Futures of Autonomous Flight: Using a Collaborative Storytelling Game to Assess Anticipatory Assumptions

1 Introduction

The passenger aviation industry has embraced electronic automation both on the ground and in the air, now including, for example, automated check-in and arrivals, automation in air traffic control systems, and onboard automation, in particular in the form of autopilot. The first autopilot was developed by Sperry in 1912, allowing a plane to fly level without constant monitoring by the pilot, while commercial adoption of autopiloting systems increased following World War II. However, until recently these systems still required a human pilot, particularly during the technically challenging take-off and landing (Elish & Hwang, 2016). With developments in automation technologies over the last year, particularly Airbus's successful automated takeoff (Airbus 2020) and Boeing's prototype autonomous air taxi (Stewart 2019), fully autonomous passenger flight is now a near-future technical possibility. But questions remain regarding how such a technological leap might be perceived.

Existing quantitative research on public perception of automated passenger flight can be contradictory: Rian Mehta et. al have developed a willingness-to-fly (WTF) metric which indicates that passengers are less comfortable with fully autonomous and remotely piloted planes than they are with piloted ones (Mehta et al, 2017). However, commercial research such as the Ansys Global Autonomous Vehicle Study indicates that 58% of respondents are 'ready to fly in an autonomous plane in the next decade' (Ansys, 2019). There is more available literature on public perceptions of UAVs and drones. Here, the quantitative surveys are more uniform in their findings, indicating that respondents are anxious about security and, in their conclusions, advocating for greater public education on existing regulation of and uses for drones (Clothier et al, 2015) (Nelson et al, 2019) (Institution of Mechanical Engineers, 2019). While these results do not directly reflect the experience of passenger flight today, they may help us to understand perceptions of autonomous flight as the context becomes more similar to that of drone usage.

Existing public perception studies often fail to engage in *why* people hold certain beliefs about automated flight. For example, Mehta et al's study does not provide a robust explanation for why participants favour piloted planes. Ansys's study indicates that participants changed their minds about their willingness to accept automated planes when it was explained how much of commercial flight is already controlled by computers, but fails to account for those who were still reluctant. We hypothesise that a fuller understanding of anticipatory assumptions (AA) regarding autonomous flight – both explicit concerns and implicit beliefs – can be developed through less deterministic, qualitative methods. To that end, we designed and deployed a collaborative storytelling game to reveal non-expert AA, in order to contribute to and expand the existing literature on public perceptions of autonomous flight. The study conducted three collaborative storytelling game sessions with self-selected public participants, in order to collectively generate stories set in futures where autonomously piloted aircraft are prevalent.

The collaborative storytelling game constitutes a *narrative futures method*, as defined by Sarah Dillon and Claire Craig (2021) in their analysis of the intersections between stories and anticipation in futures studies. Using Bishop at al's (2007) map of current futures techniques, Dillon and Craig demonstrate how stories manifest in and across the whole range of existing

futures techniques, as well as offering potential for new methods. They note that storytelling, storyimbibing and/or story analysis already define the processes of some known techniques, including incasting, backcasting and future mapping, and propose that such techniques should be classified as narrative methods. Within this category they also include Science Fiction Prototyping (SFP), collaborative storytelling games, and surrogative reasoning from existing stories (primarily, but not exclusively, science fiction stories) functioning as anticipatory models.[1] Such narrative methods function in relation to the categories of open and latent futures (Adam and Groves, 2007) and participate in, in Riel Miller's terms, Anticipation for Emergence, which is less concerned with the future as goal and more concerned with novelty, with opening up a range of possible futures through taking into account a diversity of AA, using a range of methods, and valuing a heterogeneity of knowledge creation processes (Miller, 2018).

In this context, this research aimed to develop and trial a collaborative storytelling narrative futures method; to demonstrate the importance of storytelling for the revelation of AA; and, to analyse non-expert AA regarding autonomous flight. Whilst the stories generated by the participants take the form of a narrative description and are rooted in the future, they are not scenarios, in that they are not intended to be possible or plausible, and they were not systematically generated as parts of a set within which they would offer meaningful alternatives to each other (Spaniol and Rowland 2018).[2] It is also important to note that the research does not constitute a complete hybrid strategic scenario (HSS) futures literacy method as defined by Miller (2007). Miller (2007: 347) defines futures literacy (FL) as 'the capacity to explore the potential of the present to give rise to the future' and argues that a HSS approach is one way of learning and practising FL, progressing through its three skill levels: awareness, discovery, and choice. This research focuses only on FL level 1 – awareness of AA. Whilst this would not be sufficient in itself for a more comprehensive futures approach to autonomous flight, it is sufficient to meet the delimited research aims of examining existing public perception. The revelation of such AA might aid planning – for instance, understanding public perception of autonomous flight might influence design, development and deployment of the technology by corporate actors. But the revelation of such AA might also serve a critical or ethical function, prompting corporate and other actors to reflect in advance on the need for, as well as purpose and effects of, emergent technologies.

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[1] On Science Fiction Prototyping see: Johnson (2011); Graham, Greenhill, and Callaghan (2014); Graham and Mehmood (2014); and, Schwarz, Kroehl, and von der Gracht (2014). For early examples of the technique see Callaghan, Clarke, and Chin (2004) and Egerton, Callaghan, and Clark (2008). More recently, see the papers in the Creative Prototyping Special Section of *Technological Forecasting & Social Change* 84 (2014). See Dillon and Craig (2021) for an extended analysis of the relationship (past and present) between futures studies and science fiction, covering the early futures studies literature (e.g. Livingston (1971) and Elkins (1979)) through to contemporary analyses (e.g. Miller and Bennett (2008), Schwarz et al (2014), Burnam-Fink (2015) and Fergnani and Song (2020).

[2] See Dillon and Craig (2021) for an extended analysis of the relationship between stories and scenarios in futures studies. They note that stories are essential to future studies with regard to the products of futures techniques, functioning as narrative scenarios, as the 'what if' prompt for quantitative methods, and as the framing and use-facilitation of non-narrative scenarios.

The research developed and deployed a collaborative storytelling game inspired by the tabletop role-playing game *Microscope* (Robbins, 2020). Games are an important emerging avenue to explore non-expert futures involving artificial intelligence (Avin, 2019). Foresight games such as *Eventuality* (Burnham-Fink 2016), *Shock: Social Science Fiction* (Newman, 2020) and *Impact* (Idea Couture, 2020) allow for structured participation that both renders the process of futures-making more accessible for less futures literate audiences, and encourages participants to think 'divergently' about possible implications of future technology (Candy, 2018). The game method necessitates the relinquishing of researcher control and an increase of participant agency. Whilst this method would not suit all research purposes, it is appropriate for a research project which aims to investigate participants' AA. Sociologists have long warned of the dangers of restricting participant responses by using leading questions (Hollway and Jefferson, 2013). While the game structure is not as free-form as Hollway and Jefferson's digressive storytelling method, the participant-directed structure of the game allows the researchers to limit the need to 'anticipate' what the participants' concerns might be, and vice versa, thus producing novel findings.

Like other narrative futures methods, collaborative storytelling games offer the opportunity for engaging with a wide range of publics, as well as offering the opportunity for greater civic participation, engagement, and deliberation beyond that of experts (Miller and Bennett, 2008; Milojević and Izgarjan, 2014; Paschen and Ison, 2014; Miller et al., 2015: 66–67; Reason and Heinemeyer, 2016; Merrie et al., 2018). Non-expert stakeholder input into decision-making in the policy context is becoming increasingly important, with resources such as citizens' assemblies and citizen juries being consulted by local and national government in the United Kingdom. For instance, the NGO Sciencewise, in association with the Department for Transport, recently published a report on its public dialogue concerning connected and automated vehicles. (Traverse, 2019) Meanwhile, University College London's 'Driverless Futures' project is currently focused on stakeholder meetings, expert interviews and public events to try and determine how these new technologies should be governed (Stilgoe, 2019) (Cohen et al, 2018). The premise of public consultation is geared towards delivering plausible solutions based on expert advice (Street, et al. 2014). But not all decisions and AA are grounded in impartially assessing expert opinion, and seemingly 'irrational' fears and anxieties may actually represent an intuitive or subconscious assessment of potential harms (Evans, 2010). Storytelling and storylistening allow us to access the affective and implicit beliefs non-experts have about autonomous flight – and free participants from the belief that they must provide the 'correct' answer.

This article: outlines the collaborative storytelling method the study developed; presents the results of three focus groups (FGs) at which the method was deployed; discusses those results in order to identify the nature and significance of recurrent AA across the FGs; and critically reflects on the collaborative storytelling method and avenues for future research.

2 Method

Three collaborative storytelling sessions on the topic of autonomous flight were held in Cambridge in August 2019 (Focus Group 1 = FG1), October 2019 (Focus Group 2 = FG2) and November 2019 (Focus Group 3 = FG3). FG1 had four participants, FG2 and FG3 had five participants. The non-expert participants were a self-selected group recruited from

Cambridgeshire residents in response to an open call for participants advertised on the Leverhulme Centre for the Future of Intelligence's Twitter account and through flyers placed on public notice boards. Participants were compensated with £20 Amazon vouchers for their time, and lunch was provided.

Each FG consisted of two phases: in the first phase (D), participants viewed a short reel of clips of Hollywood cinematic and televisual depictions of autonomous flight, and then engaged in discussion about their expectations for autonomous flight technology. All FGs were shown clips from *Stealth* (dir. Rob Cohen, 2005) and *The Flight of the Navigator* (dir. Randel Kleiser, 1986). FG1 also included a clip from *Interstellar* (dir. Christopher Nolan, 2014). As the research was primarily interested in assessing perceptions of automated passenger aircraft, the clip from *Interstellar* that depicted an unmanned UAV was removed in FG2 and FG3. FG2 and FG3 participants were also informed at the outset that the research was focusing on passenger aircraft. FG3 included a clip from the pilot episode of the television series *Killjoys* (SyFy, 2013-2019). The use of clips from SF films was derived from the University of Cardiff's Energy Biographies project, which demonstrated that showing research participants speculative imaginings of the future helped them to conceptualise the development of new technologies (Shirani et al, 2016).

The purpose of phase D in all FGs was: to encourage participants to creatively assess speculative applications of autonomous flight; to generate ideas about potential applications of autonomous flight that could be used in the collaborative storytelling phase (S); to evaluate conscious beliefs concerning uses for autonomous flight, as well as any hopes or reservations participants held about their uses, in order to provide a baseline against which to contrast implicit AA revealed in phase S.

Phase D was followed by Phase S. In Phase S, the participants played the collaborative storytelling game designed for the study. In order to play, the participants agreed, by consensus, on the beginning and ending of their story. This ensured a limitation on the timespan of the story, imposing a structural limit on narrative possibilities. Participants chose their own beginning and end points. Once the FG had come to a consensus, the participants wrote the beginning and ending on separate pieces of index card and placed them on either end of the table. Each participant then took a turn to contribute an event to the story. These contributions could take place at any point between the beginning and end card. The participant was completely in charge of this event: other participants were not to provide input, and participants could not skip or pass on their turn. The event could either be narrated or acted out, with participants playing different characters within the scene. This element of the game design was intended to avoid a common pitfall of the FG research method, which is the tendency of more dominant personalities to monopolise discussion.

An event card was completed to briefly summarise the event narrated or acted out by the participants and was placed on the table. The placement roughly coordinated with its place in the narrative timeline. Following the placement of an event card, all participants collectively decided whether to label the event with a 'dark' (i.e. negative, downbeat, foreboding) or 'light' (i.e. positive, uplifting, optimistic) tone. This element was included in order to incentivise balance and to avoid both overly dystopian or utopian stories. The tone was then indicated on the event card by an empty circle (light) or a filled-in circle (dark) drawn on each card. As play continued, the players gradually built out a narrative. Following each turn, participants were encouraged to keep a list of story elements they may wish to elaborate

on in the future. This document could be consulted if individual participants were struggling to come up with new ideas. Play ended when the participants agreed that the story had come to an end – in FG1S three rounds, FG2S four rounds, FG3S four rounds.

As one aim of the research was to compare participant responses during the initial discussion phase and the collaborative storytelling game, the role of the facilitator changed between each stage. During Phase D, the facilitator prompted discussion when necessary. During Phase S, the facilitator explained the rules of the game, and served to clarify any confusion about process during play, but did not participate in the game or provide suggestions for topics or events.

3 Results

Phases D and S in the FGs were audio recorded, and the proceedings transcribed. The transcriptions were analysed using thematic coding (Schreir, 2014). This method of analysis allowed for nuanced, interpretative assessment, while still providing a numeric framework for determining which themes were most prevalent. Sections 3.1-3.3 provide detailed qualitative summaries of the discussion in each FG in phase D, and a synopsis of the story produced in each FG in phase S, including topics that were discussed at length in one focus group but were not shared by others. Table 1 tracks recurring themes across the FGs, indicating which FGs and Phases they appeared in. No theme mentioned by only one participant was included in the table (no matter how many times it was mentioned), in order to minimise the overrepresentation of individual concerns. Furthermore, the table only accounts for themes that recurred across at least two focus groups. The discussion in Section 4 maps onto Table 1, focusing on the most prevalent themes across focus groups.

Table 1. Recurring themes across focus groups

Themes	**Discussion Phase**	**Storytelling Phase**
Military		
Military associations	FG1D; FG2D; FG3D	
Technological failure		
Crashing	FG1D; FG2D	FG1S; FG2S
Vulnerable to hacking		FG1S; FG2S
Vulnerabilities of remote/central control	FG3D	FG2S
Governance and responsibility		
Role of the pilot	FG1D; FG2D	
Who to blame?	FG1D	FG1S
Government/political context		FG1S; FG2S
Distrust of business		FG1S; FG3S
Public outcry/protest		FG2S; FG3S
Media outcry		FG2S; FG3S
Ban technology		FG1S; FG2S; FG3S
Cost-cutting as liability		FG1S; FG3S
Role of regulation	FG2D	FG1S
Desire for sustainability		

Stated desire for sustainability	FG2D; FG3D	
Extinction Rebellion		FG2S; FG3S
Potential benefits		
Convenience	FG3D	FG1S
Use for delivery/cargo	FG2D; FG3D	
Alleviate labour shortages	FG2D; FG3D	

3.1 Focus Group 1

3.1.1 Discussion Phase

FG1 consisted of four participants. After they viewed the clips, they discussed the potential applications of autonomous flight technology, including transport and delivery, eventually focusing on mapping and imaging applications. They expressed anxiety about replacing human pilots with artificial intelligence. They were uncertain about to what extent human oversight would be involved in fully autonomous flight, and particularly anxious as to what happens in the case of technological malfunction.

The group discussed issues of accountability and blame extensively: a key belief was the assumption that a machine could not be held accountable for failure, and particularly crashes, in the same way that a human pilot could. However, one participant did mention that an autopiloting system may be safer than a human pilot.

The discussion moved on from passenger flight to small unmanned aerial vehicles (UAVs), which they referred to exclusively as drones. The group was interested in the potential of drones for scientific research, although one participant was sceptical of the plausibility of restricting the use of technologies for specific purposes only. They argued, 'Let's say if we were developing that technology, it's hard to make sure that it would be used only for this. How do we make sure that someone else doesn't take it and capture whatever they want'. The question of the technology's usefulness to scientific research then became fraught: while one participant mentioned that drones could be useful for monitoring animal populations, another pointed out that wild animals often react negatively to being surveyed. The participant drew a connection with their own anticipated personal response in a comparable situation: 'It seems like they [the animals] don't like it. I think they were in a jungle and they were following some orangutans and the orangutans took them down, the drones, to see what it was, and why it was following them […] In the same way, when I see something fly over me, then if it happened to me at a party and suddenly you see a drone, it's like, what is it doing there'.

The discussion of animal surveillance led the participants to reflect on their own experiences of, and attitudes towards, surveillance. One participant expressed an unease at the prevalence of CCTV surveillance in the United Kingdom. Other participants expressed an ambivalent attitude towards surveillance, with one saying, 'there's nothing I can do'. There was some confusion about the legalities of private and state surveillance – particularly regarding private companies' rights to operate and access CCTV cameras. Participants were also concerned about noise levels.

The group regarded the possibility of shopping and delivery drones positively, although this was mitigated by concerns about overcrowding and noise. Participants questioned whether this technology was necessary: a participant asked, 'do we actually think that we benefit from autonomous flight aircraft? Are they going to have something positive to offer? Maybe we don't need them at all'. Another participant concurred, saying 'I think that's a very good point'. Despite this concern, participants continued to discuss beneficial uses of autonomous flight. Drones were perceived to potentially decrease traffic. One participant suggested that they might act as an automated parasol, 'like an umbrella that follows you, you don't have to carry'. The parasol drone had several different uses, such as 'holding your credit card […] it's also like security if you walk home at night'. Another participant added that it could, 'maybe have some data storage on it and internet connectivity, your own personal cloud.'

Another potential use of drones proposed in FG1D was in policing – although it is important to note that only one participant strongly advocated for this implementation. While one participant said, 'it would be tempting to use them as quick responders in cases of terrorism,' another pointed out, 'faster is not always better, because what if there was a mistaken identity'. However, speed was regarded as a benefit in terms of healthcare applications.

3.1.2 Collaborative Storytelling Phase

The story constructed in FG1 centred on a group of largely non-differentiated Cambridge students who develop a prototype 'drone'. It is initially designed to function as a mobile parasol, called an Umbrella. The story begins with the development of this prototype, and ends with a referendum being held in the UK on the use of these devices.

The Cambridge students who create the Umbrella device meet with a group of investors, including a man named Mr. Martini. One of the students attempts to sell the device with the promise that it will 'revolutionise the way we connect with people, so forget the phones, tablets and laptop'. One of the other students is hesitant about selling it, asking 'Will it get hacked, is it secure enough, or will other people be able to access my whole life'. Mr. Martini considers whether it could become popular enough that it will eventually require universal provision by the state.

The Umbrella becomes incredibly popular, particularly due to its data storage capacity and convenience. The Umbrella eventually renders the mobile phone obsolete, and several phone manufacturers and providers go bankrupt. Different types of Umbrellas are produced, with the more expensive ones providing more functionalities, such as deliveries.

The Umbrella devices begin to suffer mechanical failures, as battery malfunction causes them to fall out of the sky. The issue is quickly resolved, and the reputation of the Umbrella is restored.

Another group of friends who use the Umbrella discuss their various experiences with the device. One discusses how they were saved from a robbery by the device calling the police. Another expresses anxiety about security and privacy, because their boyfriend found out they were cheating due to the Umbrella. The Umbrella has replaced their mobile phones, and one of them says that they are incapable of navigating without the device. Another discusses how attached their children have become to their Umbrellas, while another expresses concern about the constant surveillance. Children often send their Umbrellas to school for them.

One of the founders of the Umbrella company becomes pregnant, and 'during her pregnancy her [the founder's] health was constantly monitored by the umbrella, so as to make sure that her baby was of perfect health'. Once the baby is born, it receives its own Umbrella, which monitors its sleep. The founder visits a friend, who was also pregnant, but miscarried one of the twins. The Umbrella could have prevented this, and the founder launches a campaign calling for Umbrella access for all.

A competitor for the Umbrella emerges, called the Cloud. The Cloud is cheaper than the Umbrella, but it markets users' data. Both the Cloud and the Umbrella are under increased scrutiny, and there is pressure to regulate both.

It later transpires that the government is using the devices to surveil the populace, and even as a method of voter suppression. The Umbrellas direct people past posters of a certain political party and sends them to the polling stations at certain times of day, leading to long queues. When the governments' access to personal data becomes widely known, some people stop using the Umbrellas, while others demand more information: 'there are big debates among politicians, the private companies, people supporting the technology, and people that are really scared. And in general, there is a lot of tension created around the use, the collection and the use of the personal data of the people'.

Mr. Martini has gone into politics as the leader of the junior party in a coalition government. He calls for a referendum on whether the Umbrella should be fully regulated by the state, or whether to allow other companies to bid for state contracts. The aim of the referendum is unclear. The FG1 participants indicated that potentially there are multiple referenda to determine how people want the technology to be used.

At the end of the story, the group of Cambridge students meet again, 10 years later, to reflect on the impact that their invention, the Umbrella, has had on the world. The technology has been largely unregulated until this point, and the founders express regret about the speed of development and adoption. They feel that they did not have adequate perspective at the time they were developing it to reflect on the many implications of their technology.

3.2 Focus Group 2

3.2.1 Discussion Phase

The participants expressed that the depictions of autonomous flight in the clips were disquieting. One participant asked, 'who is in control? […] Where do we have our place and agency then, as human beings, as creators'. Another said, 'it's so different and so non-human'. However, the first participant responded, 'I think […] a bit of fear regarding this topic, myself, is exactly because it seems to be more human, because there's this kind of acting, thinking for itself, almost'.

The participants then discussed the military origins of autonomous aircraft. The potential for military applications was attributed to the higher budget given to military development, pointing to precedents such as satellite technology.

One participant returned to the issue of control and assumed that there would be a pilot, at least in passenger aircraft. They stated they would be comfortable in an automated plane, if there was a pilot present. One participant drew upon their own experience with fallible

technology and urged caution. The participant said, ‘Things can and do go wrong, so I’d much rather there be a manual override switch, I guess, and someone there to use it in case something happened’.

Another participant argued that automated trains operate similarly – however, there was still hesitance about riding in automated vehicles, including self-driving cars. One of the reasons they found self-driving cars problematic was due to concerns around the reliability of visual recognition: citing in particular a belief that self-driving cars might not be able to see people with dark skin. In addition, one of the members of the focus group mentioned that technological instruments such as hearing aids break down in humid climates. They then concluded, ‘In that context, I will not be very comfortable to be inside a vehicle that we have no control, or at least I know I won’t have control of’.

While participants acknowledged the statistical safety of air travel, along with the already highly automated nature of commercial flight, they still expressed concerns about the speed of development. One participant referred to the 2019 Boeing crashes as an example of when things go wrong. They later expressed concern about artificial intelligence’s ability to compensate for the unexpected.

One participant mentioned that the development of automated passenger flights could help to alleviate a perceived labour shortage in pilots, and potentially improve their working conditions by reducing their hours. Another participant expressed anxiety about rendering pilots unemployed, while others expressed discomfort that the lack of soldiers in military planes might lead to more wars. As a participant said, ‘It’d be useful for the military, but is that a good thing? It would be useful for commercial air travel. Is that a good thing’.

Cargo transportation was seen as an acceptable use, as it did not endanger pilots or passengers. Participants emphasised the role of a pilot’s intuition in dangerous scenarios and questioned whether an AI would be capable of making those decisions.

Sustainability was a significant concern in FG2D. Automated aircraft was not seen as a priority for ‘us to live here safely and happily […] is this a need? And if there is a need, what sort of need, and how can we get it in a more sustainable way’. While one participant suggested that automated flight may make it easier and cheaper to fly, others did not think that would be a good thing. There was a suggestion that somehow government regulation could make flights cheaper and yet also not provide more flights, but a participant argued that ‘it’s economically difficult to do that. You can’t make something cheaper but also restrict it’.

The participants unanimously rejected the Facilitator’s prompt to consider that future aircraft might be more environmentally friendly. One participant asked, ‘Do you think that people have the resources to work on that, who are interested in making it greener?’ Another responded, ‘No, not the United States military’. The former then continued, ‘I get that it could have real advantages and maybe help us in tackling solutions for issues, but then again, what worries me is, the people in positions of power to work on that and move forward to make decisions, which direction, it will be developed’.

One participant said he would analyse the statistics, comparing the rate of crashing between human-piloted planes and fully autonomous ones. One participant mentioned that automated planes might be faster, which would make it a more attractive prospect: another agreed that it would be convenient, but doubted that automated planes would be faster.

3.2.2 Collaborative Storytelling Phase

FG2's story begins with the first fully autonomous commercial flight launching. The story concludes with all automated flights being simultaneously hacked. The participants clarified that the automated flights do not have pilots but do have flight attendants.

In this story, Jeremy Corbyn (the leader of the left-wing UK Labour party at the time of FG2) has become Prime Minister and announces a goal for the United Kingdom to become carbon-neutral by 2025. This leads to a resurgence in activity by UK-based environmental protest group Extinction Rebellion, to hold Corbyn to this commitment. Extinction Rebellion groups also become active in the United States, to pressure the US government to limit flights.

US President Donald Trump accidentally declares a 'war on climate,' leading to escalating tactics by the militant splinter group, Extinction Revolution.

A controversial study is published that claims that automated flights are less safe than crewed ones. This follows an incident where a passenger on an automated plane has a heart attack, and the plane cannot be stopped. Following this, a United Nations regulatory body, the International Autonomous Aviation Authority (IAAA), is established to investigate the safety of these planes and then, later, to coordinate the aircraft network. Control of this network is placed in a central hub in Geneva, which initially improves safety.

A leak comes from the IAAA that a plane has gone missing, and that the IAAA has covered it up. The families of the passengers lead a media outcry. A software engineer, Kate, quits her job at SpaceX, which won the bid to provide the software for the IAAA. Before leaving, Kate installs a backdoor in the central hub. Kate's motivations are unclear, but she has some connection to Extinction Revolution and is discontented about the IAAA's reaction to the missing plane. The IAAA acknowledges that Kate has left, but business continues as usual.

Extinction Revolution attempts to use Kate's backdoor to hack into a plane. The plane is carrying a group of Republican senators on their way to an oil conference. All governments agree that automated planes need to be grounded. Extinction Revolution then hack the planes to destroy their engines.

3.3 Focus Group 3

3.3.1 Discussion Phase

One participant, commenting on the clip of *Stealth*, argued that if aircraft could fight all wars, there would be no need for combat. One participant questioned if people would accept automated flight, because 'it removed the element of human responsibility. If there's no-one manning the plane, or the aircraft, then who are you going to blame if something goes wrong? I think some people always need someone to blame'. Another suggested that 'the brand' behind automated planes would suffer if there were crashes. Participants compared automated planes to other forms of automated or driverless transport, such as Cambridge's guided busway. One participant argued that the financial incentives of automated buses and automated flights were not comparable, because running more buses is more efficient in terms of numbers of passengers served.

Automated flight was seen as having a range of potential uses, including transportation of passengers and goods. One participant mentioned space travel. Exploration and delivery were mentioned as possible applications. Automated passenger planes were regarded as liable to crash. The potential convenience of individual units would make autonomous flight more attractive. Comfort and price reduction were mentioned as positives, as well as alleviating traffic and mitigating the need for parking. Emergency rescue and disaster relief were posited as potential beneficial applications. One participant discussed their own experiences with cities with very narrow roads – in that case, flying ambulances may serve a direct public health need. A participant argued that improvement in autonomous flight technology would inevitably lead to greater surveillance and more warfare. Another observed: 'I think when there's technology that's potentially destructive, [there] is a danger of it falling in the wrong hands'.

Sustainability was mentioned as an important factor to consider when developing autonomous aircraft but FG3 was, like FG2, generally pessimistic about the possibility of using renewable energy in aircraft. Shopping and delivery were mentioned as potential uses, but one participant questioned the need for drones for such minor or trivial tasks.

3.3.2 Collaborative Storytelling Phase

FG3's story begins with two passengers named Starlord and Gamora (named after the protagonists of the popular Marvel film *Guardians of the Galaxy* (dir. James Gunn, 2014)). They take an automated shuttle from Earth to Mars. The end event involves the company that ran the shuttle dealing with the PR fallout of a disaster during this journey.

Before they are due to embark on the ship, Starlord and Gamora are momentarily dissuaded from travelling due to a bad interplanetary weather forecast. However, they decide to make the trip because the tickets are heavily discounted. Part of the reason why the flight is so cheap is because there are no human staff on board; passengers receive a one-day training course in safety techniques before they are allowed to fly.

The passenger ship between Earth and Mars is seemingly hit by a meteor shower, which causes the ship to lose communication. This means that the base on Mars can no longer track it. The passengers wake up to discover that they are going off course.

Some of the passengers are directed by the ship's computers to evacuate onto a small life-preservation vessel attached to the ship. The artificial intelligence uses the passengers' personal data to decide who is allowed onto the rescue capsule. The capsule becomes stranded in another dimension, and the passengers who evacuated eventually die.

It turns out that the aircraft's AI has been manipulated by aliens, who are seeking to extract water from humans. The aliens have hacked the aircraft's AI in order to ensure that it directs the strongest human specimens to the escape capsule and then the aliens cause the capsule to go to a different dimension.

The news of the disaster, and particularly of the fact that only half of the passengers could be saved, makes it back to Mars and causes a media outcry. A rival company sends out a rescue 'ship' to help the remaining passengers stranded between Earth and Mars, and Starlord and Gamora finally make it to Mars. A new president of the Global Space Agency decides that automated spacecraft should be reserved for cargo only – this regulation addresses the

desires of those who want to ban automated passenger flight, but causes discontent because the need for human staff on passenger flights increases the cost of flying.

4 Discussion

This section discusses recurrent themes in the focus groups, in particular comparing the two different phases. The analysis is focused on themes that recur across more than one focus group, coded into five categories: military associations, technological failure, sustainability, governance and responsibility, and potential benefits. The comparative analysis reveals both differences between *stated* concerns and beliefs in the discussion phase and *implicit* assumptions evidenced by the storytelling and, where there is continuity of theme, the storytelling phase provides detail and nuance absent from the discussion. While participants identified a number of potential benefits of autonomous flight technology in the discussion phases, the storytelling phases revealed that AA about autonomous flight are situated within a complex matrix of concerns including: technology's military associations; the reliability and security of emergent technologies, in particular with regard to crashes, cybersecurity, and levels of trust in human, corporate and market actors; governance and responsibility, specifically the power or effectiveness of regulation, accountability, and media and public opinion; and the relationship between aviation, sustainability and the climate crisis.

4.1 Military associations

During the discussion phase, each of the three focus groups mentioned an association of autonomous flight with the military. As mentioned in section 3.2.1, participants demonstrated awareness of the pipeline of technological development from military R&D to civilian uses. In FG2D, the military origin of autonomous flight was perceived to preclude any possibility that it might be environmentally friendly. Participants throughout the discussion phases unanimously rejected any benefit of autonomous warfare.

It is likely that the choice of prompt clips led the participants to discuss military applications – the clip from *Stealth* showed a fictional autonomous fighter plane; the scene from *Flight of the Navigator* was set on a military base. As discussed in 4.7.1, future research should attempt to diversify prompts for discussion: in that section we reflect in more detail on the influence of the clips.

It should be noted here thought that, although this issue arose in Phase D, the participants did not build upon this association in Phase S. All three stories focused on civilian applications of autonomous flight technology – the Umbrella device arose from a student start-up, while the other two stories dealt with commercial travel.

4.2 Technological failure

The potential of technological failure was a highly salient concern in Phases D and S across all three focus groups.

4.2.1 Crashes

Anxieties about crashing were mentioned in FG1D, FG1S, FG2D and FG2S. These included discussion of the possibility of crashing, and participants made direct references to recent high profile news stories about passenger aircraft crashes. The possibility of crashing was a significant explicit concern in the discussion phases, and was also salient in the stories. However, the crashing's effect on public perceptions of the Umbrella was minimal in FG1S, and it eventually transpired that the 'crashing' referred to in FG2S was, in fact, a tactical grounding by Extinction Rebellion hackers. Fear of accidental crashing becomes less salient than cybersecurity.

Confirming findings from existing quantitative surveys, participants in all the FGs were invested in the possibility of keeping a human pilot onboard, 'in case something goes wrong'. This investment in human capabilities - particularly 'human in the loop' systems where there is operational automation - recurs in studies about willingness to use autonomous vehicles more generally. For instance, people prefer human drivers to automated ambulances, even if an automated ambulance allows for more EMTs providing direct care (Winter et al, 2018). In FG2D, the participants discussed other forms of autonomous travel and whilst driverless trains were perceived as safe, concerns remained regarding the safety of autonomous planes specifically. While the AA that autonomous flight is more dangerous than piloted aircraft is not necessarily rational, it nevertheless needs to be taken into account when understanding public perceptions of autonomous flight.

4.2.2 Human trust

This assumption that the human is better at piloting than the automated systems remained largely unexamined within the focus groups, with only one participant in FG2D expressing that automated flight may be safer. When this preference was interrogated, participants generally framed the abilities of the human in terms of intuitive or emotional response. This confirms existing arguments that the difference between the human and machine is emotionality, in particular an 'unpredictable emotional responsiveness'. (Seaman, 2007, p. 251) While some participants called this a 'Luddite' attitude, or otherwise indicated that such preferences were irrational, the preference for a human piloted plane persisted in the majority of participants. Public perception of the safety of autonomous flight is informed by established and explicit beliefs in the superiority of the human over the machine with regard to effective intuitive or inventive response, in particular in unexpected situations.

While the possibility of crashing was mentioned during all three discussion phases, crashing only occurred in one of the FG stories, and not in one involving passenger aircraft. In FG1's story, the Umbrella develops a fault which causes it to fall out of the sky. While it is responsible for killing some people, the fault is quickly fixed, and the rapid response increases public trust in the Umbrella. While there was an obvious *stated* anxiety about crashing in the discussion phases, the topic did not have high salience within FGs' stories. Instead, the failings associated with autonomous flight were located within different types of technological failure – data use, security, and hacking – and in fact with the human factor. A key difference between the AA in the discussion and the AA in the stories was that in the stories the AI did not spontaneously distribute sensitive information or otherwise go haywire – instead, it was manipulated by human actors with differing motivations.

4.2.3 Cybersecurity

In FG1's story, the main perceived threat of the Umbrella was its connectivity to personal data

and the subsequent threat of surveillance. This surveillance was detrimental at both an individual and collective level, with regard to breaches of personal privacy and interference in democratic processes. Concerns about data security, as well as questions about the need for universal provision of the device, led to the series of referenda at the end of the story. While some anxieties are directly related to the drone's mobility – for instance, 'leading' people past political posters in order to influence their vote – many of these concerns would be just as applicable to any data storage device. In the storytelling phase, participants' AA about cybersecurity more generally informed their perception of the individual and collective effects of a personal UAV device.

Autonomous flight's perceived vulnerability to nefarious hacking was central to FG2 and FG3's stories. In FG2S, the central HQ meant to oversee the autonomous aircraft was uniquely vulnerable to hacking by Extinction Revolution. In FG3S, the Earth to Mars transport suffered from a malfunctioning computer guidance system, the central control on Mars lost communication with the craft, and the aliens were able to hack and gain control over the ship's AI. There is an existing anxiety surrounding the reliability of digital communication in emergencies which informs an AA that autonomous flight would also be vulnerable to potential communication failure problems. The shared central database in FG2S makes the planes more vulnerable to hacking, meaning that planes can be 'hidden' from their network. FG3S also expresses an AA that tracking an autonomous flight remotely would be difficult, but it is unclear from the participants' story whether this a problem that could be resolved simply by the presence of a pilot.

4.3.4 Corporate and market trust

A final recurrent theme with regard to technological failure was the 'rush to the bottom,' with low-cost technologies associated with poorer data and other security. In FG1, while the participants clarified that the Umbrella was also affected by data breaches, it was explicitly stated that the Cloud was cheaper because it sold personal data to third parties. In FG3's story, the protagonists continued with their journey despite poor forecasts because their ticket was heavily discounted. The lack of a pilot is perceived to significantly reduce the cost of the aircraft, but while participants in the discussion phase mentioned lower prices as a potential benefit of autonomous flight, the stories reveal the assumption that lower costs necessarily come with less functionality and security. Belief in the reduced security and functionality of low cost technologies, expressed most clearly during the storytelling phases of each focus group, is compounded by the AA that corporations in the future will prioritise profit over user security and safety.

4.4 Governance and responsibility

4.4.1 Regulation

The storytelling phase of the focus groups revealed a distrust of corporate motives in developing autonomous flight technology, and an ambivalence about governments' ability to control bad actors. These themes are strongly connected – the failure of regulatory approaches are deeply intertwined with this distrust. In the stories, protections against problems with autonomous flight are only granted as a response to public or media outcry, and even then the responses are insufficient. The starkest divide between the participants' stated beliefs and priorities and the implicit attitudes revealed in their stories is demonstrated by, on the one hand, their stated desire for regulation, and, on the other, their storytelling's

focus on the failures of democratic accountability. This is in line with previous observations of the role of games in futures practice, in that they 'help us to access what we disown' (Inayatullah 2017, 103). That is, games allow a space for participants to state negative prejudices about business, governments and democracy that they will not overtly acknowledge.

Participants explicitly suggested that regulation might be the answer to the failure of market incentives in their discussion phase. For instance, during FG1D, the participants debated at length the need to regulate the use of drones for surveillance, and FG2D participants discussed reducing flight demand and cost. Questions of regulation also arose in the storytelling phases. In contrast to the strong desire in the discussion phases for some form of regulation, the stories explored the limitations of using a regulatory framework, either due to the perceived vested interests of political actors, or the weakness of regulatory powers in relation to market forces.

In FG1S, the investor-turned-politician Mr. Martini uses his political position as the leader of the minority party in a coalition government to ensure that his Cloud device will have access to government contracts. In this instance, politicians cannot be trusted to make decisions for the good of the people, due to their close relationship with business. Regulatory interventions are also framed as largely ineffectual: in FG3S, the new leader of the Global Space Agency announces a ban on entirely autonomous passenger planes, but this causes discontent as the prices of flights between Earth and Mars go up. While the participants often explicitly mentioned legislation as an ideal curb to the potential dangers of autonomous flight in the discussion phase, the stories exposed the limitations of a purely regulatory approach.

4.4.2 Accountability

Part of the desire for regulation is grounded in a need for control and agency over the development of emergent technology. In FG1D, the responsibility for monitoring the use of UAVs was even placed on the public: one participant suggested that 'maybe you should have a hotline that you can call if there's a problem with a drone that you see, I think, so you feel in control again. Maybe you can have a number on each drone […] so they can be held accountable'.

There is a requirement, stated explicitly in FG1D and in FG3D, to assign accountability and blame for malfunction to human, not machine, actors although both are perceived as agential and potentially deserving of punitive measures: 'Do you destroy it as punishment? Or, do you punish the one that wrote the code'. This punitive attitude towards error is at odds with the actual process of investigating malfunction in the airline industry: the aim of investigation is to avoid future failure, rather than to attribute blame to specific actors (Moraes Naves Mendes, 2019).

The debate around accountability and blame with regard to AI technologies is active in the wider literature, with Elish and Hwang insisting that 'this accountability must exist not only in the form of the operator or the physical manufacturer of a system, but also in the designers of the software and human-machine interface (HMI) that directs the system and creates the structures for potential human intervention' (Elish & Hwang, 2016, p. 2). They insist that 'a computational agent is not, and must not, be seen as an individual agent but rather as an extension of the engineers and designers—the human agents—who developed it' (Elish & Hwang, 2016, p. 2). The stories reveal a non-expert awareness of this extensive network of

accountability, but demonstrate a focus on concern about corporate accountability, and betray an anticipation of the autonomous machine as culpable agent.

In FG3's story, the care of the passengers on the autonomous flight is placed entirely in the hands of AI. The shuttlecraft does not even have flight attendants. This displaces risk and accountability from the corporation to the AI, but in addition reveals a hidden displacement of risk, accountability, and labour to the passenger, who has to undertake pre-flight safety training (Penn, 2021). This story extrapolates the current displacement of labour from flight attendants and other airport staff to passengers in budget airlines such as EasyJet and RyanAir. In this story, the logical endpoint of this automation is the replacement of human and corporate decision-making and accountability with unaccountable automated decision making – deracinated from human empathy, common sense, and adaptability – which in fact depends upon the displacement of safety labour and accountability for failure to the individual customer.

4.4.3 The media and public opinion

Available means of democratic response to new technologies are deemed lacking: in the FG stories, the failures of technology are met with public or media outcry. On the one hand, this could be seen as democracy and the media working effectively in its check-and-balance role. The media plays an important role in leveraging democratic response to political choices, such as mediating the acceptability of overseas conflict (Singer, 2009). Public protest in the FG stories is treated as corrective to business's and government's decision-making. However, the effectiveness of public protest as a constructive counterweight to vested political and financial interests breaks down: first, in the perceived corruption and close connection between politics and business, as seen in section 4.4.1; second, in the danger of aggressive over-correction. Media outcry is seen as a key driver of political action, but, within these stories, this does not always lead to effective decision-making.

4.5 Sustainability and the climate crisis

The desire for sustainability was a key area where the desires of the public and the motivations of corporate and political agents were perceived to be in conflict. Environmental protection was a key concern for FG2D and FG2S and FG3D, and the development of autonomous flight was regarded as largely incompatible with the actions necessary to preserve the planet as an environment that can sustainably support human and other life. In FG2D and FG3D, participants explicitly addressed concerns about the environment, relating this to the perceived climate impact of passenger flight, including anticipated autonomous flight.

In FG3D, participants were pessimistic about the possible development of sustainable aviation. The lack of sustainable options was attributed to a lack of responsibility and interest by those developing aviation technologies. Furthermore, there was a discussion about the logistical impediments to green transportation, such as the lack of progress in developing batteries, and the high levels of extraction needed to mine cobalt. This connection was explicit and highly salient in FG2D, with the participants discussing at length the implications of more frequent flights on the environment. The development of autonomous flight was positioned as a 'distraction' from the more pressing issues of sustainability.

There exists a rigid AA that there is no possibility of, and no industry desire for, sustainable flight. This AA corresponds with existing evidence regarding the current environmental impact of aviation. The European Union Aviation Safety Agency (EASA) Aviation Report indicates that in 2016, aviation was responsible for 3.6% of total EU28 Greenhouse Gas Emissions, with the number of flights growing 8% between 2014 and 2017. Although the aviation industry does reduce its net emissions through carbon offsetting and emissions trading, uptake of cleaner sources of energy is predicted to be low for the near future (European Union Aviation Safety Agency, 2019). This AA is not influenced by awareness of any existing aviation research towards sustainability, or any record of a trajectory of the improvement of aviation's environmental impact over recent history.

Aviation in these discussion phases is positioned as disproportionately wasteful and polluting and, in the storytelling phases, direct action is necessary to address this. In FGS2, the militant splinter group Extinction Revolution targets the new autonomous flight computer network and particularly a plane full of Republican senators attending an oil conference. The high visibility of Extinction Rebellion in the UK media in 2019 likely inspired this attention to direct action. As discussed above, direct action is seen as a potential method to 'force' corporate and state actors to care about the environment, but the efficacy of this approach is unclear in the story: although Extinction Rebellion grounds the planes, the story does not resolve whether this led to any long-term change in policy or governance. Extinction Rebellion is also mentioned in FG3S, but in this instance Extinction Rebellion functions as a mode of public protest more generally, as their goal is to 'stop space travel' and to 'raise awareness about safety'. Just as in 4.4.3, Extinction Rebellion becomes a symbol that confirms the belief that public outcry is the only means of effecting change on state and private actors.

The FG participants exhibit a fixed AA that future sustainable air transport is impossible, and that stakeholders are not sufficiently invested in developing technology to mitigate aviation's environmental impact. AA such as this inhibit participants from imagining beneficial applications of autonomous flight.

4.6 Potential benefits

In the discussion phases of all three focus groups, potential benefits of autonomous flight were identified and discussed. Transportation of cargo and applications for healthcare were positively regarded across the FGSs. Participants were more ambivalent about the use of UAVs for delivery – citing concerns about crowding and noise – but there was enthusiasm about the increased convenience this could provide. Convenience was also cited as a benefit in FG3D, particularly as an automated personal vehicle would mitigate the effects of traffic and time spent parking. This confirms current research on the appeal of autonomous cars, which has found that potential convenience is a key driver of acceptability (Panagiotopoulos & Dimitrakopolous, 2018). Despite identification of these potential benefits, FG participants were unconvinced about the need for autonomous flight technology: the question of what this would be used for, and if these developments were strictly necessary, recurred across all three focus groups' discussion phases.

Attention to potential benefits of autonomous flight did not extend to the storytelling phases. FG3 expressed the fewest reservations about the technology in the discussion phase, but their story indicated little interest in exploring potential positives of the technology, and instead

focused on a catastrophic journey by a low-budget airline. FG1, whose discussion phase was balanced between aspirations and reservations, formed a story around a potential use that they were highly excited about in the discussion phase – the 'personal drone' – but the storytelling format produced nuanced exploration of the implications of the technology, and its potential misuses. This study's findings suggest that even when potential benefits are discussed, they do not have high salience in the discussion or storytelling phases.

4.7 Reflection on Method

It is clear from the results of this study that the collaborative storytelling game developed can be usefully deployed to understand AA about autonomous flight. There are a number of key areas to be addressed in future development of this research.

4.7.1 Use of video clips

One of the effects of using the video clips as a prompt for the discussion was that it may have resulted in a skewing of the discussion towards military applications. Aside from this skew, which as discussed in 4.1 was limited to the discussion phase, we do not believe that the clips unduly influenced the direction of the discussion or the storytelling. The stories created by the focus groups featured significantly different applications of autonomous flight technology from those included in the clips – for instance, while there was one clip included of a UAV in the first focus group, the group turned to commercial applications, rather than the military usage present in the *Interstellar* clip. None of the clips featured conventional passenger planes or interplanetary shuttles, the subjects of the second and third focus groups' stories. The clips were kept purposefully short, with an emphasis on the visual representations of autonomous flight, and often taken from the middle of the film, with little plot or narrative contextualisation, in order to minimise their influence on the participants' stories. Key recurring themes across the clips (for instance, anthropomorphised artificial intelligence) were notably absent from the storytelling phases. While we cannot entirely dismiss the influence of the clips, we conclude that their potential skew factor was less important than the role they played in facilitating imaginative discussion of potential future technologies. In future research, investigation is needed as to whether the use of different prompts, such as short written scenarios or speculative design documents, may produce different discussion and storytelling results.

4.7.2 Collaborative story generation

One problem with focus groups is that certain voices can dominate over others. The patterns of domination tend to reproduce entrenched hierarchies of power inequality more generally. The collaborative storytelling method with its emphasis on independent turn-taking was developed in order to address and mitigate this problem. It was partially successful in this respect, but there were still instances where more vocal participants steered the storytelling, and at times talked over others. In future, the facilitator could be more active in intervening to remind participants of the turn-taking rules, and alert those who are breaking them. Greater input could also be achieved from the outset by encouraging each participant to generate an idea for their collaborative story independently, sharing with the group, and then collectively voting on which story idea to pursue.

The study also raises the larger methodological question of whether the storytelling format lends itself more to exploration of risks and conflict than benefits. These make for more

interesting stories than utopian visions or peaceful, harmonious developments and 'business as usual' extrapolations. We attempted to control for this through the use of light and dark tones on each event card (see section 2), but participants regularly had to be reminded to implement this part of the study design. Work which uses stories in order to produce data and information – either through the analysis of existing stories or through the generation of new stories – must be cognisant of this potential limitation or bias of narrative form. At the same time, this does not preclude the usefulness of stories nor outweigh the advantages that they offer (see sections 1 and 5).

4.7.3 Discussion phase

It might be productive to introduce a second discussion phrase, after the collaborative storytelling phase, to determine if the nature of discussion had changed significantly, influenced by the more imaginative thinking of the storytelling phase. However, this raises practical concerns regarding the length of the sessions, and the stamina of the participants. It may be more viable in an asynchronous or staggered structure, potentially online (see section 4.7.5).

4.7.4 Participants

Our geographic focus – drawing from the population of Cambridge and the Cambridgeshire area – resulted in our participants being predominantly university-educated students or professionals. Future research could employ outside recruiters to ensure a greater diversity of demographic backgrounds. The results of this preliminary study might also be usefully compared to further research focused on specific stakeholder groups, both non-expert and expert, including frequent flyers, residents living under flight paths, aviation engineers and industry employees.

4.7.5 Potential for moving online

While the focus groups analysed above took place in person, the collaborative storytelling method could function online. Roleplaying game apps such as Roll20, or even more general conferencing software such as Microsoft Teams, could support both synchronous and asynchronous play. This would not only enable research to continue under current social distancing guidelines due to the COVID-19 pandemic, but allow researchers to conduct focus groups with geographically disparate groups and facilitate scaling-up the number of focus groups that can take place.

4.7.6 Development as futures method

As the focus of the study was the revelation of AA, the study remained at level 1 of futures literacy practice. Future research might investigate the potential to develop the method in order to move participants on to further FL levels – discovery (FL2) and choice (FL3). Future development of the research could consider how to develop the method in order to move on to the 'rigorous imagining' that takes place in FL2, helping participants to develop 'the capacity to overcome the limitations imposed by values and expectations when thinking about the future' (Miller, 2007: 350). Similarly, future development could consider how to integrate the method into achieving FL3, which integrates FL1 and FL2 'to think about the potential of the present and provides the link to action' (Miller, 2007: 356). The development of the method in such a way would be of particular use to actors wanting to move from the identification of AA to effecting change in public perception of autonomous flight.

5 Conclusion

Collaborative storytelling games are an important avenue for futures researchers and practitioners to assess AA around emergent technology in a manner accessible for non-experts. This method is highly adaptable and can be used to generate stories on a wide variety of technologies. The use of storytelling provides a method that productively cedes agency and decision-making to participants, avoiding the known pitfalls of survey-based questioning when assessing abstract emotional responses, and bypassing the 'transparent account problem' (or the notion that participants will, or are even able to, accurately and candidly express the motivations behind their feelings to researchers) (Hollway and Jefferson, 2013). Qualitative analysis of participant discussion and storytelling revealed AA that may have remained undetected in a survey strictly delineated by predetermined questions, or by the use of pre-prepared scenarios as prompts. This study therefore provides a new futures methodology for assessing AA in relation to emergent technologies and, through the use of this methodology in relation to a specific case study, contributes to existing work on public perception of autonomous flight.

This study found that while participants were able to identify a number of positive applications of autonomous flight technology, the discussion and stories focused more closely on potential problems that might arise from AI-controlled aircraft. The study confirmed our hypothesis that a detailed understanding of AA regarding autonomous flight can be achieved through qualitative analysis, which can confirm, extend and/or complement quantitative research. Both the discussion and storytelling phases revealed the complex web of concerns in which AA of autonomous flight are embedded. The storytelling phase was further productive in enabling participants to locate autonomous flight within a detailed imagined future. This setting required the consideration of the technology in relation to its social and human contexts, interactions and uses, causing explicit AA to be nuanced, or implicit AA to be revealed, through the storytelling.

These stories demonstrate that non-experts situate their beliefs and attitudes towards new technologies within frameworks that are deeply indebted to their present cultural and political context and cannot be considered outside of that context. Public perception of autonomous flight is determined by AA embedded in concerns about technological failure, the trustworthiness of business and governments, and the climate crisis. Work remains to be done if relevant stakeholders wish to communicate potential positive effects of autonomous flight technology. Such work needs to contend with the fact that AA regarding autonomous flight are primarily determined by contemporary issues and concerns, including ones that might be considered tangential to possible or plausible technical futures.

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