UK Research and Innovation

Future Flight Social Science Considerations and Research

Forward Strategy
December 2021

Background and Rationale

The Future Flight Challenge is a £300 million programme, jointly funded by the UK government and industry, to position the UK as a world-leader in the third aviation revolution. It aims to stimulate the development and application of new aviation technologies in the UK and to harness their significant potential environmental, social, and economic benefits for society. The four-year programme is creating the aviation system of the future and is working towards demonstrating the safe integration and operation of drones, advanced air mobility and regional aircraft, with advancements in electrification and autonomy by 2024.

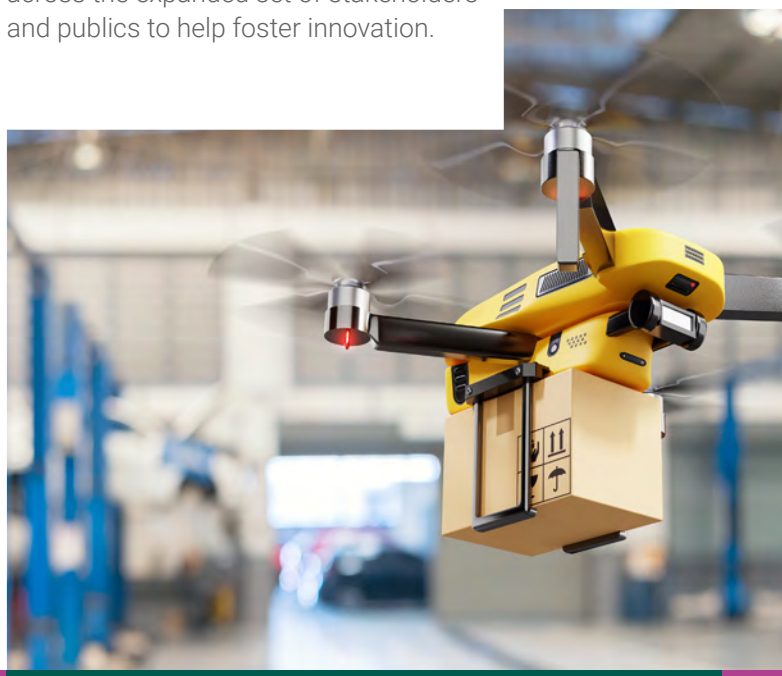
The Future Flight Challenge has established the vision for the future aviation system in 2030 and provided a roadmap that will position the UK as a global leader in advanced aviation solutions. To achieve this the Future Flight Challenge has brought together stakeholders from multiple sectors beyond aviation and aerospace, building a Future Flight ecosystem comprised of businesses, government bodies, research and technology organisations, academia, professional institutions, local authorities, social scientists and consumers. This nascent innovation ecosystem is central to the development of the systems, products and services for Future Flight.

Future Flight technologies have the potential to transform how we connect people, transport goods, and deliver services in a sustainable way providing socio- economic benefits using new classes of air vehicles with novel technologies. Furthermore, Future Flight technologies have the potential to transform our day-to-day lives, not only changing the way we travel, but also how we live, how we work, our consumer habits, our healthcare or public service provision, and our urban/rural environments. Therefore, the success of Future Flight technologies will hinge in no small part on perceptions of their trustworthiness and of their potential positive social benefits outweighing their perceived negative social or environmental impacts across a wide range of users/non-users and stakeholders at an individual, organisational, community or social level.

The future of aviation is at a pivotal point, with novel and innovative developments taking place in many different technological fields. However, the Future Flight Challenge encompasses a complex range of social, economic, and environmental issues that cut across a diverse range of sectors, stakeholders and disciplinary research foci. It is therefore vital that social and economic researchers are engaged from the outset to enable a whole systems perspective, ensuring a better understanding of how individuals, groups of users/non-users, stakeholders within the innovation ecosystem and wider publics react, respond to, and ultimately adopt or reject these new technologies and forms of aviation.

This understanding requires a systematic, multi-disciplinary based approach to appreciate the social and cultural contexts, contingencies and implications of Future Flight. This requires us to build on mapping broader public acceptance or use cases to enable a more holistic understanding of interconnected stakeholders, users/non-users, and their lived experience, in order to identify socially informed pathways for technological development and delivery.

Multi-disciplinary social science research is vital in this process, allowing for effective and equitable engagement or exchange of ideas between innovators, wider stakeholders, and diverse publics. This can enable a more comprehensive understanding of broader social needs, values, opportunities and challenges in relation to Future Flight, and relationship building across the expanded set of stakeholders and publics to help foster innovation.



This forward strategy paper provides an initial assessment of the research landscape, to identify five broad and interconnected research themes that the Future Flight Challenge consider priorities for social and economic research attention.

1 **Understanding the Innovation Ecosystem:** governance, organisational trust, new business models, logistics and operations management.

2 **Public and Social Readiness:** public perceptions, social desirability, images and narratives.

3 **Impacts on Rural and Urban Environments:** urban/rural planning, infrastructure development, and broader environmental issues (including privacy, noise and visual pollution).

4 **Communities and Social Impacts:** accessibility, socio-economic factors, equality and social inclusion.

5 **Trustworthiness, regulatory frameworks and implications:** safety, risk, insurance and legal issues.

This forward strategy paper outlines the starting position for wider engagement across academia, industry, and the public sector. The themes outlined, encompassing broad areas of research, are not definitive and reflect the fact that this specific configuration of more and less established social and economic research strands is itself as emergent as the technologies and the innovation ecosystem which we are seeking to study. It is important to recognise that the strategies for multi-disciplinary research in this field of study will need to be flexible and responsive to the shifts within the broader innovation ecosystem and emerging technological capabilities. These short summaries are intended to outline the initial priority needs identified in each area in relation to Future Flight for engagement between those working in industry and STEMM fields and social and economic researchers (along with those working in relevant fields in the humanities and arts). This forward strategy paper draws on the work and an initial report developed in November 2020 by the Future Flight Challenge Social Science Interim Working Group. [1]

1 Understanding the Innovation Ecosystem: governance, organisational trust, new business models, logistics and operations management.

The Future Flight Challenge, the development of a wider UK based innovation ecosystem around new aviation technologies, and the application of these technologies both nationally and internationally will open up a range of opportunities for UK businesses and the economy. Social science researchers can provide valuable insight into this process by mapping and building a model of the innovation ecosystem around Future Flight, identifying the stakeholders and players in the supply chain that are necessary to realise the Future Flight 2030 Vision.

Such mapping and engagement will help to identify the role that different stakeholders can and do play in the innovation ecosystem and where these ties can be strengthened or further developed to identify pathways for development and delivery. For example, it might be that the ecosystem is constrained by particular challenges related to skills, finance or regulation. Mapping can help to identify how to strengthen the system to help remove any developmental bottlenecks. Moreover, it might help to elucidate the important role public sector intervention could play (in terms of financial support, advocacy, convenor, or lead consumer) in early development of technologies, or where opportunities for private sector investment lie, or industry consolidation may be on the horizon.

Better understanding of the innovation ecosystem can advance understanding of how these potentially disruptive technologies might influence the market position and value of existing firms, including how these changes might influence business models and opportunities for entrepreneurship. It could also enable better identification of potential new supply chains and effects on (and gaps within) existing ones, helping to maximise the value of public investments. Moreover, it can help to identify the potential for new business opportunities and models, as well as to identify the potential for market failure. Such mapping could also help to ascertain where the leverage points are across both the supply and demand side, helping to foster innovation. This will enable a broad cross-section of UK industry and stakeholders to position itself at the forefront of the third aviation revolution.

[1]Membership of Interim Working Group: Chair: Professor Jill MacBryde, Professor of Innovation & Operations Management, Strathclyde University; Professor Fern Elsdon-Baker, Director ISTEMMiCS, University of Birmingham; Professor Charlotte Clark (PhD Environmental Psychology) Professor of Epidemiology, St Georges University of London; Paul Manners, Director, National Co-ordinating Centre for Public Engagement; Dr Louise Reardon, Institute of Local Government Studies, University of Birmingham; Professor Stephen Roper, Professor of Enterprise, Director, Enterprise Research Centre, University of Warwick; Samantha Field, ESRC, UKRI; Bruce Etherington, ESRC, UKRI; Kerissa Khan – Future Flight Innovation Lead, UKRI.

The role of government as financier of early-stage innovation may be particularly important in the post-COVID-19 context for example, where private risk capital is likely to be limited. Moreover, Government can also play an important role in facilitating networks and fostering information sharing to avoid duplication of development and support collaboration between industry and academia. Mapping can help to identify the needs of firms, and where collaboration and resource exchange may be fruitful between parties.

The Future Flight Challenge Socio-Economic Study in association with PWC (2021) helped to identify some of the logistical issues across six use cases. For example, looking at the time, energy and cost comparisons between using traditional transportation versus new classes of electric air vehicles. This has laid some of the groundwork for more comprehensive economic and social research that examines future implications for logistics, supply chains, economic or business models and operations management. Alongside developing further focussed economic modelling, social science research can contribute in other ways, for example modelling and looking at optimisation of routes and at location of hubs, charging stations etc. There are also important social science dimensions in terms of the types of goods being transferred or the provision of services. Some may be viewed as more socially desirable than others (e.g., 'blue light services', delivery of organs, medical tests, equipment or treatment, blood transfer and supply of goods that will help businesses and society). Further research that adopts a person-centred approach is needed to better understand the potential benefits of these kinds of service provision (e.g., speed versus cost in relation to benefits in healthcare service provision). Conversely, there is also an urgent need to consider the potential negatives of new forms of service provision or goods delivery, for example displacement of low skilled jobs such as delivery drivers in relation to the creation of more skilled roles, or the potential for a reduction in more traditional transport or services to rural or remote communities e.g ferries.

A range of preliminary top-level research questions were identified by the interim working group including:

- Who are the main actors in the UK Future Flight innovation ecosystem (or systems). How are they linked?
- Is the ecosystem constrained by particular challenges related to skills, finance, regulation?
- What can be done to strengthen the system and remove any developmental bottlenecks?
- Does the UK have complete or nascent supply chains in these sectors or are there specific gaps which could be addressed through investment or competitive initiatives?
- What are the future scenarios for the Future Flight sectors? How will this potentially disruptive technology influence the market position and value of existing firms? How will this change and influence business models? Where will entrepreneurship come from in these sectors?
- How aware are UK firms of the potential value of Future Flight technologies? Do they have the capabilities (skills) to contribute to the development of the technologies and adopt these technologies effectively as maturity arrives? Does UK industry have the potential to develop capabilities and skills for industrialisation at scale?
- What are the health economic models and potential social implications of bespoke delivery services such as for organs, medical tests, equipment or treatments and blood transfer?
- What are the new modes and models of business that will be needed to enable the supply chain and the supply of goods/services?
- What implications do new business models have for current commercial or public service provision of goods and services? How might this impact on current workforces, educational or skills pathways?
- What actors (institutions, individuals, groups – public, private, academic, community, third sector) are involved in the development of these technologies (and at what scale)?
- What actors are influencing the financing and incentivisation of the development and application of these technologies?
- Which actors have the most power/influence in shaping the development of these technologies and this sector. Who is currently not influencing these processes? How can these actors be better included in 'the conversation'?

2 Public and Social Readiness: public perceptions, social desirability, images and narratives.

Research into the public perceptions of drones and other advanced air mobility (AAM) has tended to adopt a use case approach, identifying the requirements for a technology to function effectively in a particular scenario or for a particular purpose. However, whilst a valuable resource, use cases would benefit from linking into cross-cutting research that allows the opportunity to engage with broader social, economic or political macro-trends, individual/group/community level behavioural or attitudinal factors, or public perceptions, concerns, desirability or readiness.

Some initial work in relation to specific technologies or contexts has been undertaken (e.g., drones). However, we currently have little understanding of not only perceptions, but also awareness of, potentially controversial implementation (e.g., Beyond Visual Line of Sight deployment, Unmanned Aerial Vehicles (UAVs) or last mile/inch drone delivery). Such understanding is important as it is clear that the transformational nature of these technologies means that they have the potential to have significant and wide-reaching impacts far beyond the traditional aviation sector and Future Flight itself.

We therefore also need to pay much closer attention to the social context within which technologies are to be used and for what purposes, including the ways in which social systems of media and cultural industries (for example) create future imageries for flight, and how this shape norms and expectations, in publics external to, but also within, the innovation ecosystem. For instance, drones are often highlighted in the media, or depicted in film, when used for potentially controversial or harmful purposes, such as in warfare, for spying, or terrorism. These narratives influence

public trust, and in turn readiness to accept such technologies, but we know relatively little about where these social narratives emerge from, and how these can be shaped to create fertile ground for significant technological and market uptake. Adopting a systemic social science research approach will allow for cross-cutting research that complements but also moves beyond a use-case approach, which may fail to pick up on the larger social trends or narratives that could negatively impact on publics' trust in or perceptions of, or readiness for Future Flight technologies and their overall social desirability.

Furthermore, as has been identified in the Future Flight Vision and Roadmap (2021) there is a clear and pressing need for UK public consultation to understand acceptability of autonomous technology for drones and passenger carrying AAM. Participatory social science research approaches will provide a vital space for reciprocal dialogue with communities of interest and wider publics. This will be key to better understanding the social challenges in implementing Future Flight technologies and fostering opportunities for socially informed innovation that is driven by public and social desirability.

A range of preliminary top-level research questions were identified by the interim working group including:

- What are current trends in public perceptions, awareness or desirability of what 'Future Flight' might actually consist of. How do these differ from what is currently technologically plausible, desired/ seen as economically viable by industry stakeholders, or perceived by policy makers/ stakeholders as socially or economically desirable?
- What are public perceptions of the potential for social or environmental good or harm of Future Flight initiatives? What are the levers that might influence public perceptions?
- What are the public perceptions of potential risks, and the scale of such risks, in regard to mortality, physical harm or psychological wellbeing?
- What information sources do publics access and see as reliable in relation to Future Flight?
- How might depictions of Future Flight in popular culture impact on the public perceptions of social value and social harm of such initiatives?
- How salient are reported public perceptions and survey responses?
- How do debates surrounding perceptions of the social harm/ good of Future Flight relate to broader social concerns (e.g. future of employment and broader economic concerns, climate crisis, conservation, impact of COVID-19 etc)? How might this differ in relation to demographic variables (socioeconomic status, gender, ethnicity, age etc)?
- What are key stakeholders (e.g. in industry, policy etc.) perceptions of public concerns/ priorities and how might these differ from those raised by publics themselves?
- How does this play out in terms of perceptions of social good/harm, environmental good/harm and perception of risk/scale of risk?

3 Impacts on Rural and Urban Environments: urban/rural planning, infrastructure development, and broader environmental issues (inc. privacy, noise and visual pollution).

The Future Flight Challenge brings clear environmental benefits in relation to the development of new electric aviation technologies or links to broader aims to decarbonise aviation. However, beyond the positive benefits in terms of the global climate crisis, the localised impact of Future Flight on rural and urban environments is a recognised concern. However, there is limited research in this area and a lack of public awareness of the potential implications, risks or impacts on our lived experience of our local environment from these technologies. Key priority issues in this area are the impacts of noise and visual pollution on health, differential benefits for, or impacts on, rural and urban communities, and implications for planning and privacy. Each of which have the potential to become focal points for dissent, publics concerns or push-back. Concerns over noise of existing aircraft for example, have been a growing cause of community action and a barrier towards airport expansion. As the future aviation system could feature highly distributed networks of airports and vertiports to bring transport options closer to users, such concerns and push-back could potentially intensify.

The potential effects of noise exposure on physical health, mental health and quality of life both in the short and long term, therefore, need to be considered. We know from research on the current aviation sector that becoming newly exposed to noise causes a change-effect – that is annoyance responses are higher than you would predict from the noise exposure per se, and that this has a negative influence on wellbeing. More research, therefore, on the human response to noise associated with the future aviation environment in the early stages of technological development may enable more effective design not only of air vehicles, but also airspace and ground infrastructure, mitigating risks of negative noise response which may impede roll-out of operations.

Similarly, there are also visual 'non-acoustic' factors, such as light emitted from UAVs, that could cause distress and have implications on health factors, such as sleep. Moreover, wellbeing may be negatively impacted within certain communities by an increase in flight movements or potential for congestion at low altitudes. There is still limited understanding of visual impacts within existing aviation systems, but individual, social and situational factors could all influence response, and in turn have societal as well as take-up implications. Knowledge about these factors could be garnered through both laboratory and field studies. Moreover, the intersection between noise, visual and other environmental factors needs a stronger knowledge base and greater consideration.

There are also important questions about the extent to which publics will be willing to trade-off privacy for potential benefits of Future Flight services, or if considerations about privacy can be mitigated. For example, use of drones for building or infrastructure surveillance, policing and security, or by other commercial entities (e.g. estate agents to photograph properties) may raise concerns from residents or nearby land-owners as to who has access to information about their properties or the data collected on them indirectly through what might be legitimate and legal uses of drones. Drawing on research examining road-based transport systems, it is known that the creation of new transport infrastructure can induce travel demand, we might therefore expect the same for new forms of aviation transport. This will have implications in terms of the potential for localised hotspots of increased low-level aviation traffic or congestion, which may negatively affect different communities in terms of privacy, noise and visual pollution. It is vital here to engage with both user and non-user groups as those who directly benefit from these new forms of aviation, may not be the ones who are most impacted in terms of changes to their local environment.

Some would argue that the sooner we can gather information about the human response to factors like light and sound coming from new classes of air vehicles, the faster we can use this knowledge to design the future aviation system 'right first time'. This goes beyond the vehicles themselves, and also expands to the physical, digital and airspace infrastructure, that need to be designed to mitigate noise or visual pollution.

Future Flight technologies not only bring with them the requirement for new infrastructure but also potentially new rural or urban planning requirements. Although, at this point, it is difficult to anticipate what the exact requirements are likely to be, landing spaces will be critical as may recharging points. There are critical tipping points that will need to be identified in regard to planning e.g. at what point do we need to start consideration

of including these factors, such as supporting energy infrastructure, in the design and development of new buildings and the retrofitting of older estates.

There is also need to consider the broader economic implications of these environmental factors. For example, potential implications for house prices near Hubs, which may be noisy. Also, the inequitable distribution of infrastructure, for example risks of Hubs being concentrated in more deprived areas with cheaper land, or incentivised to these areas which might have economic benefits, but have unintended effects on health and wellbeing. These are important issues for society in which social science researchers can contribute to the body of understanding.

A range of preliminary top-level research questions were identified by the interim working group including:

- Given the different sound profiles of new air vehicles, how will these impact on health and wellbeing?
- How will the different sound profiles of new air vehicles interact with other aviation and noise sources, particularly urban road traffic and ambient background noise in differing urban and rural locations?
- What are the implications for urban and rural planning processes as well as local/national government policy, infrastructure development and design of facilities or systems?
- What are the considerations and timescales that need to be taken into account in the design and development of new buildings and the retrofitting of older estates?
- How can new vehicles, facilities and systems be best integrated into existing airspace, infrastructure and aviation systems?
- How might new aviation vehicles, facilities and systems be best integrated with existing mobility systems (e.g. public transport, rail or road based systems)? What are the environmental, economic and social benefits of integrating Future Flight facilities and systems with other forms of transport infrastructure?
- How might different communities, regions or environments be differentially impacted on, or conversely benefited, by Future Flight technologies?
- What are the economic and social trade-offs of differential impacts on local environments or quality of life?

4 Communities and Social Impacts: accessibility, socio-economic factors, equality and social inclusion.

There are fundamentally important questions about the implications of Future Flight on communities, including in relation to social inclusion and equality that need to be addressed. The potential considerations are diverse and exist at micro, meso, and macro levels. Future Flight may offer the opportunity to reduce social exclusion, through for example improving access to goods, healthcare provision and services for currently disconnected or remote communities (including at speed) or offering a more cost-effective transport solution for areas not served by public transport. There are questions about the ways in which Future Flight might change the future of work for example, both in terms of place of work and the nature of the commute but also the type of work available. For example, Future Flight might replace 'low-skilled' work such as driving of light goods vehicles on the roads, with higher skilled work as pilots of drones beyond visual line of sight.

There are also questions about the ability of different groups being able to utilise and benefit from Future Flight technologies or the provision of goods and services and if not, the potential risks of Future Flight inadvertently exacerbating existing inequalities. There is a danger that some aviation applications might be seen as 'toys for the wealthy' rather than providing benefits to wider society. There is a need to be mindful of this perception given the public money invested. Alongside wider public consultation, more in-depth and comprehensive social science research is needed to contribute towards ensuring that benefits are accessible and inclusive of individuals, groups or communities across wider society.

We also need to understand more readily the inherent risks within the development of Future Flight. There may be groups who are at higher risk of physical (or psychological) harm in relation to Future Flight including members of workforces and publics (both users and non-users). Moreover, it is an open question whether people living with disabilities will be able to benefit from these technologies. Physical accessibility is a cross-cutting issue, with many modes of transport having barriers for those with disabilities or physical/mental health concerns (e.g. embarkation on to public transport, overcrowding, and non-stair access to platforms). There is also a need to examine accessibility through intersectional approaches that take into account affects, accessibility or issues for particular demographics (e.g. across age, gender).

A range of preliminary top-level research questions were identified by the interim working group including:

- What will the differential impacts on communities or publics be and how might Future Flight initiatives mitigate or increase social inequalities?
- Will there be potential for social inequity in relation to broader social benefits and access to these e.g. relevant modes of transport or newly created jobs?
- Will there be potential for inequity in terms of potential negative impacts of Future Flight that increase social deprivation, exclusion, quality of life and wellbeing across different social groups?
- How will Future Flight initiatives potentially impact negatively or positively on the future of work both in terms of those workers who are directly impacted and those who are indirectly impacted?
- Will there be a perception of job displacement/loss? Or will this be seen as potential to upskill the workforce in the aerospace and aviation sectors to ensure UK high value design skills remain competitive with other countries advancing in these high-technology areas?
- To what degree do those currently working in relevant sectors perceive Future Flight to constitute a positive impact or conversely negative risk to their livelihood? How does this map onto the perceptions of positive or negative impacts held by senior decision makers within organisational structures and other senior stakeholders within the innovation ecosystem?
- What are the inherent risks within the development of Future Flight? Will there be groups who are at higher risk of physical (or psychological) harm in relation to Future Flight including members of workforces and publics (both users and non-users)? To what extent will Future Flight technologies, like drones, reduce the risk to personnel working in high-risk challenging environments, for example, working at heights or inspection of powerlines and offshore wind farms?
- How will different stakeholders and publics be engaged with during development of new technologies including workers who are directly impacted on, workers who are indirectly impacted on, potential users, and broader publics/non-users?
- Would new aviation systems, vehicles, and infrastructure (both physical and digital) help people with disabilities? Or conversely could they lead people with certain disabilities to be or feel excluded?
- What key considerations must be adopted for an inclusive human-centered design approach for future aviation systems, vehicles and infrastructure?
- What does greater connectivity mean for regions with already lower value jobs? Does it make it easier to bring higher value jobs to the region or easier for people to reside in the region and go to high value jobs elsewhere? How might this interrelate with changes to working patterns and commutes engendered by the COVID-19 pandemic?

5 Trustworthiness, regulation frameworks and implications: safety, risk, insurance and legal issues.

Given the types of new aviation technologies under development, there is a recognised need to pay considerable attention to safety, regulatory frameworks and implications of their implementation. Related to this there are issues around insuring vehicles and their consignments, but also issues around potential damage to property, other vehicles and human life. Whilst there are some issues that will be specific to flight, there are many issues that overlap with other emerging technologies – for example autonomous vehicles.

While technical risks inherent in the products and infrastructures will be considered by engineers, the social risks, such as from the volume of air traffic, would benefit from input from management science and statistical analysis. While research is ongoing to understand risks in the skies from increased air traffic, to date limited consideration has been afforded, to understanding ground risk from increased low-level flight. There is a need to examine in more detail the possible ground safety issues or scenarios and their implications for public safety and public services. For example, the need for additional resources and capability of our emergency services to deal with such situations. Moreover, cyber security and the potential for criminal activity is an area that needs more investigation – both in terms of people's fears and indeed the mitigation of risk. Whilst Future Flight may well have a positive effect on public services, for example in transporting medical goods quickly, and saving lives, it could also put pressure on other parts of the system. There are social scientists looking at a range of interlinked issues including public service delivery across 'blue light services', cybersecurity and planning, who can provide valuable insight for Future Flight in these and related areas. Social science research can provide important insights that may help mitigate such possibilities and better understand the impacts on public trust and the trustworthiness of these new aviation technologies in light of these myriad risks.

When researching concerns over security, trust and risk it is vital to understand perceptions of new aviation technologies, within their social, political and organisational contexts. For example, further social science research is needed to better understand the extent to which stakeholders and wider publics' trust in relevant authorities or organisations (for example the certification and regulatory bodies, police or specific business groups) varies across different social groups, organisations or communities and how this might relate to perspectives on social or environmental harm/goods and risks. Given the role that publics' trust of these new aviation technologies will play in their uptake and adoption, there is an identified need for further consideration of when and how stakeholders and wider publics are brought into the discussion of regulatory, policy and legislative frameworks. Ideally a variety of stakeholders and wider publics should be involved in co-designing these frameworks to ensure they are supported and ultimately effectual. Social science and related humanities researchers, including those engaged in participatory research, can provide important insights here to better understand or mitigate public concerns and ensure feasibility of the technology and necessary frameworks.

Moreover, as has been acknowledged in relation to other smart mobility innovations such as autonomous vehicles, there is limited recognition and understanding of the role different governance systems and processes play in relation to successful implementation of/transition to use of these technologies. There is also little understanding of the extent to which governance relationships are changed, facilitated and constrained as a result of the implementation of such technologies. For example, we need to consider how these new technologies undermine and challenge current policy instruments, tools and regulations, or indeed create new policy instruments that can be used to harness positive social outcomes. Furthermore, we need to understand what the implications of these changes are for public trust, public protection and the achievement of other important and interconnected societal goals.

A range of preliminary top-level research questions were identified by the interim working group including:

- How does the public's trust in, or awareness of, relevant authorities or organisations (e.g. CAA, police, government, specific business groups etc.) vary across different social groups? How does this relate to their perspectives on social or environmental harm/good and risks?
- What concerns do publics raise in relation to different stakeholders perceived agendas or gains?
- How might organisational trust within key organisations or inter-organisations impact on development, uptake and adoption of new technologies?
- How might trust and communication impact on interactions between key stakeholders in relation to broader governance, regulation and policy making?
- How are the public groups most likely to be negatively impacted by Future Flight perceived by decision makers and other stakeholders and where might there be opportunities for their representation within decision making processes? What practical steps can be taken to allow for members of these groups/communities to engage with decision making/ policy in this domain?
- What does the governance map of this nascent sector look like and what are the implications of this?
- To what extent is policy making integrated in this area or bounded by the technology? To what extent are the whole system implications of the technology being considered by stakeholders?
- What are the underlying assumptions and issue framings guiding policymaking and innovation in this area – how realistic are these assumptions and what are their implications?
- How might new technologies undermine and challenge current policy instruments, tools and regulations, or indeed create new policy instruments that can be used to harness positive social outcomes?
- At what scale is policy, regulation and legislation most appropriate? For example, should each city be able to determine its own noise regulations around drones? Do we need regional/sub-regional legislation to ensure feasibility of the technology?
- To what extent is the development of these new technologies compatible with other important policy agendas, for example decarbonisation, wellbeing, social isolation?
- Do the technologies reinforce existing path dependencies or unlock new potential solutions?
- To what extent are governments considering this compatibility or the potential of the implications for other agendas?
- What role is government playing in fostering (or constraining) connections between these agendas, where are the opportunities or critical junctures for governance interventions to ensure positive outcomes?

Recommendations for next steps

The Future Flight Challenge encompasses a complex range of issues that cut across many sectors, a diverse range of stakeholders and a range of research foci. There is a pressing need to better understand how individuals, groups of users/non-users, stakeholders within the innovation ecosystem and wider publics react, respond and ultimately adopt or reject these new technologies and forms of aviation. A systematic multi-disciplinary based approach to understanding the social and cultural contexts, contingencies and implications of Future Flight is therefore required. This presents a significant, but exciting, challenge from a social sciences perspective and an opportunity to move beyond mapping broader public perceptions or use cases, to build a more holistic understanding of interconnected stakeholders, users and non-users in order to identify pathways for socially informed development, delivery and implementation of these new aviation technologies.

It is clear that the transformational nature of these new aviation technologies means that they have the potential to have significant and wide-reaching impacts far beyond the traditional aviation sector and the Future Flight Challenge itself. This shift is indicative of the ways in which Future Flight will remake the boundaries of various disciplinary and stakeholder eco-systems. The Future Flight Challenge necessitates sustained translation and collaboration between disciplines and sectors, alongside engagement with a wider range of communities/ publics, and a vastly expanded group of stakeholders that moves beyond traditional aviation research, networks and communities of interest.

- To achieve this the following recommendations for next steps have been identified:**To build long lasting research networks of relevant disciplinary experts and stakeholders in conversation with industry and policy makers**. This will enable a whole systems approach to understanding in more depth the potential environmental, social, and economic benefits and impacts of new aviation technologies, systems and infrastructures, as well as building better understanding of the policy, regulatory and legislative frameworks that will be necessary to deliver the Future Flight 2030 Vision. It is vital that these networks are representative of a broader range of expertise and insight from social sciences, humanities, STEMM and industry/ public sector stakeholders in what is a nascent field of social scientific study.

- **To identify the essential, baseline and primary social and economic research priorities in the period up to 2024**. Building an initial roadmap for social and economic research themes and sub-themes necessary to support and inform innovation processes within the Future Flight Challenge and the wider innovation ecosystem, and to provide social and economic insight for relevant stakeholders, policy makers and regulatory bodies in the period up to 2024. This should be done in consultation with a broader range of specialists and stakeholders, and where possible draw on wider public dialogue activities and insights.

- **To identify longer term transformational social and economic research priorities and a strategic research roadmap for the next 10-15 years**. Outlining the framework of research and researcher capacity building that will be necessary to realise the Future Flight Vision up to 2030 and beyond. This will draw on wider research networks and look to establish a flourishing field of multi-disciplinary research that will be necessary to better understand the mid-long term environmental, social, and economic benefits and impacts of new aviation technologies, systems and infrastructures, as they unfold in light of new technological capabilities or opportunities for development and implementation.

- **To engage in initial public dialogue and participatory consultation, alongside first stage baseline nationally representative data collection**. This will provide the necessary baseline to identify future research priorities in dialogue with publics and that are reflective of wider publics' interests, concerns and perspectives from the outset. This will be key to better understand the social challenges in implementing new aviation technologies and fostering opportunities for socially informed innovation that is driven by public and social desirability.

- **To build longer term opportunities for public dialogue, and participatory or person-centred research up to 2024 and beyond**. It is important to recognise that the terms and nature of publics' interests, concerns and perspectives will shift as the technological capabilities become more apparent and embedded within the public sphere. As technological development and testing progress, it is envisaged that the ways in which stakeholders and wider publics might visualise or perceive the social benefits and impacts will adjust or reflect these and changing popular culture narratives around new aviation technologies.
- **To build forums for policy, regulatory and legislative engagement and impact at the local, regional, national, and international levels**. Drawing on world leading UK research, industry expertise and thought leadership, alongside insights from upstream and ongoing dialogues with stakeholders, communities of interest, and wider publics, to inform the successful design, development and implementation of relevant policy, regulatory and legislative frameworks.

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