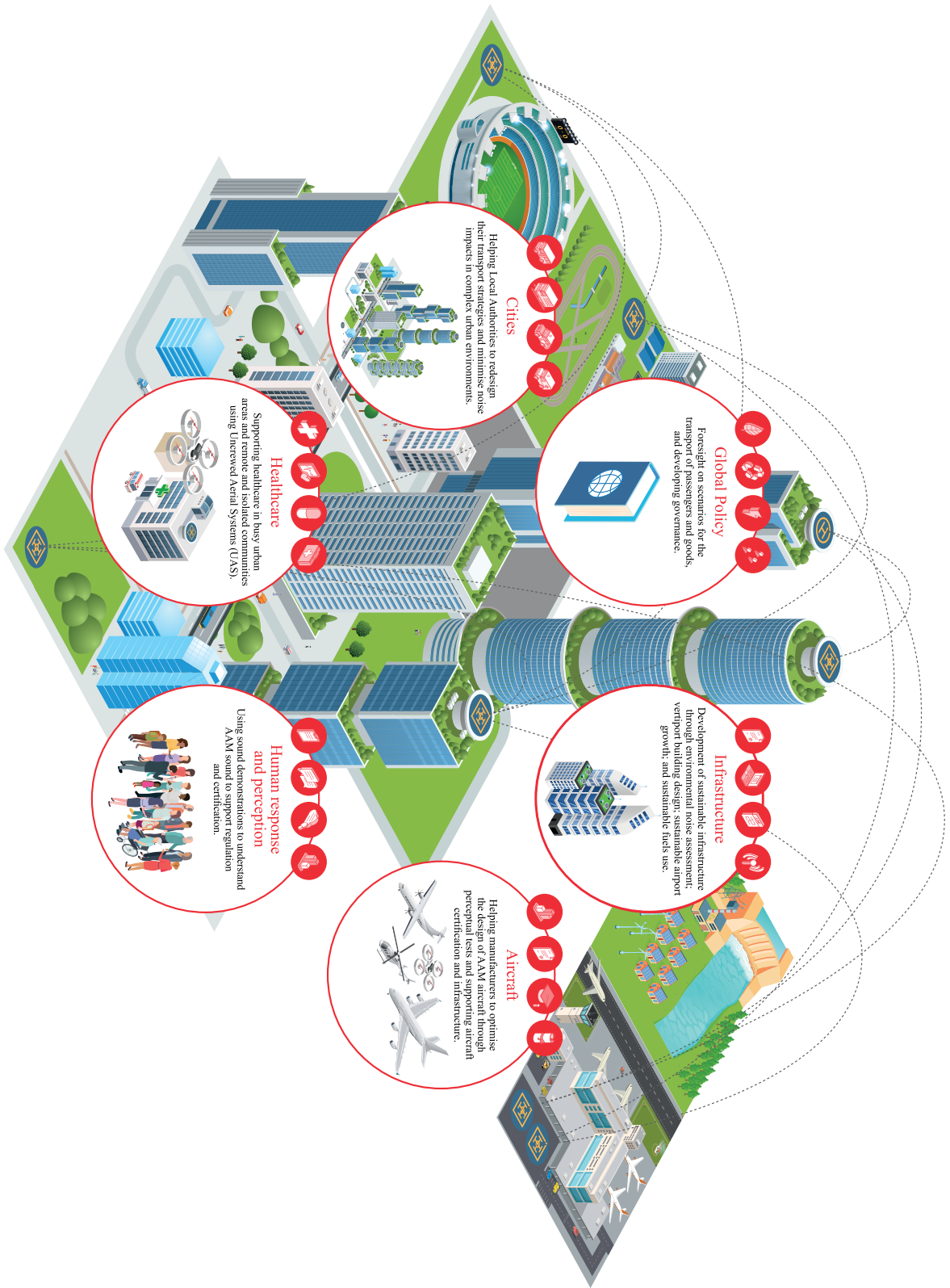


We shape a better world.

ARUP

Advanced Air Mobility

[www.arup.com](http://www.arup.com)



## Contents

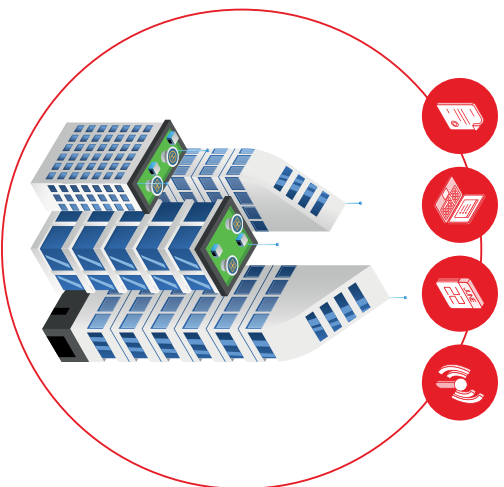


Infrastructure	4
Aircraft	6
Healthcare	7
Human response and perception	8
Cities	9
Global Policy	10

# Infrastructure



Development of sustainable infrastructure through environmental noise assessment; vertiport building design; sustainable airport growth; and sustainable fuels use.



## Noise impact assessments of Advanced Air Mobility operations



Noise profiles of Advanced Air Mobility (AAM) aircraft differ from those of traditional aircraft and there are many new and emerging technologies. These include drones, electric and hybrid-electric aircraft. Even though these aircraft are generally quieter than conventional aircraft, their noise signature is more tonal and may therefore elicit a different response from people compared to noise from conventional aircraft.

Fully understanding the sound (noise levels and signature) is key to defining appropriate vertiport locations and flight paths. An pioneering study can be used to design the flight routes to mitigate and minimise impacts on noise sensitive receptors such as residences, hospitals and schools.

## Vertiport terminal building acoustic design

Arup's vision of vertiport terminal buildings is that design should be centred on the human experience, providing environments appropriate for their unique uses. We believe that the success of a building is found in achieving both the right aural and visual environment. The acoustic design of each space should be appropriate to its use, allowing good communication whilst stimulating and supporting the activities intended within each space.

Key design considerations for the aural environment are to promote calm or excitement, orientation, communication, reassurance, safety and relaxation. The acoustic design should also ensure conditions are appropriate for the various occupancy conditions.



## Providing vertiport infrastructure for a sustainable air transportation system in metropolitan areas.

The Advanced Air Mobility (AAM) industry is pushing forward the electrification of air transport, which will help propel the aviation industry in its journey towards net zero. Arup is supporting the development of sustainable infrastructure that minimises its impact on the cities in which it is built, creating a sustainable air transportation system in metropolitan areas.





### **Integration of inclusive design, future proofing**

Inclusive design provides buildings and landscapes that are accessible for all users and maximises independence for the differing

requirements of our diverse societies, including considerations relating to personal circumstances such as age, culture, disability, gender and family status. Designing for accessibility and inclusion means designing with the future in mind, considering not only the diversity of the current demographics but also the changes over the lifetime of a building or space.

This includes looking at existing provisions - e.g. existing access audits to audit the existing aviation space and its approaches, assess the existing fabric against the current regulations and best practice documents, and identifying opportunities within the space for further consideration; as well as looking at trends and changing demographics, to consider the impact of current designs on future populations, and to provide solutions that look beyond code compliance.

Providing an access and inclusive design statement at planning will facilitate planning approval discussions and set a clear direction for the team to develop the design in subsequent stages of the project.



### **Occupational and passengers' health and wellbeing**

It is important to understand the impact of the built environment, including the implications of

the physical design, and the impact of sound and noise, on passengers and staff working within the area, including specific considerations relating to neurodiversity and sensory requirements. This will help create spaces that are safe and comfortable in use, but also to help facilitate navigation and communication. Promoting healthier behaviours (e.g. walking and cycling) will also help climate change objectives and improve air quality.



### **Building and presenting a case for planning approval**

Sound demonstrations provide a powerful mechanism for engaging in meaningful and collaborative discussions with policy developers,

key stakeholders and decision makers, which will be essential to achieving societal acceptance needed for planning approval for AAM. Calibrated sound demonstrations facilitate the best understanding of sound from AAM technologies and so promote policies and principles that are essential to the responsible design, inception and growth of AAM infrastructure and AAM aircraft operation.



### **Sustainably managed airport growth**

Accommodating passenger growth while reducing net carbon emissions and noise requires a holistic, integrated

multidisciplinary approach to environmental and health impact assessment to support planning applications; airspace modernisation and airspace change; noise mitigation strategies and Airport Noise Action Plans; development of noise insulation strategies, program and delivery; and development of sustainably managed airport growth strategies.



### **Hydrogen for aviation**

How hydrogen can replace traditional fossil fuels, leading to net zero flights and truly sustainable aviation, and the implications nationally, regionally, and for individual airports.



### **Renewable energy and airport resilience**

How airports can become more resilient and thrive in a sustainable future, through diversification and investment in renewable energy and alternative fuels.

## Aircraft



Helping manufacturers to optimise the design of AAM aircraft through perceptual tests and supporting aircraft certification and infrastructure.



### Helping manufacturers to optimize the design of AAM aircraft through perceptual tests



The acoustic signature of

Advanced Air Mobility aircraft are significantly different in character, both temporally and spectrally, to those from existing vehicle classes.

Even though these aircraft are potentially quieter, sole consideration of the overall vehicle noise level is unlikely to achieve public acceptance since other acoustic features (such as high pitch tonal sound) might be more noticeable leading to annoyance.

Through an experimental design process, in which aircraft noise models are coupled with auralisation, manufacturers have the opportunity to identify and eliminate obvious adverse acoustic features during key design stages.

By leading iterative sound quality workshops, we are assisting design teams to experience and assess their options. The gathered psychoacoustic information is analysed to define desirable design configurations as well as operational parameters.

### Supporting aircraft certification and infrastructure



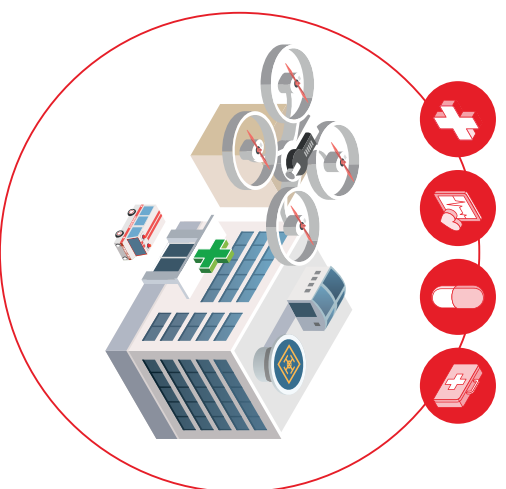
Because AAM vehicles are a novel noise source, studies are needed to generate an evidence base to inform certification, including human response to noise from these vehicles.

Arup has been partnering with Cranfield University to create a knowledge base to improve aircraft technology and regulatory, economic and environmental paradigms. There are three major parallel study streams: the development of mature paradigms for certification and operational approvals of FAA Part 23 hybrid-electric aircraft; the investigation of the financial and environmental implications of operating electric and hybrid-electric aircraft in various configurations within the airline operating environment; and investigation of energy optimisation.

# Healthcare



Supporting healthcare in busy urban areas and remote and isolated communities using Uncrewed Aerial Systems (UAS).



## **AAM for healthcare**

Uncrewed Aerial Systems (UAS) offer a clean and efficient means of supporting healthcare in busy urban areas and remote and isolated communities. Public acceptance of UAS for healthcare is likely to be greater than for many other applications of this technology, however, there remains a need to build trust, address concerns and remove barriers to acceptance of a UAS healthcare network. This can be supported through demonstration; active and independent engagement; and open and fair communication using sound demonstrations paired with a questionnaire designed to assess the social viability of the use of UAS for healthcare services.

# Human response and perception



Using sound demonstrations to understand AAM sound to support regulation and certification.



## Human response studies for Advanced Air Mobility



Understanding how people respond to different sources of sound is key to the design and assessment of the acoustic environment. It

allows for better acoustic design and a more robust assessment of the impacts of noise on people. This is particularly important for emerging technologies such as Advanced Air Mobility where ensuring public acceptance is vital to the uptake of the technology.

Arup undertook a pilot study on UAM noise that forms part of the recent E/ASA report Study on the societal acceptance of Urban Air Mobility in Europe. This first European study on acceptance of UAM included a set of perceptual tests to assess citizens' perception of UAM noise.

## Social licence and public perception



As with any new technology, the general public might express some reservations to the introduction of AAM. Presenting information

through an objective, factual approach to community engagement facilitates informed judgements founded on independent and defensible science, allowing the establishment of a trustful relationship between the general public and the AAM community.

Arup has extensive experience in airport expansion projects, where there is a need to communicate effectively with local communities and to explain potential environmental impacts. In particular, enabling communities and other stakeholders to understand the implications of the changes to the sound environment in the vicinity of airports and aircraft routes is essential to robust and effective consultation.

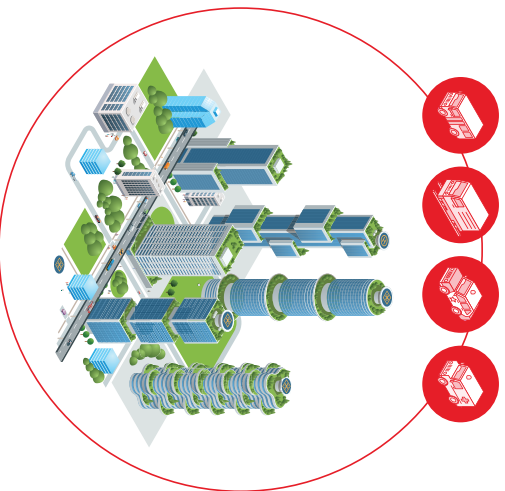
## Consultation and stakeholder engagement

Learning from lived experience is of utmost importance, and so engagement with the community to get feedback and integrate this into the process and the design, will result in better and more inclusive solutions. Our approach is holistic, working collaboratively as a multidisciplinary team, together with the community and stakeholders, to weave inclusion as a golden thread throughout the project.

# Cities



Helping Local Authorities to redesign their transport strategies and minimise noise impacts in complex urban environments.



## Helping Local Authorities to redesign their transport strategy



The introduction of Advanced Air Mobility presents opportunities for local authorities to reshape the transportation of goods and passengers within the urban environment and to make emergency services such as air ambulances and drug delivery more efficient. Forward-thinking local authorities are rapidly adapting their transportation strategies to respond not only to operator and infrastructure demands but also to community concerns. Approval of new flight corridors and vertiport locations are likely to fall under the responsibility of local officers with limited aviation knowledge.

Arup created auralisations of a series of generic AAM vehicles based on physics-based noise models to inform local authorities of potential noise impacts of future vertiports, vehicles and flight corridors, prior to the implementation of AAM. In combination with our aviation planning and urban planning colleagues, we are assisting local authorities in their upcoming transportation framework to ensure that AAM policies balance noise, equity and integration with surface transportation.

## Predicting noise impacts in complex urban environments

Arup is using digital tools to combine source noise models with 3D modelling of sound propagation and reflection in geometrically complex urban environments to allow us to understand the impacts of sound at ground level and through the full height of all buildings.

Our tools and assessment methods can also include sound propagation across water and green areas.

## Whole journey

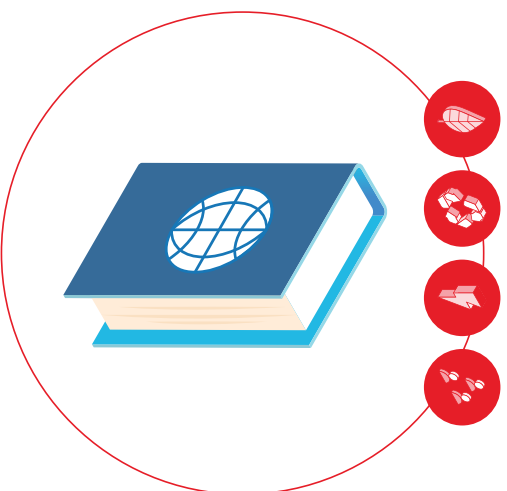


It is important to provide positive contributions to independence and opportunity from both a local and international scale, from the requirements of staff working within these spaces, and the passengers passing through. Inclusive design principles will need to be adopted for the whole journey. Our team works with clients to determine the user journey from home to connecting infrastructure, to the aircraft, and to understand and provide inclusive solutions for each barrier along the route.

# Global Policy



Foresight on scenarios for the transport of passengers and goods, and developing governance.



## **Future mobility visions for government and thought leadership**



Foresight pieces were produced for the UK Department for Transport by Arup, as early as

2019, on visions of potential futures in relation to the transport of passengers and goods in the UK, including Mobility as a Service (Maas), Smart Infrastructure and Construction, Hybrid Aviation, and Hyperloop. Arup is also an active participant of the NASA Technical Working Group for AAM noise and contributed to the first white paper “Urban Air Mobility Noise: Current Practice, Gaps and Recommendations,” a report aimed at addressing barriers to operation of AAM within the urban environment. The white paper provides a background of current practice, gaps, and recommendations in four areas of interest: tools and technologies; ground and flight testing; human response metrics; and regulation and policy.



**Contact:**

**Dr David Hiller**

Associate Director,  
Acoustics, Audiovisual & Theatre Consulting

t: +44 161 602 9233

m: +44 7747 768 535

e: [David.Hiller@arup.com](mailto:David.Hiller@arup.com)

**Dr. Ana Luisa P. Maldonado**

Senior Acoustic Consultant &  
Global Aviation Skills Research Manager

t: +44 1962 829 932

e: [AnaLuisa.Maldonado@arup.com](mailto:AnaLuisa.Maldonado@arup.com)

[arup.com](http://arup.com)