
UK
Civil Aviation
Authority
Aviation Futures
Two-year progress
Report

Introduction

The early 21st century is a challenging time for government and for regulat**ory bodies.** The emergence and rapid development of new, disruptive technologies and business models poses tough questions for regulators like the CAA: As novel, complex spheres of activity expand and become more common, how can we hope to understand and influence them – ensuring they are safe, secure, fair and conducive to the public good?

In these circumstances, it has never been more important for regulators to be able to think and act flexibly in the face of unexpected regulatory challenges – and, where necessary, to question old assumptions and ways of working.

The founding of Aviation Futures, the CAA's in-house think tank, is a critical part of this effort. By bringing a cross section of CAA staff together with a diverse panel of external experts, Aviation Futures enables us to look at difficult policy problems from a fresh perspective, bringing insight, knowledge and different ways of thinking to bear on our work.

Since its first meeting in June 2017, the Aviation Futures panel has informed CAA thinking on a variety of issues, from changing public attitudes towards noise, to flying taxis and delivery drones to the consequences of big data for commercial aviation consumers.

Aviation Futures is just one piece in a suite of initiatives intended to help the CAA respond to the changing face of aviation and regulation. The CAA has also established a horizon scanning programme to enhance our awareness of emerging trends, phenomena and technologies that might impact on the industry or our ability to regulate it. In addition to this, the CAA is in the process of establishing an Innovation Hub, which will enable the CAA to regulate new aviation technologies and business models in a far more pro-active manner than before. To be as effective as possible, these three projects need to be closely coordinated, enabling them to usefully build on one another's work and to avoid duplication of effort.

Following a successful first two years, Aviation Futures is therefore entering a new phase. To ensure harmonisation of the CAA's futures facing initiatives, the think tank will be moving from the CAA's policy development team, where it was founded, to the CAA's new Innovation Hub. The benefits of such a move will be considerable, with the support of the innovation team improving Aviation Futures discussions' relevance to CAA work, and its ability to inform and influence CAA thinking.

With the launch of the new CAA Innovation Hub, now is a natural time for the CAA to make its work on future regulation more visible to the wider policy world. For Aviation Futures, this is a chance to share its thinking more widely – opening up a dialogue with other policymakers and stakeholders on areas of common interest. At this exciting juncture for what is still a relatively new initiative, this report takes stock of what has been accomplished so far, as well as looking forward to what we hope to achieve in the coming months and years.

The thinking behind Aviation Futures

Aviation Futures is a panel that meets four times a year to explore questions relevant to CAA policy, strategy and organisational thinking.

This panel consists of sixteen people: eight external experts from outside of the CAA and eight members of CAA staff, drawn from across the organisation. The chair of Aviation Futures is a member of the external panel and the deputy chair a senior CAA colleague.

For the meetings discussed in this report, the topics were developed jointly between the chair, the deputy chair and the think tank's broader membership.

Aviation Futures meetings typically lasted half a day and consisted of facilitated discussion around a clearly defined exam question. Panellists were provided with briefing materials in advance where necessary, but this was kept to a minimum to enable participants to come to the question in hand with an open mind as possible. Where possible, a person with expertise in the topic (either from the panel or from elsewhere) was invited to give a presentation at the start of the session.

Following each meeting, the key points from the discussions were captured, with the most important learnings, observations and suggestions brought to the fore. As well as being used to inform the CAA board, the outputs of Aviation Futures discussions served as useful launchpads for further exploration of a given topic, and often guided further internal policy development and research. In many cases, topics explored at a higher level were examined in more depth in subsequent Aviation Futures meetings.

Direct benefits – enhanced policy development

Aviation Futures meetings typically aim to contribute to CAA policymaking in one of the following ways.

To enhance CAA awareness and understanding of emerging trends and technologies (and their implications) and to help the CAA interrogate specific questions raised in these areas

When considering how emerging trends and technologies might affect one industry or sector, it is particularly useful to consider analogous experiences, as well as thinking and assumptions, from other areas. As such, the diversity of the Aviation Futures panel, with external panellists bringing experience of a variety of industries and disciplines, enhances the CAA's ability to engage productively with questions of this nature.

The thinking behind Aviation Futures

To bring new perspectives and considerations to bear on pre-existing policy questions

While the CAA has a high level of expertise across its areas of regulatory responsibility, the relatively narrow focus of individual teams is not always conducive to innovative or novel approaches to policy problems – and can lead to the development of 'group think'. The policy development process therefore benefits from exposure to the broader array of expertise and experience brought by the external panel – as well as a diverse internal panel. Moreover, the discursive format of the meetings, along with the different backgrounds of panellists, lends itself well to first-principles thinking, and to the development of creative questions and solutions.

Indirect benefits – organisational culture change

While Aviation Futures was primarily founded to provide a forum for discussion of difficult existing and future policy questions, it was also hoped that it would bring broader, more indirect benefits to the organisation.

Specifically, Aviation Futures is intended to contribute to a broader cultural shift across the CAA. The Aviation Futures panel interacts with representatives from a range of CAA departments, exposing colleagues (either directly or through further communications) to innovative new ideas and ways of working.

Aviation Futures also helps make the CAA more intellectually 'porous'. The presence of the external panel, along with the practice of bringing in external speakers for specific meetings, creates frequent opportunities for the exchange of ideas and intelligence between the CAA and other entities.

What we have achieved

There have been seven Aviation Futures meetings since June 2017. The following section captures the most important points to have emerged from these discussions, arranging them thematically.

Aviation futures – meetings to date

Scenario mapping

June 2017 | The CAA's regulatory stance on noise
October 2017 | Future disruptions to aviation

Challenges and opportunities presented by emerging technologies

January 2018 | Automation
April 2018 | Consumer interaction with data
September 2018 | Urban air mobility (flying taxis)

Futureproofing the CAA

December 2018 | The CAA's Innovation Hub (operating model and culture)
February 2019 | The CAA's Innovation Hub (funding options)

Scenario mapping

The first two sessions involved broad scenario mapping exercises, in which panellists considered different possible futures and phenomena, and explored their possible consequences for the CAA and the aviation industry. In the first session, the panel used this technique to explore how alternative regulatory stances regarding aviation noise might play out in different circumstances. The topic for the second session was broader, looking at trends and large, one-off events that might occur between 10 to 35 years in the future and that would significantly disrupt the aviation industry and/or the CAA's ability to regulate it. This session concluded with a discussion about how other successful organisations think about and prepare for an uncertain future.

KEY MESSAGES

Where there is government policy justifying such a direction, the CAA may want to consider leading beyond its authority on noise issues.

- The CAA needs to be able to deal with unexpected regulatory challenges in a more agile manner.
- The integrated, systematic nature of aviation is both a strength and a vulnerability. For example, if one disruption occurs at one airport or airline, it will have a subsequent impact on the entire network.

What we have achieved

In the first session on noise, Aviation Futures members used a scenario mapping exercise to explore what taking a more active or more passive regulatory stance on noise might mean for the CAA (and the sector) in the future, depending on whether aviation growth was high or low.

We established that the worlds in which the CAA takes a hands-off approach to noise tend to feature more risks to those impacted by noise (i.e. through a fragmented regulatory environment or an outright lack of protection) than those in which the CAA takes a more interventionist approach, by leading beyond authority. We also explored the risks and opportunities for a regulator for each approach.

This discussion fed into a CAA Board meeting (a monthly Policy and Information Exchange session). Board members agreed with Aviation Futures' conclusions and recommended that the CAA lead beyond its authority on noise issues – but only when there was a government policy that justified the CAA's direction.

The second session was devoted to mapping possible disruptions and was particularly useful in identifying phenomena that might undermine the CAA's ability to regulate in a changing world, thereby undermining our capacity to fulfil our core principles of protecting public safety and consumer choice.

The panel generated a list of potential future disruptions and innovations that could impact aviation, and charted their likelihood and impact. These were combined with the outputs from the CAA's internal horizon exercise scanning and shared with the CAA Board for their 2018 Away Day. The Board exercise resulted in two key priorities for the CAA to address – personalised pricing and self-learning systems – both of which were informed by the Aviation Futures discussion.

An important lesson learnt from the session was that, given the difficulty of predicting future disruptions, one of the most useful things an organisation can do to prepare is to set itself up to become more agile and forward looking. Rather than preparing for specific eventualities that may or may not come about, the CAA needs to become better able to see changes on the horizon and to respond quickly to them at that stage. Maintaining an open mind and a flexible approach is key in an area where we no longer hold the expertise, but must absorb information from the

right sources to make informed decisions on our regulatory direction. Panellists talked about organisations that do this well, and it was identified that giving staff an opportunity to interact directly with new technologies could help them understand potential uses and impacts. This approach is being built into the CAA's new Innovation team.

Figure 1 – output from the first Aviation Futures future meeting: one group's output from the noise scenario mapping exercise

More things flying in UK airspace (including traditional aircraft but also new technologies – and they have more and/or different noise impacts)

The CAA has a reduced appetite to act

Scenario 1: The CAA shows a reduced appetite to act, but there is more activity in airspace

What does this world look like?

- The CAA is defensive: 'that's not our role'.
- CAA lacks resource or willingness or both.
- Retrospective regulation: the CAA just does what it has to, on things that have already happened (e.g. regulate only the aircraft that have already been brought to market).
- The CAA is absent from conversations: Google and Government do a deal together, CAA is told to regulate the outcome of it.

What might this mean for the CAA?

- Fragmentation: other regulators take on roles traditionally assigned to the CAA, or new regulators are formed to fill in gaps the CAA chooses to ignore.
- Stakeholders pressure the Government to reform CAA.

Scenario 2: The CAA shows a reduced appetite to act, but there is more activity in airspace

What does this world look like?

- The CAA asks the Government for more powers.
- The CAA regulates code as well as people: smart cities and geo-fencing become part of our narrative.
- The CAA needs new and different resources to consider big ethical and legal questions like: if a computer-generated code operates another computer (i.e. a drone), who is responsible if it crashes?

What might this mean for the CAA?

- The CAA makes a bid to widen its remit, regulating ground-based technology as well as air-based.
- The CAA widens its remit beyond borders: France subcontracts the UK CAA to manage its airspace.

Scenario 3: The CAA shows a reduced appetite to act, but there is more activity in airspace

Why would there be fewer things flying?

- Terrorism changes appetite to fly; Concerns about unmanned aircraft changes appetite to fly; Pandemic shuts the skies down; Less freight due to 3D printing; Global crash driven by Brexit or other global powers.

Scenario 4: The CAA shows a reduced appetite to act, but there is more activity in airspace

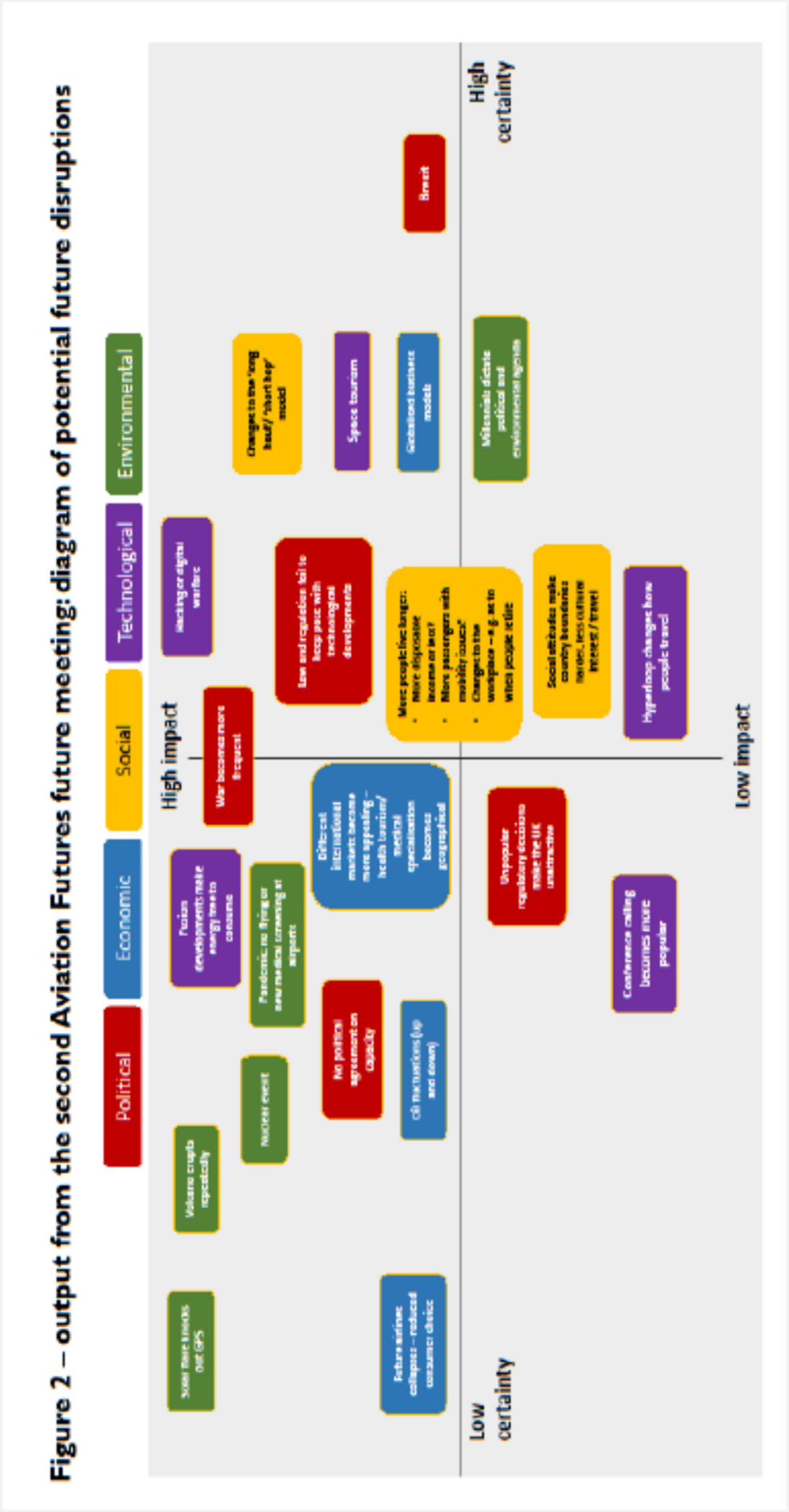
What does this world look like?

- The CAA starts to consider and plan for the events in the left hand box now.
- The CAA is frustrated! Keen to act but nothing to act on.

The CAA has an increased appetite to act (but not necessarily a Government mandate to do so)

Fewer things flying in UK airspace

What we have achieved



What we have achieved

Challenges and opportunities presented by emerging technologies

KEY MESSAGES

Automation

- The CAA has an important role in assisting government to ensure that the public have confidence in UTM technologies' safety and benefits.
- The CAA may also have a role providing clarity to industry on what may well prove to be a complex, cross-jurisdictional regulatory regime for UTM technologies.

Consumer interaction with data

- New data technologies could undermine the efficacy of informational regulation. If the use of these technologies is not regulated, the CAA may want to consider more direct regulatory interventions to protect consumers.

Urban air mobility (flying taxis)

- In considering how to regulate passenger drones, the CAA can develop a new regulatory framework from first principles or build iteratively on the existing regulatory regime for helicopters. While the former approach would theoretically allow for greater environmental and social protections, a less radical framework, implemented more quickly, might have a greater effect on the shape of the burgeoning industry.

The session on automation, which was attended by a representative from the Department for Transport, focused on two applications of automation to aviation: autonomous air traffic management and UTM (Unified e-Traffic Management), which encompasses the integration of all new types of aerial technology with existing aircraft, and drone swarm technologies, whereby unmanned aerial vehicles are clustered and controlled in a new way.

We used the meeting to explore the competing demands of government, industry and the public with regards to the regulation of these new technologies, where these demands might come into conflict and – in such cases – how they might be reconciled.

The panel agreed that, beyond ensuring that air traffic management, UTM and swarm technologies are safe, CAA has an important role in assisting government to ensure that the public have confidence in such technologies' safety and benefits. The panel also agreed that the CAA may also have a role providing clarity to industry on what may well prove to be a complex, cross-jurisdictional regulatory environment for these technologies.

The session on consumer interaction with data and algorithms started broadly, looking at three technologies (lifelong personal avatar assistants, intention decoding

algorithms and public mood monitoring) with the potential to affect the means by which consumers act (and are acted upon) in the aviation market.

The panel's consideration of these technologies identified two trends that could well characterise the aviation market of the near future:

- Companies start to exert more control over how consumers access and consider information in the aviation market. (For instance, technologies such as personalised search and 'hypernudge' could determine the deals that consumers see and which they perceive to be best.)
- Companies' treatment of consumers becomes more personalised. (In particular, the practice of personalised pricing stands to lead to a market in which two consumers are quoted different prices for the same product based on their perceived willingness to pay.)

Both of these trends are already visible in the aviation market and both point to a challenge for the CAA, whose regulatory model for consumer protection is premised on the idea that information can empower consumers to avoid poor deals and treatment, and to vote with their feet. If the future is one in which companies have more control over the market information than consumers see (and how they see it), this model may become less effective. In particular, the panel noted its concern about the practice of personalised pricing, which could undermine consumers' de facto ability to shop around in the market and could systematically disadvantage vulnerable consumers.

The session on urban air mobility (flying taxis) started with discussion of the potential risks and opportunities presented by passenger drones.

The panel then considered how the CAA might regulate to ensure their use is compatible with positive social, economic and environmental outcomes.

It was observed that, in regulating passenger drones, the CAA can go in one of two directions, either developing a new regulatory framework from first-principles (working backwards from the environmental, social or economic outcomes it would like to see realised) or building iteratively on the existing regulatory regime for helicopters. The former approach would enable us to build-in greater environmental and social protections than those that exist for helicopters, and – if embarked upon soon enough – could incentivise industry to develop quieter drones and more egalitarian business models.

However, developing a regulatory model from scratch would take longer than building on existing regulation, meaning that we'd have to wait longer to start piloting and testing the technology. As the longer we wait, the less we are able to influence how drone technologies (and business models) develop, there may be advantages to designing and implementing a less radical framework sooner.

This issue of speed is particularly relevant, given that early regulation of passenger drones will likely affect the decisions made by those developing and investing in the technology. For instance, if the CAA were to make it clear that it intends to require passenger drones to conform to exacting noise standards, start-ups and industry may place greater emphasis on developing quieter aircraft, or on developing business models that would lead to lower levels of noise pollution. The regulatory precedent set by the CAA could also affect how other countries decide to regulate passenger drones, placing further pressure on industry to develop products that comply with the CAA's standards.

Futureproofing the CAA

KEY MESSAGES

Operating model and culture

- The CAA's regulatory lab and sandbox will create an intimate relationship between the CAA and industry. This presents risks as well as opportunities.
- The traditional regulatory sandbox model – which exists to help new business models within existing regulatory frameworks – may not be applicable for the CAA's innovation teams, who are likely to be dealing with technologies requiring new regulatory principles.

Funding model

- The CAA should leave open flexibility in how it funds its innovation teams

The session on the innovation team's operating model and culture explored how the regulatory lab, sandbox and the innovation gateway could be set up to deliver most benefit.

While alive to the benefits that could be brought by the introduction of a regulatory lab and a regulatory sandbox, the panel noted the risks associated with the close relationship to industry these initiatives would bring. The CAA will have to be careful to ensure that its approach to regulation is not inappropriately guided by the needs of the companies with which it is in conversation, and the risk of that regulatory capture is minimised. Likewise, if the CAA's approach to the regulation of a particular technology is overly informed by the particular business models presented to it through the sandbox, there is a risk that other companies using different business models find themselves locked out of the market.

The panel also stressed the importance of considering what sandbox operating model would be most appropriate for the CAA. It was noted that sandboxes generally fit into one of two kinds:

What we have achieved

- Traditional sandboxes enable new ideas to be tested in a regulatory 'safe space' against a backdrop of established law and regulation. These work best when the technology or business model does not constitute a huge departure from what is already done in the regulated market – in circumstances in which existing law and regulation applies to the new idea. Traditional sandboxes exist to help companies adapt their products so they are able to get on the right side of regulation and the law. They are designed to help reduce the cost of market entry for new innovators by allowing to test new technologies without fully committing to a launch. Traditional sandboxes also allow innovators to avoid the risk of sinking funds in a product only to have them be refused regulatory approval.
- Early-stage sandboxes exist to help regulators develop an understanding of an emerging (or potentially emerging) market and its regulatory needs, and to collectively raise innovators' confidence and understanding of what may be completely new regulatory approaches. Early-stage sandboxes are therefore more appropriate in circumstances in which there is applicable regulation for the new technology or business model. This might be the case where the technology in question is entirely new, or because the application of that technology is without precedent.

Given the likelihood that many of the technologies that the CAA's innovation teams will be dealing with will require new regulatory principles, it may make sense for the CAA to develop an early-stage sandbox, rather than a traditional one.

The session on long term sustainable funding models for the Innovation Hub explored potential means by which the innovation team might be funded in the medium to long term.

A key observation from these discussions was the difficulty of balancing the pros and cons of different funding models.

- Models where the user of regulatory services pay directly for those services risk compromising regulatory independence.
- Grant funding can be very useful, but can be restrictive, allowing little flexibility in how money is used. The availability of grants cannot be guaranteed in the long term.
- Models where the regulator funds regulatory activity itself can provide a higher degree of independence and flexibility, but can constitute a financial strain (particularly in cases where demand for regulatory services spikes unexpectedly).

Given this, the panel stressed the importance of taking a flexible approach to funding. It was suggested that grant funding could be very useful to provide the innovation teams with early cashflow and visibility, but that, in the long term, the CAA may want to consider transitioning to a subscription model, for example, for some of its regulatory services. To minimise the risk this could pose to our regulatory independence, it was suggested that subscribers to this service would get access to CAA networks, events and other resources – thereby reducing the feeling that

subscribers were paying for particular regulatory outcomes. This may follow a professional services model where what is provided is expertise, as opposed to a specified outcome or result.

Cross subsidisation models (whereby the CAA funds the innovation team with money from the its levy on industry, for instance) were also considered. However, it was noted that new technologies and uses of airspace may well disrupt the means by which the CAA's other regulatory services are funded. As such, the innovation teams must not work on the premise that the CAA's broader funding model will remain the same indefinitely, but must instead remain abreast of developments and influence as appropriate.

Our influence on strategy and thinking

Influence on CAA strategy and projects

The outputs from the meeting on the CAA's regulatory stance on noise fed into CAA Board discussion – at which agreed it was right for the CAA to lead beyond authority on noise, provided there were a clear government policy guiding the CAA actions.

The outputs from the meeting on potential future disruptions to aviation and the session on consumer interaction with data were used in a CAA board Away Day at which the Board asked the CAA to prioritise two areas of work – personalised pricing and self-learning systems – both of which were investigated by Aviation Futures.

Influence on public policy

In its response to a call for evidence on its Aviation Strategy, The Department for Transport cited Aviation Futures' as an example of a public body developing working to develop thinking around the issues presented by automation. The Department's response also echoed many of the points raised at the Aviation Futures session on the topic, such as the challenges of integrating automated processes with existing traffic and the importance of understanding public perceptions of automation.

Influence on CAA policy development and research

The session of the CAA's regulatory stance on noise prompted further organisational thinking and research about public appetite for regulatory intervention. One manifestation of this was the commissioning of survey research on the UK public's desire for regulators and government to embark on direct regulatory intervention in different sets of circumstances. This was published in 2019, and can be seen online here. Another result was a CAA public engagement exercise on possible interventions on aviation noise.

Discussions on the regulation of flying taxis as well as innovation operating models and funding options have fed into the work of the Innovation Hub.

The future

As Aviation Futures continues to mature, and its work becomes increasingly coordinated with that of the Innovation Hub, the focus of the group is likely to evolve.

Potential future areas to explore

As before, CAA staff will work closely with Aviation Futures' chair and the external panel to determine the group's agenda. We expect that many topics of future discussion will arise out of future conversations and out of future horizon scanning sessions. In addition to this, however, the following are areas that may be worthwhile exploring with the think tank.

- **Public attitudes towards emerging technologies:**

  A common barrier to the roll out of emerging technologies is public concern about their safety, ethics, and the distribution of associated costs and benefits. In some cases, widespread misunderstanding of the nature of – and risks associated with – new technologies has led to significant public backlash, leading to projects and research being put on hold. What are the best ways for regulators to understand public concerns about new technologies, and how can we ensure that regulatory trade-offs between different values and goods accord with public values and priorities?

- **Spaceflight:**

  As the commercial spaceflight industry grows, the CAA may find itself having to consider how to incorporate spacecraft into UK airspace. How do we expect this technology (and the associated business models) to develop, what are the trade-offs and what are the safety risks?

- **New technologies in aviation security**

  Advances in machine learning and sensor technology have the potential to significantly enhance the abilities of aviation security forces. What specific practices might be possible, and what knock-on effects would they have on the experience of flying if implemented widely? In considering if and how such technologies are used, the CAA may also want to consider the balance between security and other values, such as privacy.

- **Climate change and the environmental impact of flying:**

  As concern about global temperature rises becomes more intense amongst policymakers and the public alike, how should the CAA seek to respond to anticipated increased public demands for action? As the CAA has relatively little regulatory power in this area, how might we reconcile people's expectations of us and what we are able to do? In the longer term, how might global temperature rises affect the aviation industry and what challenges will this pose for its regulation?

The future

- **Automated aerial delivery**

  Companies such as Amazon envision a future in which everyday items are shipped by drones, rather than by people. The regulatory parameters set by the CAA are likely to determine the viability of such a business model, the shape it takes and the effect it has on the economy and society. The CAA needs to consider the principles it would use to determine what companies like Amazon should be allowed to do, and under what circumstances. This is a key issue for the Innovation Hub in its first year of operation and the CAA welcomes the challenges that the Aviation Futures Think Tank can provide in recognition of some of the broader aspects mentioned above, such as public acceptance, security, privacy, noise levels and environmental impact.

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Enquiries: innovation@caa.co.uk