The Role of Aviation Accidents in Shaping the FAA's Outlook on Technology

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Lawrence Phan

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Advisor

MC Forelle, Department of Engineering and Society

Introduction

Before I first started working for the Federal Aviation Administration (FAA), I envisioned a workplace at the cutting edge of technology, mirroring the complexity and significance of its mandate to oversee America's skies. These notions were dispelled completely on my first day in the office. Far from the modernity I had expected, I found myself using technology that belonged in a museum, as one coworker jokingly remarked. Some technology in the hardware labs were stamped with faded logos dating back to the mid-80s, resulting in labs resembling a technological chimera that meshed together technology from the last three decades. Shockingly, even essential operations like tracking flight progress were handled with pens and sticky notes – a method stubbornly resistant to digitization. During my time at the FAA, I continually found myself pondering how an organization overseeing a critical component to the U.S. national infrastructure could be equipped with such outdated technology.

Since its founding in 1958, the FAA has overseen the United States' civil aviation sector, ensuring its safety, efficiency, and advancement. Civil aviation is a crucial pillar of the US economy, having contributed $1.8 trillion dollars and 11 million jobs in 2018 alone (Federal Aviation Administration, 2021)This sector’s value extends beyond economic metrics, as civil aviation is fundamental in connecting American society, bridging vast distances between individuals, businesses, and goods. Looking to the future, aviation in the U.S. is poised for significant growth, with forecasts predicting a 4.3% yearly increase in air transport demand over the next 20 years (Federal Aviation Administration, 2022). This growth trajectory poses a myriad of challenges for the FAA’s aging technological infrastructure, which has faced mounting scrutiny regarding its ability to keep up with both the expanding volume of U.S. national airspace traffic and the rapid growth of modern technology in the aerospace industry.

In an age of rapid technological advancement, the FAA's pace in modernizing its systems appears markedly slow. A glaring example is that half of all FAA Navigational Aids are more than 30 years old, surpassing the intended service life of 20 to 25 years. This includes crucial systems vital for air safety (Ground-Based Aviation Infrastructure Coalition, 2021). The challenge extends beyond hardware; for instance, the code for the Notice to Air Missions (NOTAM) system, crucial for alerting pilots to flight hazards, is also three decades old and not due for an update for another six years (Nolen, 2023). The repercussions of outdated FAA technology have led to several operational hurdles. Notably, numerous air traffic control outages in the 1990s were linked to the FAA's outdated infrastructure, with antiquated IBM computer hardware bearing the brunt of the responsibility (National Transportation Safety Board, 1996). For a more recent example, in January 2023, system malfunctions led to a nationwide halt in flight departures (Shepardson, 2023), and in the same period, Florida airports experienced significant delays due to system breakdowns (Fung, 2023). Often, the FAA's technological difficulties are simply attributed to bureaucratic failures or ad hominem criticism of its leadership. I also fell victim to this type of one-dimensional criticism of the FAA, having initially cited demographic issues as the primary reason for their aged technology. However, a deeper exploration reveals that a complex web of social and historical factors has shaped this issue.

The central thesis of this paper is that the FAA's struggles in updating their technology stems from reactionary effects of aviation disasters causing the agency to reinforce a careful mindset regarding rapid technological growth. The literature review covers the psychological impacts of aviation disasters on American society. It then details how FAA regulations designed around safety restrict technological advancement as well as highlighting how European safety frameworks have been more lenient in comparison. Finally, it provides contextual detail on the

overall conservative culture within the FAA when dealing with technology. Data sources for this study included public opinion surveys, congressional records, FAA reports, and investigation findings, supplemented by academic journal articles and newspapers. The data was primarily analyzed through four methods: historical analysis, causal analysis, case studies, and comparative analysis, all of which were conducted under the Social Construction of Technology (SCOT) framework. Analysis found that public reactions to disaster influences the FAA's philosophy around technology, Congress has continually pushed the FAA to implement more restrictive regulations, and the disasters themselves can cause the FAA to solidify their cautious views on technology. Additionally, it was found that the amount and unique nature of aviation incidents occuring in the U.S. tend to amplify the aforementioned factors that have moved the FAA towards their current mindset around technology. Synthesizing the analysis on this topic finds that the way in which various relevant groups react to aviation disasters all drives the FAA to be less willing to adopt technological advancements, thereby explaining the FAA's problems with aged technology.

Literature Review

Traveling by air is by far the safest form of transportation; over the last ten years the death rate for air travel has been orders of magnitude lower than buses, trains, and motor vehicles (National Safety Council, 2023). Despite this statistic, aviation accidents hold a disproportionately strong grip on the US national psyche. This can be shown in how the media covers such accidents. From 1991-2015, while the total number of aviation incidents over time had been shown to decrease, the media coverage on these incidents increased (van der Meer, Kroon, Verhoeven, & Jonkman, 2019). Furthermore, in 2014, a year marked by several air

tragedies, a Google Trends analysis indicated that the 992 deaths from air travel that year received 43% more attention than the 1.24 million ground traffic fatalities (DePillis, 2014). Media narratives surrounding these incidents are pivotal in shaping societal fears and perceptions, which directly impacts public attitudes towards flying (Wang, Cole, & Chancellor, 2010). The high death tolls and the collective nature of aviation disasters mean that they tend to stoke far more fear among the public than other types of accidents. The prevalence of flight anxiety has been estimated to be as high as 40% of the general population in the United States (Van Gerwen & Diekstra, 1997).

The Federal Aviation Administration (FAA) itself acknowledges that its evolution has been significantly shaped by aviation accidents, stating that the prevention and mitigation of such events is central to its mission (Federal Aviation Administration, 2008). As a result, the FAA has developed regulatory framework strongly aimed at enhancing safety. However, these regulations often come at the cost of technological progress, which can be seen the the continuing development of Urban Air Mobility (UAM). The UAM project proposes the use of compact, low-altitude aircraft to alleviate traffic in urban zones, mirroring the older concept of flying cars. Navigating the FAA's web of safety-centric regulations has not only postponed the UAM Concept of Operations by more than a year but has also notably restricted the UAM certification process for the past four years (Office of Inspector General, 2023). Examples like these illustrate how the FAA's rigorous adherence to safety hinders technological progress. Comparatively, the European Union Aviation Safety Agency (EASA) has shown a different approach to technology, being more agile, thorough, and willing to integrate and accept new technologies into their regulatory framework when compared to the FAA (U.S. Government Accountability Office,

2022). The FAA's restrictive regulatory framework around technology reflects a broader overall mindset within the agency.

Throughout history the FAA has been characterized by a deeply ingrained resistance to change and a reluctance to incorporate technological advancements (U.S. Government Accountability Office, 1996). These attitudes persist into modern times, underscored by a comprehensive analysis conducted by the Monitor Group between 2010 and 2011, which revealed an inherent unwillingness to undertake significant changes within the agency. The Monitor Group's conclusion was drawn from extensive interviews with FAA personnel across all levels of the organization, indicating that the FAA's conservative mindset towards innovation is universal. A notable example illustrating these reluctant attitudes within the FAA is their non-utilization of the Department of Defense's (DoD) substantial research and development in aircraft surveillance and security, a decision not driven by the quality of the DoD's contributions but by the FAA's aversion to technological advancement. Additionally, the agency has faced a series of delays and financial overruns in their NextGen modernization program, with setbacks being blamed on their traditional organizational methods clashing with NextGen's ambitions for sweeping technological transformation (Office of Inspector General, 2014).

This study leaned on Bijker's Social Construction of Technology (SCOT) framework as a basis for analysis. SCOT's main ideas are that a myriad of social forces shape how technology develops, and that technology cannot be understood without factoring in how it is embedded within a broader social context. Some important definitions surrounding the framework are interpretive flexibility – the idea that differing social groups can assign different meanings to technological artifacts, tradeoffs – the varying interpretations of a technology between different

groups, and relevant social groups – groups that play a role in the development of technology through their own unique perspectives on it. The purpose of this framework's usage in this study is to tie together the existing research on this topic by using the social aspects of aviation disasters to the technical and cultural issues within the FAA.

Methods

To conduct a comprehensive analysis of the impact of aviation disasters on the regulatory stance of the Federal Aviation Administration (FAA), a variety of primary and secondary sources were employed. The collection of data was primarily centered around post-incident reactions from the American public, Congress, and the FAA itself. Primary data sources included public opinion surveys, congressional records, FAA reports, and investigation findings. These primary sources were further supplemented by secondary sources: academic journal articles and newspapers. This combination of these sources provided insight into the incidents themselves, as well as the reactions surrounding them.

Causal analysis was employed to directly link the FAA's cautious attitudes towards technology with public sentiment shaped by high-profile aviation disasters. A quantitative opinion poll and psychological research provided statistics used to establish how the public sentiments of fear and distrust following aviation disasters. Analysis was then conducted with a focus on how the American public, being a relevant social group in the technological progression of the FAA, has influenced the FAA's attitudes toward technology through their sentiments of fear and mistrust.

The historical analysis component of this study involved an examination of how significant aviation disasters resulted in post-disaster shifts in the FAA's regulatory policies that were spurred on by Congress. The focus was on how Congress, a relevant social group in the advancement of the FAA's technology, directly impacted how the FAA regulated technology throughout history. Investigations into notable disasters such as the Boeing 737 MAX crisis and the ValuJet 592 crash were scrutinized to determine what role technology played in these incidents. Congressional records were then used to outline how exactly Congress played a role in spurring the FAA to double down on technological restrictions. Once the sources were analyzed, the final phase of the historical analysis involved synthesizing the data to identify a historical pattern.

A case study of the Boeing 737 MAX disasters through the lens of SCOT helped in establishing how and why the FAA, in considerations about the tradeoffs between automation and safety, tend to lean heavily toward the safety side. Analysis of statistics from an FAA report established the aforementioned tradeoff. Review of literature studying the Boeing 737 MAX crashes was then used to provide details on the case and solidify an argument of why the FAA feels justified not to change its attitudes about technology in the wake of the incident.

Finally, comparative analysis between the FAA and its European counterparts was used as a rebuttal to a potential counterargument. The analysis focused on how the differing volume and nature of accidents that occur in both regions causes interpretive flexibility of technology between the two agencies. A newspaper was used to first establish differing interpretations on automation technology, which was followed literature on the case of Asiana Airlines Flight 214 to demonstrate why the FAA had differing viewpoints due to this, and other experiences. Finally,

statistical comparisons between the American and European airspace were employed to bolster analysis of why the two agencies' interpretations on technology differ.

Analysis

Public sentiments brought about by aviation disasters have fueled the FAA's skepticism of new technologies. Each high-profile accident that occurs amplifies public scrutiny of the FAA's ability to ensure air safety, regardless of the agency's relevance to the incident. In March 2015, Germanwings Flight 9525 was deliberately brought down by its pilot in the French Alps, killing all 150 people on board. Despite the accident occuring outside US airspace, an Economist/YouGov survey conducted immediately following the crash indicated that distrust in the FAA spiked to 23% (Frankovic, 2015). These distrusting public sentiments in turn drive the FAA to implement regulations that prioritize safety, aiming to alleviate public concerns and uphold confidence in air travel. Aviation disasters not only inspire temporary public mistrust, but also a general sentiment of fear, as demonstrated in polls showing that nearly half of Americans have some form of flight anxiety (Van Gerwen & Diekstra, 1997). Widespread fear among the American public sways the FAA to have more cautious attitudes towards technology reflect public anxieties surrounding flying. This effect can be seen when comparing the FAA to the National Highway Traffic Safety Administration (NHTSA). In 2016, U.S. Transportation Secretary Anthony Foxx ordered the NHTSA to tighten safety regulations on automotive technologies in a manner directly modeled off the FAA, taking the stance that the FAA had stronger regulations on technology (Snavely, 2016). Statistically, automotive deaths outnumber aviation deaths by a factor of 1000 (National Safety Council, 2023), but heightened public fears

of flying compared to driving explain why the FAA has approached technology with a stricter outlook than the NHTSA.

Aviation disasters spur Congressional action which has, over the years, pushed the FAA to develop a regulatory framework that is harsh on new technology. Congress today holds a significant amount of influence over the FAA, possessesing legislative authority over operations as well as budgetary control; however, this wasn't always the case. The agency had long operated with a degree of independence from Congress. This changed following two back-to-back disasters – a 1978 mid-air collision over San Diego, and a 1979 crash in Chicago. The combined death toll of these incidents was 417, prompting Congress to enact legislation that forced the FAA to restrict the certification process of new airliners (Lombardo, 1980). Since the initial oversight increase that began in the 80s, a pattern has formed where an aviation disaster occurs, it is found during investigation that the FAA overlooked potentially dangerous technologies when certifying airliners, which prompts Congress to pass legislation making the agency double down on safety regulations around technology. This was as seen in 1996 following the ValuJet Flight 592 crash in the Everglades that killed 110 people. Reports criticized the FAA for certifying the new Boeing 777 despite numerous potential technical problems, which prompting Congress to step in and push the agency to enhance technological regulations (Carlisle, 2001). The pattern was observed again in 2020 following two fatal Boeing 737 MAX crashes that killed 346 people, where Congress legislated harsher FAA oversight during certification (Shepardson, 2020). In the wake of numerous aviation tragedies, the continual buildup of legislation mandating the FAA's implmentation of stricter certification policies has caused the FAA's regulatory framework to be restrictive to new forms of technology.

The FAA's conservative approach to adopting new technologies is a direct result of its involvement in high-profile aviation disasters. As automation technology has progressed, automation-related crashes have begun to make up a growing share of aviation accidents. From 2003 to 2013, 60% of accidents over that period of time cited automation as a factor (Federal Aviation Administration, 2013). Each technology driven aviation disaster the FAA is forced to deal with further entrenches a "better safe than sorry" mindset within the agency. In 2018 and 2019, two Boeing 737 MAX airliner crashes resulted in the deaths of 346 people. Investigations into these incidents revealed that the the aircraft's automated flight control systems played a crucial role in both airliners nose-diving out of the sky (Elias, 2019). In this particular instance, the embrace of new automation technologies resulted in disastorous, highly visible consequences while any benefits the technology may have introduced were mostly invisible contributions to a system that had already worked. Using past tragedies as a basis for reflection on tradeoffs between the benefits and risks of technology gives justification to the FAA's careful outlook on the adoption of new technology. The tragedies cement the idea that, in the short run, the benefits of rapid technological advancement in no way outweigh the risks, which is a reason why the FAA has taken technological progress at a slow pace.

One counterargument to the points made in this paper is that aviation disasters happen all across the world, but the reactionary fallouts leading to restrictive technological attitudes isn't a globally observed phenomenon; this counterargument can be refuted by examining how the nature of the U.S. National Airspace amplifies the consequences these reactionary effects for the FAA. While the FAA views cockpit automation with skepticism, the EASA seems to take the opposite approach, believing the technology to be a force for enhancing safety. In debates surrounding the technology, the FAA has taken a stance advocating for its reduction while

emphasizing the importance of manual human piloting, starkly contrasting the views of the EASA, who intend to approve single-pilot cockpits by 2027 (Pasztor, 2023). This split in viewpoints can be explained by examining highlighting how the FAA's more extensive experience with certain types of disasters can lead to contrasting viewpoints. In 2013, Asiana Airlines Flight 214 crashed on final approach into San Francisco International Airport, resulting in 3 deaths and 187 injuries. The blame for this accident was placed on Asiana's policy of encouraging pilots to rely on cockpit automation systems built into the planes while deemphasizing manual flight operations (Chow, Yortsos, & Meshkati, 2014). The ocurrence of such an incident within U.S. airspace means that the FAA was more directly involved than its counterparts in Europe, meaning the FAA's greater degree of experience dealing with such incidents has caused the agency to take a more stringent approach on automated technologies than its counterparts in Europe. Examination of the nature of the United States National Airspace provides further insight into why the FAA's attitudes on technology distinguishes itself from the EASA. The United States airspace carried around 670 million airline passengers in 2021, the greatest amount of air traffic by a wide margin (The World Bank). It follows that the total number of fatalities from aviation crashes in the US are also generally higher, with around 1100 fatalities occuring from 2018-2020 (Bureau of Transportation Statistics, 2021) compared to the 243 fatalities in Europe over the same period (European Union Aviation Safety Agency, 2023). Due to the sheer volume of air traffic that the FAA handles, it deals with aviation disasters involving technology than the EASA. This compels the FAA to have a harsher mindset towards technology than similar agencies that don't handle incidents with the same frequency or severity.

Conclusion

Through this comprehensive exploration of the Federal Aviation Administration's (FAA) approach to technological adoption, it becomes evident that the organization's conservative stance is not merely a product of bureaucratic sluggishness or aged demographics, but instead is a deeply ingrained response shaped by historical aviation disasters and the resultant public and legislative pressures. This study highlights the complex interplay between societal fears, legislative actions, and technological advancements, showing that the FAA's cautious approach to new technologies is an adaptation to the expectations placed on them by Americans across varying relevant groups. The study posits that the FAA's hesitance is not an oversight but a deliberate and considered strategy motivated by complex sociotechnical factors. This perspective shift challenges the simplistic criticism often directed at the FAA and invites a more nuanced understanding of the agency's regulatory posture.

This analysis provides a foundational understanding that could influence future policy decisions and strategic directions. Policymakers could recognize the significant impact that they themselves have had on this issue and therefore shift their reactionary strategies following aviation disasters in a manner that better considers far-reaching consequences. Additionally, the FAA and media outlets could focus on improving communication strategies around aviation safety and technological adoption, thereby potentially easing public fears and opening avenues for more rapid technological integration. This study lays the groundwork for further inquiry into the relationship between social factors and technology policy in safety-critical industries. Researchers can expand this work by comparing the FAA's responses to those of other international aviation authorities in similar crises, providing a global view of how society shapes technological advancement.

Tackling the FAA's complex issues with technology requires a deep understanding of the FAA's position within an ever-changing technological landscape. This research underlines the necessity for continuing to explore these issues in an in-depth manner, as doing so may guide the FAA to more nuanced and complex solutions. Looking ahead, how the FAA addresses these technological challenges will be pivotal in defining the path of U.S. civil aviation, ensuring it remains secure, effective, and open to future innovations.

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