly.

Aircraft consistently lowering their landing gear as late as possible would cut noise in many communities by 3 - 5 decibels.

On departure:
There are winners and losers. A steeper ascent would benefit some communities directly under the flight path but would disbenefit others. The situation, though, would improve if all planes reached the heights they are required to meet. The introduction of the new PBN routes should remove conflict with routes from other airports and thus allow planes to continue climbing even some distance from the airport.

Number of aircraft
An increase in flight numbers at any airport would reduce the noise benefits of quieter aircraft and improved operational practices.

References:
(1). Sustainable Aviation Road Map https://www.sustainableaviation.co.uk/goals/noise/
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(3). https://theconversation.com/whisper-it-jet-engines-are-getting-quieter-44331
(4). Sustainable Aviation 2017 Progress Report https://www.sustainableaviation.co.uk/goals/noise/

John Stewart, chair HACAN**,** **June 2020**

HACAN can be contacted on johnstewart2@btconnect.com; 020 7737 6641; www.hacan.org.uk