Jet engines are getting quieter

July 8 2015, by Jeremy Astley

Credit: AI-generated image (disclaimer)

With no sign of our appetite for air travel diminishing, we need to create quieter aircraft that are easier to live with. In fact, while those living near airports may beg to differ, data included in the Airports Commission report into a new runway for London shows a very significant reduction in aircraft noise over several decades.

The noisiness of an individual aircraft at departure and approach is described by its Effective Perceived Noise Level (EPNL). This is measured when the aircraft enters service, and is used to track noise improvements between successive generations of aircraft.

As this Airports Commission report chart shows, EPNL has fallen since modern turbojet and turbofan engines were first introduced – roughly a halving of radiated acoustic energy per decade. This is a remarkable technical achievement – a 95% reduction in the sound power generated by aircraft jet engines since their introduction.

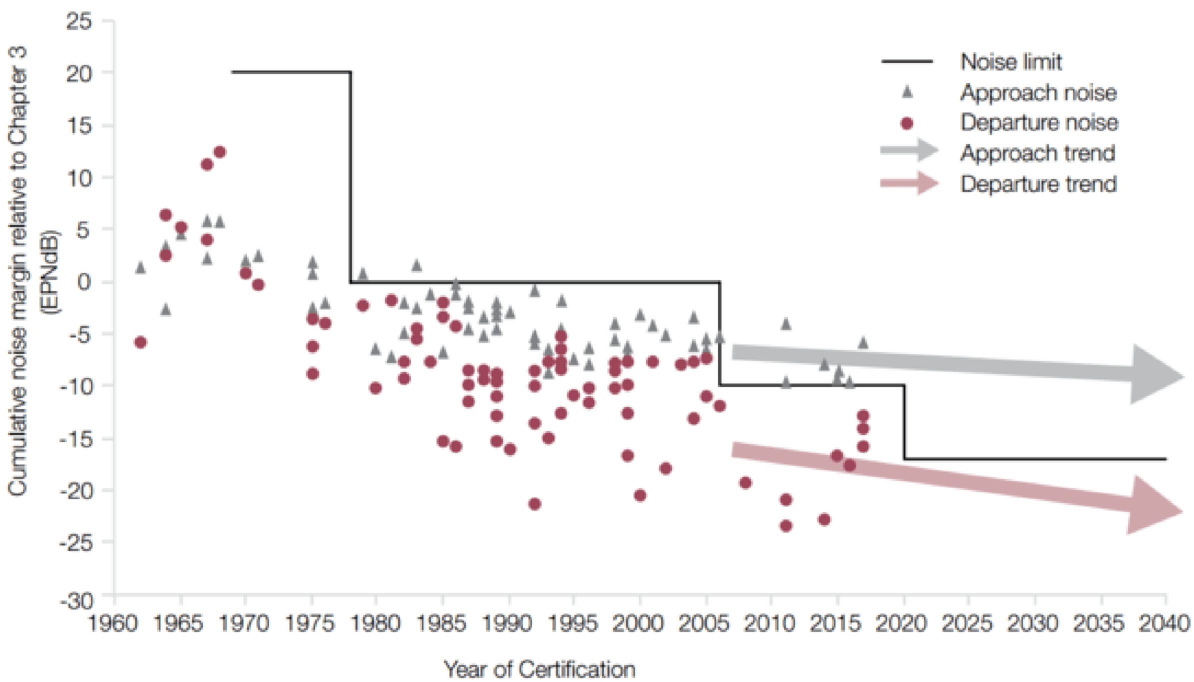
However, over the same period there has been an explosion in air travel and the number of flights and passengers has risen exponentially. The issue then is not whether aircraft are getting quieter, but whether they are doing so sufficiently quickly to compensate for the fact that there's so many more of them.

The answer also depends upon how quickly older, noisier aircraft are retired from service. In the UK, the net effect has been positive – aircraft are becoming quieter at a rate that outweighs the increase in traffic and the Airports Commission expects this trend to continue.

When air is too loud

Aircraft noise is generated by turbulent flows of air over and around surfaces. This includes air going into and out of the engine, and air flowing around the airframe – fuselage, wings and other aerodynamic surfaces such as flaps, slats and landing gear.

Figure 9.1: Historic and future trends in cumulative certificated aircraft noise levels from noise discussion paper, 1960-2040



Noise levels have, despite what some may feel, been falling. Credit: Airports Commission/Crown Copyright

What has brought about the continuing reductions in aircraft noise since the 1970s? The largest factor driving down aircraft noise has been a move towards higher and higher "bypass ratios" – originally sought after for greater engine efficiency, but which fortunately generate lower noise too.

The bypass ratio is the proportion of the air which enters the engine inlet but bypasses the turbojet and exits at low speed, in comparison to the hot, high-speed jet coming from the engine core.

This ratio has risen – all the air entering turbojet engines of the earliest airliners passed through the engine. In the turbofan designs of the 1960s and early 1970s this fell to around a third, while the engines powering large modern aircraft today such as the Airbus A380, Boeing 787 and Airbus A350 draw only a tenth of the air into the engine core. These engines have larger, more slowly-rotating fans with fewer blades – all features that reduce the aircraft's noise profile.

Quieter engines

This process still has some way to run. Turbofan engines in smaller aircraft have lower bypass ratios than those in larger, wide-bodied aircraft, but development of new engines is underway for the venerable Airbus A320 and Boeing 737 families, and newer jets such as the Bombardier CSeries and the Mitsubishi MRJ. Such narrow-bodied jets constitute 70% of the commercial fleet, so this will have a profound impact on noise levels as they replace older jets.

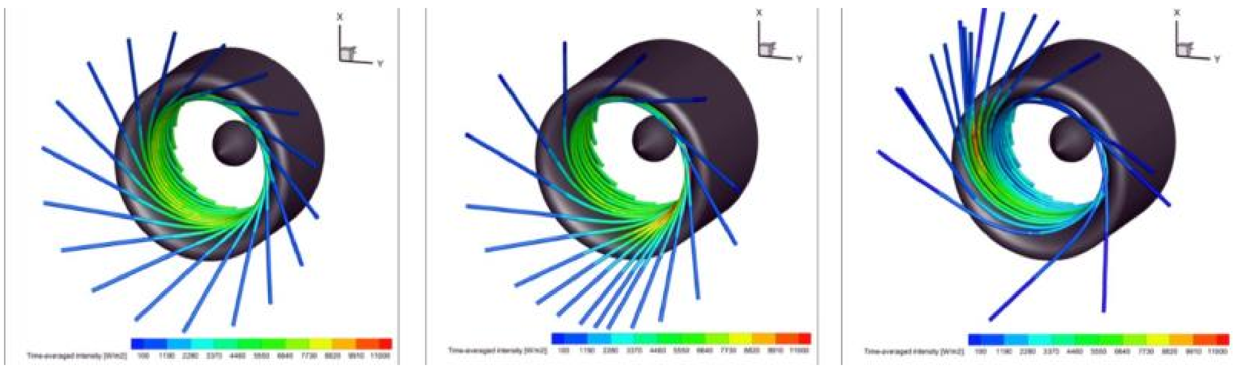
Better engines for larger aircraft are coming too, based on the same turbofan technology. Using a gearbox to uncouple the fan and the low pressure turbine will improve performance and reduce noise. A market leader here is the Pratt and Whitney PW1000G geared turbofan developed over the last decade and due to enter service, is anticipated to lead to larger, quieter and more fuel-efficient engines with bypass ratios approaching 15:1.

Lockheed Tristar, a classic airliner of the 1970s. Credit: Jon Proctor

Other techniques to quieten engines include acoustic liners on the inner walls of the intake and bypass ducts which absorb acoustic energy, and improved aerodynamic fan design and outlet vanes. Both of these have been made possible by the power of modern computers to accurately simulate airflow dynamics – there is scope for further advances in this area.

Quieter airframes

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.



Computer simulation of acoustic energy streaming out of a turbofan intake at different fan speeds. Credit: Z Rarata/University of Southampton, Author provided

In the longer term, after 2050, completely new aircraft geometries that use blended wing designs, and even morphing geometry – aircraft that change shape – will potentially lead to major reductions in airframe noise, greater efficiency and improved environmental impact. All just as well, as by then there'll be many more people still wishing to fly.

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