

A Mobile App for Assessing the Acoustic Perception of Aircraft Propulsion Systems

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1. Abstract

Noise is a major factor in the acceptance of aircraft. Novel propulsion systems (e.g. distributed, electric) can be designed with acoustics in mind (e.g. in terms of propulsor position on or over the wing) [2]. This requires knowledge of the relationship between technical parameters and the annoyingness and unpleasantness of the resulting sound, which is usually inferred from psychoacoustic laboratory studies. In this paper we present an alternative approach: an openly distributed **mobile app** (patent pending) allows a **large and diverse audience** to:

- 1. Set the engine parameters
- 2. Hear the corresponding auralised sound
- 3. Rate the sound using a standardised questionnaire.

2. App Components

2.1 Aircraft Builder

- Basic design parameters: propellers vs ducted fans, number of propulsion units, number of fan blades...
- Operating point parameters: rotational speed, mass flow
- Parameters are limited, and constrain each other, to technically possible values

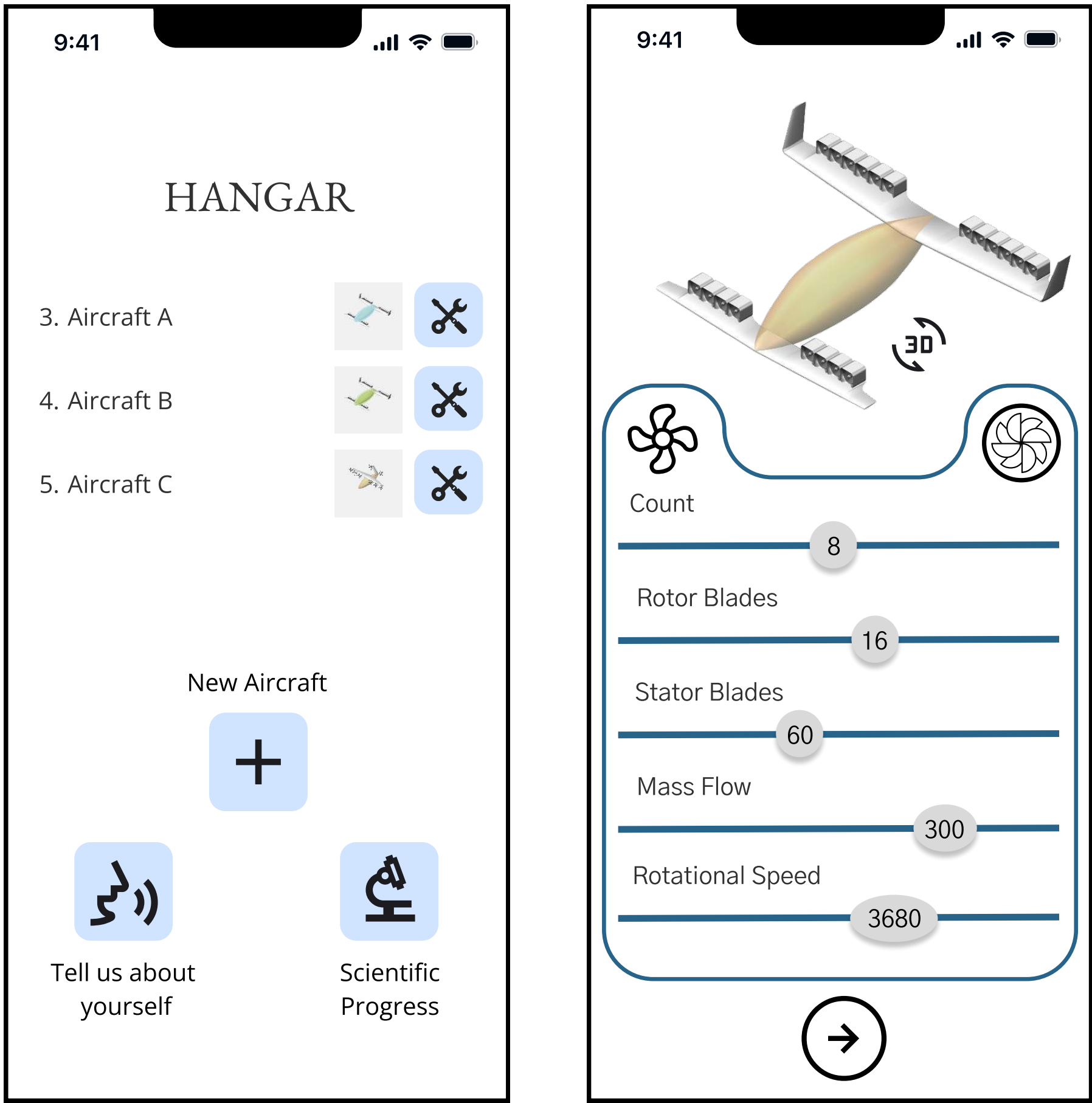


Figure 1: Left: Homepage with links to different activities. Right: Aircraft propulsor configurator with 3d model of the aircraft, choice between fan and propeller, and sliders for various parameters

2.2 Sound Player

Plays a sound corresponding to the entered configuration, **pre-generated** by a tool chain under active development by ⁴ [4, 1, 6]

- Given engine parameters, this tool creates physics-based predictions of the resulting sound
- Further processing creates a sound file that corresponds to what an observer would hear if the aircraft were to fly on a designated path at a designated distance, taking into account acoustic effects like atmospheric turbulence or ground reflections [5, 7]

2.3 Sound Rating Scales

Based on previous work on the valence and quality of aircraft sound [10, 8, 9]. Users rate

1. How unpleasant the sound was
2. How much the sound would have disturbed them if heard in their daily life
3. How they would describe the sound to another person using a list of adjectives.

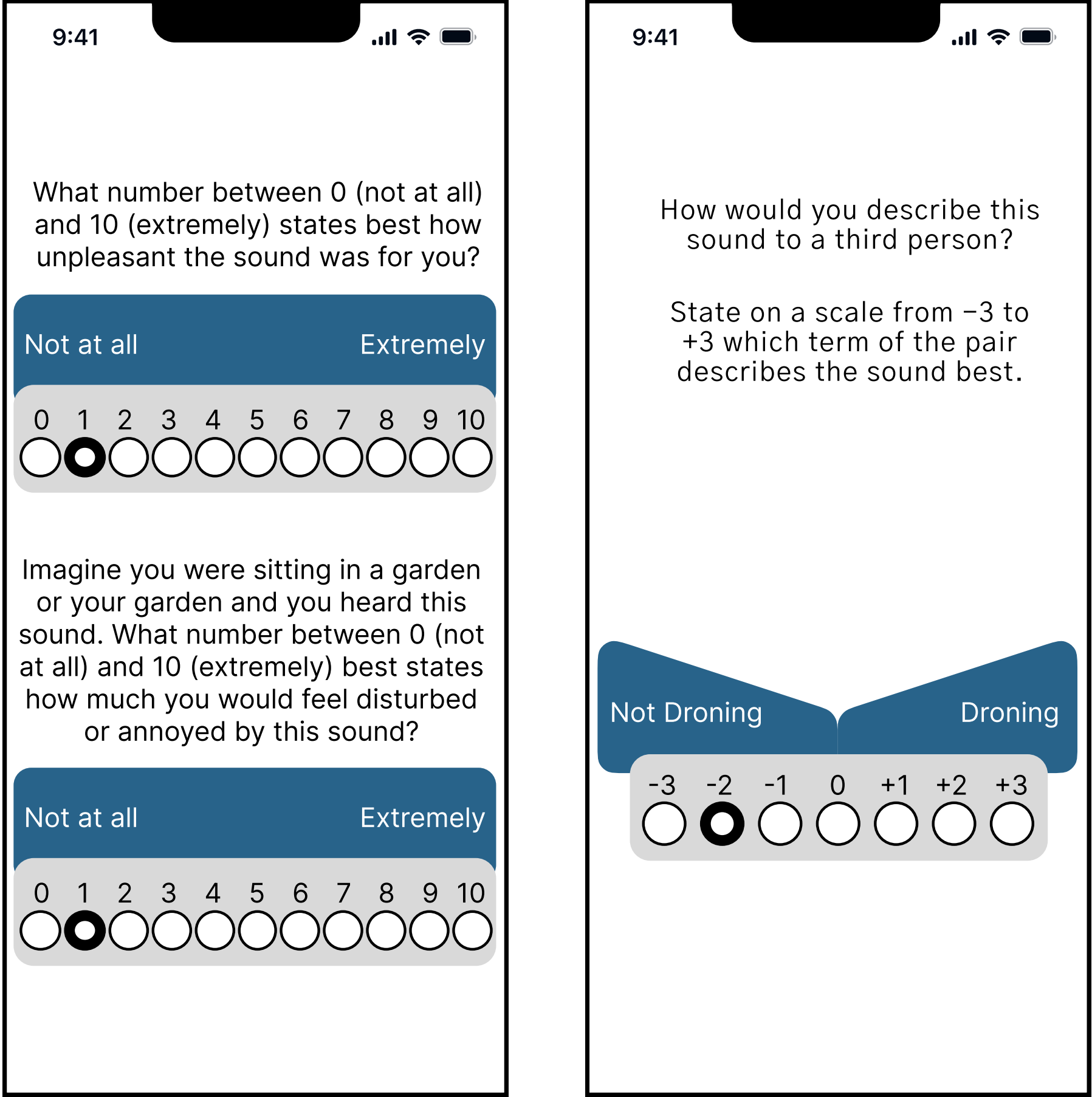


Figure 2: Rating scales for the unpleasantness and annoyance of the sound (left) and its descriptive qualities (right, showing one of 10 items)

Let’s find out
which aircraft
configurations
sound annoy-
ing - and why

2.4 Additional Engagement Features

Features for increasing the number of participants and the number of contributions per participant:

- “Workshop”: Colour and name the aircraft
- ”Expert Mode”: Re-listen to a sound with a more feature-rich audio player (e.g. select snippets and loop, show spectrogram)
- “Pilot License”: Awards badges for reaching milestones.

These are separate from the sound ratings so as to not influence them.

3. Forthcoming Research

We plan to distribute the app both publicly and to interest groups (e.g. residents near airports, aviation

clubs, schools). When analysing the data, we ask

- How do sound ratings in the app compare with ratings from focused listening tests in the lab?
- How varied are the sounds created by the app users? Are they biased towards a subset of parameters?
- Sound variations -> statistically detectable variations of ratings of sound valence and quality?
- Highest-rated configurations
- Inter-rater agreement?
- Interaction effects?
- Confounding socioeconomic variables?

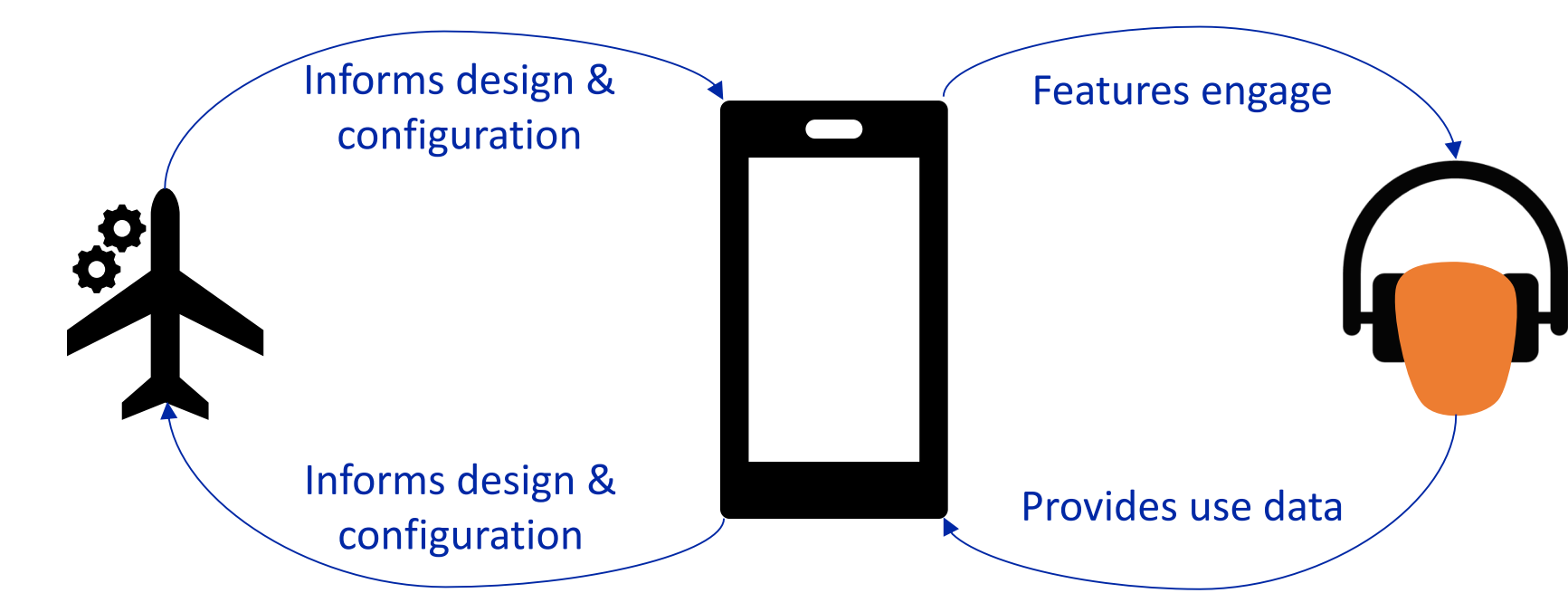
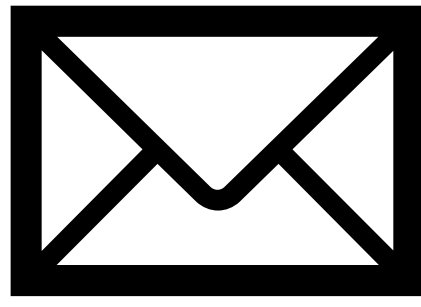


Figure 3: Idealised process for the design of tolerated, accepted and endorsed aircraft. The user perceives and engages with app features. This produces use data, which is processed to inform the design of aircraft. The current design of the aircraft, in turn, informs the design of the app.

The app will be updated with new configuration options of interest to aeroacoustic research. The sound profile is not the only feature of an aircraft that determines its acceptance. Likewise, aircraft are not the only technology where human perception data would be helpful in the design process: the app can serve as a framework for other research questions.

4. Contact us



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Project Press Release



Deutsches Zentrum
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German Aerospace Center

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