AURALISATION: A VALUABLE CONSULTATION AND ENGAGEMENT TOOL FOR INFRASTRUCTURE PROJECTS – CASE STUDY OF AIRSPACE CHANGE FOR A REGIONAL AIRPORT

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1 Introduction

Since the late 1990s, Arup has developed and used an auralisation capability to inform the design of some of the world's best arts and culture venues. Through Arup SoundLabs around the world, clients, designers, major stakeholders and the general public have been able to take informed decisions by experiencing the acoustic implications of designs as they are developed. More recently, auralisation technology has been developed to simulate sound generation and propagation during planning and design for a broad range of infrastructure projects, such as the High Speed 2 railway, A66 highway and Heathrow airspace change and expansion in the UK; Texas Central High Speed railway and LADoT Advanced Air Mobility (AAM) policy in the US; and a wind farm development in Tasmania.

The aviation industry is currently introducing new disruptive technologies principally to improve its sustainability performance. The introduction of electric aircraft and Advanced Air Mobility (AAM) vehicles is likely to revolutionize regional airspace, creating new opportunities for regional airports. Although it is possible to achieve lower noise levels for these new vehicles compared to traditional light aircraft, the sound characteristics (for example, tonality and high pitch due to electric motors) and their potential for higher traffic, could give rise to concerns about noise being more noticeable and disturbing to local communities than the current situation.

Through a series of sound demonstrations, members of the public and stakeholders could experience and judge for themselves the impacts of the proposed airspace and infrastructure changes, such as new types of aircraft, modification of flight paths and increased air traffic.

2 Auralisation Method

Arup's rigorous methodology has been developed and refined over the years to create representative sound demonstrations of infrastructure projects. The methodology is scalable, covering the needs, requirements, and constraints of the project. It has beensuccessfully applied, for example, to a regional UK airport to address public concerns and assist in the local authority planning process for the airport development masterplan.

Arup's sound demonstrations are created by recording the existing soundscape of the communities surrounding the airport, as shown in Figure 1. By recording the ambient and aircraft flight sounds, the listeners are immersed in a virtual soundscape environment with which they are familiar and can relate to.

Airspace changes are synthetized by combining ambient sound recordings with the sound expected for the new flight conditions.



Figure 1: Ambient sound and existing flight recordings in surrounding communities.

Our methodology relies on recordings as much as possible, captured through a thorough process. As shown in Figure 2, field recordings are performed with:

- ambisonics microphone, to capture the 3-dimension sound field, enabling the reproduction of moving sources.
- calibrated sound level meter, to ensure the recorded sound field can be reproduced at the correct sound level.
- video camera (360° or not) can also be included to provided visual support or create, when required, fully immersive Virtual Reality (VR) demonstrations.

To represent the different airspace changes (e.g., flight paths, flight operation or aircraft), the sound of aircraft operating in similar conditions is recorded. When necessary, these recording are corrected to represent specific flight conditions, for example by adjusting the sound propagation attenuation.

Upcoming hybrid/electric aircrafts and AAM vehicles have the potential to revolutionise regional people and goods transportation. These vehicles are still in development and sound recordings are not widely available at this stage. However, to assess the public perception and potential impact on

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Figure 2: Measurement set-up to capture aircraft flyover - from left to right: video camera, ambisonic microphone, sound level meter.

community health and well-being, a few studies [1, 2] have been already undertaken, mostly by using synthesised sounds, created either through a simple model developed by Arup [3] or more advanced software (NASA ANOPPS).

3 Auralisation Reproduction

Arup's sound demonstrations can be delivered through various systems, depending on the requirements of the project.

Traditionally for the UK regional airport, public consultations are undertaken in a community hall, where all aspects of the scheme are presented simultaneously. Such face-to-face public consultations enable direct discussion between stakeholders. However, the event can be relatively noisy: it is essential to avoid nearby discussions contaminating the representativeness of the sound demonstrations. If a dedicated, isolated room is not available in the hall, soundproofed booths can be used to minimise noise cross-contamination. These booths can also include sensors tracking head movements to provide a better immersive experience using a VR set, as shown in Figure 3.

In the last few years, especially due to the COVID travel restrictions, virtual public consultations are becoming more frequent. Through Arup's online platform[1], auralisation can also be included. These online sound demonstrations, such as shown in Figure 4, generally allow the size of the participant pool to be increased and can also be accompanied by an online questionnaire to capture participant opinions and comments on the scheme. The calibrations of online demonstrations are however performed at the discretion of the participants and could be affected by uncontrolled listener environments and reproduction systems. To minimise the variations between users, the calibration process is described and performed at the start of the demonstration. Online demonstrations are also limited to illustrate relative changes between current and future scenarios.

At critical decision stages of the project, sound demonstrations can be performed in one of Arup's worldwide auralisation facilities (m|Lab or SoundLab) to ensure that the sounds are reproduced with high fidelity.



Figure 3: Dedicated soundproofed booth for immersive VR demonstrations.

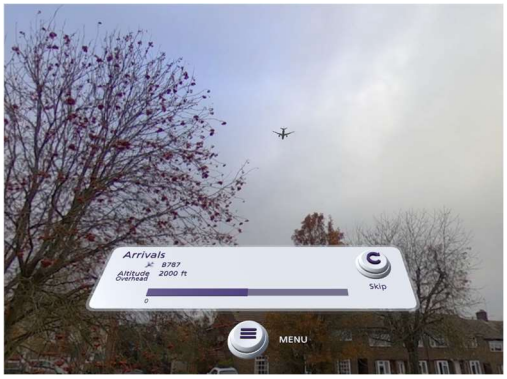

Figure 4: Interactive virtual reality simulation of aircraft passing overhead.

4 Conclusion

Auralisation has proven to be a valuable consultation and engagement tool in many infrastructure projects. Through a rigorous process, complex concepts are made easily accessible. Auralisation has been successfully used to:

- facilitate dialogue on implications for public health and wellbeing from a noise perspective;
- increase transparency on how stakeholders could be affected by a proposed development;
- ensure proposals are inclusive and accessible;
- support data-driven decision making;
- help identify stakeholders' needs and concerns;
- build trust amongst the entities through impartial advice

References

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