Technology in the Aviation Industry
(STS Topic)

ChoreoNova Ticketing System
(Technical Topic)

A Thesis Prospectus In STS 4500

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Bachelor of Science in Computer Science

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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.

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Approved:  Date 11/25/19

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Peer Review and Comments

During the course of writing my prospectus, I have received a lot of feedback from Professor Michael Gorman. I would like to thank him for his diligence in reviewing my work and helping to point my prospectus in a better direction.

I have also received feedback from my peer Vivian Pham. Generally speaking, Vivian likes the direction I am taking with my prospectus and has been a great pillar of moral support throughout the writing and editing process. I would like to thank her for all her help and support throughout the semester.

One very important point to the Actor-Network Theory that Professor Gorman brought up was the effect of technology on the mental models of the employees involved. Mental models are often ignored in much analysis as they tend to be more invisible than concrete statistics such as job loss or work hours. However, they too have a very important impact on the efficiency of the employees, and thus the overall effectiveness of the entire aviation network. I would like to thank him for providing me the article by Ashley Nunes which further provided me more sources in regards to this topic to look into.

Professor Gorman also brought up how there could be a human factor involved with the Automatic Dependant Surveillance Broadcast system being used in Australia. However, upon further research, not much information came up on the human side of the system. Since the human factors that would affect users of ADS-B would be similar to those that affect air traffic controllers in general, I decided to just use the description of those human factors as an answer to that comment as well.

Another shortcoming in my prospectus was not pointing out the potential effects on flights due to overreliance on technology. Some past examples of delays caused by IT failure have now been added to provide an idea of the scale of the effects IT failure can have on flights not just at major airports, but across the North American continent and beyond.

Professor Gorman has commented that he does not see that Actor-Network Theory as a framework adds much benefit or information to my prospectus. Instead, he has suggested switching to a cognitive science framework that would further dive into the analysis of how technology can impact human cognition, particularly of those actors involved within the aviation industry. Seeing that different actors may experience different effects from technology and also that ANT is able to provide views into more broader effects of technology, such as the business side of aviation or the overall economy of the system, I have decided to keep ANT and supplement my analysis with the cognitive science framework to analyze even more effects of technology in aviation. An ANT diagram was added as part of the framework.

Lastly, Professor Gorman also helped me greatly refine my writing, providing feedback on sentences that were mostly superfluous and did not add much meaning to my writing. In response to these comments, I have been able to greatly refine my prospectus by eliminating these sentences, allowing my writing to be more concise and meaningful.

Introduction

ChoreoNova is a non-profit dance presentation company with a mission to develop, produce, and present transformative contemporary dance works that tell impassioned stories. ChoreoNova also hopes to promote personal empowerment and communal justice with all those in the communities they perform in and they help to improve individual and collective resilience amongst community members as well. Thus, their core values include storytelling, well-being, diversity, inclusiveness, cooperation, and self-supporting. ChoreoNova currently holds around three to four events per year. Each of these shows has multiple showings at different times and days, potentially at different venues as well. In recent years, ChoreoNova's performances have been increasingly moving towards using more forms of media than just simply dance, integrating the arts with the sciences. Our main objective in this Capstone group is to develop a system to allow these dance presentations, as well as other ChoreoNova events, to have an efficient and high quality ticketing system by the end of the Spring 2020 semester.

Currently, ChoreoNova's way of listing events and selling tickets are very disjointed and disconnected due to compatibility issues with the way their main webpage is built. Their current website is built on Joomla, where they have found many compatibility issues when they attempted to integrate new webpages onto their site. Their current method of selling tickets include having all their events listed on their main website in the "Events" tab. However, users are not able to purchase tickets from that "Events" page, which is merely used to display upcoming events that ChoreoNova is holding. Instead, users must go through another link sent to them in a newsletter via email or found on ChoreoNova's Facebook page to access an EventBrite page for the specific event's date and time they would like to order tickets for. Overall, ChoreoNova's current band-aid solution to not being able to integrate links onto their webpage is

extremely inelegant and unscalable. First off, this is a very inefficient process for users as after seeing an event they may be interested in on ChoreoNova's main webpage, they would need to somehow find this other link to the EventBrite page via email or Facebook. If this user had not signed up for the newsletter before or does not own a Facebook account, it would be virtually impossible for them to access this EventBrite page and order tickets to attend the event. For more impatient users, all this clicking and searching for the proper link to order tickets may even discourage them from purchasing tickets altogether, resulting in ChoreoNova losing business. On top of that, ChoreoNova is also handing over control of their ticket sales to a third-party company: EventBrite. This means they lose control over a lot of the revenue they generate and also are giving EventBrite valuable data that they could have kept for themselves. As such, our goal is to help ChoreoNova find a more elegant solution to their ticket sales, integrating everything into one system linked to the main website throughout this school year.

Currently, our plan is to split most of the work on this ticketing system into two semesters worth of work. The first semester will be focused on putting together a functioning ticketing system where users can see events and purchase tickets altogether in one system. The second semester we will focus on integrating our system with ChoreoNova's existing systems while adding more additional features into our ticketing system we have built in the first semester. Once the systems are in place, the user interface (UI) and user experience (UX) will then be worked on. Choreonova values a smooth and enjoyable experience for their customers, and therefore wants the ticketing system to reflect this.

This project is important for many reasons, as it supports the arts and the local Charlottesville community. In recent years, the rise of STEM careers has in many cases displaced studies that are sometimes referred to as "softer" studies, such as the arts. Many see

STEM as more productive for society, contributing more to the further advancement than something like the arts. However, society needs balance and many times, the arts provide that balance by introducing more abstract concepts, such as humanity or justice, all necessary for a full functioning society. With no humanity, society would have lost its human roots, removing us from our very own nature. The arts, especially a company like ChoreoNova, which promotes inclusivity, well-being, and cooperation help to ensure this social aspect of our species is not lost. ChoreoNova also has the added benefit of being a company that is local here to Charlottesville. As the divide between the University of Virginia continues to grow with the local Charlottesville area, it is very important for University of Virginia students to have the opportunity to give back to the surrounding area, and to thank them for welcoming us into their home for the past four years.

System Design

The main goal of the capstone project for ChoreoNova is to create a functioning ticketing system that will allow customers to purchase tickets for events. The ticketing system has a number of requirements that need to be met. These specifications were put in place by our client, Davida Rae. Her original vision was to have the system embedded on her original website. However, our group felt it was best for testing and building purposes to have our product be a completely separate website and link it straight from our client's own website. Doing it this way allowed us to make modifications without impacting or conflicting with our client's work.

In terms of functional requirements, our group has to prioritize ease for users, as that is the main obstacle facing ChoreoNova's current band-aid solution. The main goal of our project is to allow typical ChoreoNova customers, who have varying levels of technological experience,

to be able to easily go on the main ChoreoNova website, click the link to buy tickets, and then purchase the tickets in a reasonable amount of time.

The front-end is the part of the website that the users can access and interact with. The front-end is being built to be logical and streamlined. The client has placed heavy emphasis on reducing the number of clicks and webpage redirects. The current front-end design has been created around this vision, and only requires 3 webpage redirects to purchase a ticket. First, the user is redirected from the main website to the homepage of the ticketing website. From here, the user can then pick an event from this page. There is a list view and also a calendar view to select an event from. There are also filters if the user wants to reduce the number of events or only see the events of a certain type. Once the user has decided on an event, they will then click on the event and be redirected to the ticket purchasing page. Here, the user must select the quantity, location, and accommodations they want. Then, the user will purchase the tickets and be finally redirected to a confirmation page. This system will default to a simple system that a person who is not technologically savvy will be able to complete, but will provide the tools, such as calendars and filters, that allow more advanced users to have a more refined experience.

The product needs to also have an easy-to-use back-end system for our client or any other ChoreoNova employees to access the website as an admin and be able to modify objects, view statistics, and be able to look at user demographics so they can plan for their next event. Having an admin back-end system will also give the flexibility for ChoreoNova to expand with more employees and more shows if they choose to do so in the future. This will lay the groundwork for years, if not decades, of future development. The back-end for this system will hold all the information that ChoreoNova will need in regards to ticketing, with the most important information including the event that tickets are being sold for, how many tickets are left for that

event, the price of tickets, a seating chart if relevant, and special requests that specific customers may have, for example, special accomodations. This information would be stored in a database that will be easily accessible by ChoreoNova employees and display all the information for them efficiently and effectively.

Our group is using Django, a web framework that uses Python as the programming language and has an MVC structure. MVC structures stand for Model-View-Controller. It is a three-tiered structure that keeps data, presentation, and logic separate from each other. Using this framework allows our ticketing system to be able to store tickets and events as models, display the desired information as a view on the rendered webpage, and control how a user interacts with the system. The actions of a user determine what views and models are impacted. For example, if someone orders a ticket, the view will update to an "order success" message, and then the ticket model will decrease by a value of one, signifying that one ticket has been removed from the system as it has been sold.

System Requirements

System requirements are the various functionalities that the system we are building must contain, per our customer's wishes. Gathering system requirements allows us to begin the process of building a system by planning what needs to be done. By splitting the list of system requirements into minimum requirements, desired requirements, and optional requirements, we will know which features should be prioritized. The minimum requirements are as follows:

- As a user, I should be able to buy a ticket to the event I selected so that I have a verified method of entrance.

- As a user, I should be able to input any special requests so that the company knows how to accommodate my needs.
- As a user, I want to be able to get back and forth between the main website and the ticketing website easily.
- As the owner, I need to be able to connect my bank account to a payment page in the website so people can make transactions on the same page.
- As an admin, I should be able to create an event and include the appropriate details so that users can see what events are occurring.
- As an admin, I should be able to track ticket sales so that I can see the number of remaining tickets for an event.
- As an admin, I should be able to know that the ticketing website will not conflict with the already existing software.
- As an admin, I should be able to see which tickets have a special request so that I can properly accommodate their needs.

After the minimum requirements have been completed and we have a functioning ticketing system, we will be able to work on desired requirements. These include:

- As a user, I should be able to select which seat I want in the venue so that I know where I will be sitting.
- As a user, I should be able to print or receive a QR code after I purchase my ticket so that I can present it to get into the event.
- As a user, I want to be able to look at a calendar of events to make it easier to find out which performances I can attend.
- As a user, I should be able to see how many tickets are left easily.

- As an admin, I should be able to edit the event throughout the sale period so that I can make updates as needed.
- As an admin, I should be able to list different seating categories with the number of seats available per category so that I can keep track of sales and seating arrangements.

Finally, if there is any time left after the completion of the ticketing system, we will work on the optional requirements:

- As a user, I should be able to organize events by type so that I know which shows I would be interested in.

Implementing these features will create a ticketing website that is versatile, elegant, and functional. This system will allow the client to stop focusing on technical issues, and put more passion and time into their art. Our client runs a nonprofit dance company and helps bring art to the community of Charlottesville or wherever they choose to perform, and our product helps them run it more smoothly and efficiently. This is also a very good opportunity for us as future software developers to be able to develop and code a product for a real life client. Our software development experience has so far only been with professors that know what to expect based on some form of grading guidelines. Working with someone who is not used to working for a software development team is a useful real life experience, because in the future when we may have to develop for a non-technical customer. This project will not only help artistic endeavours and the Charlottesville community, but will also aid our team in becoming more patient and effective developers.

Introduction

With the rise of the digital realm, it seems that day by day, everything is "going digital", from paying for one's groceries using Apple Pay to autonomous vehicles to even university lectures, which now can be recorded by a professor remotely and watched from the comfort of students' own beds. It is without a doubt that the aviation industry too has begun transitioning much of its day-to-day processes to the digital world as well, especially thanks to the efficiency it introduces, which satisfies rising consumer expectations (Post, 2016). By implementing more efficient technological solutions, airlines are able to save more money, boosting their own revenue, and also create customer loyalty through increased service satisfaction (Post, 2016). Beyond airliners, airports themselves are also adopting more digital solutions as they too are run like businesses in many parts of the world, requiring an increasing stream of revenue to stay afloat.

Technology can also be used beyond helping the robust aviation industry make more money. Ultimately, better technology can help planes navigate the skies more efficiently. Automation has already changed the types of tasks a pilot has to do in the cockpit, transforming the role of a pilot from commanding the plane to being a mere troubleshooter (Wendover Productions, 2018). The ever increasing power of technology will further help air traffic controllers better allocate flight paths in the most efficient manner through more powerful simulations, analysis, etc., all with the end goal of delivering as many passengers through the skies as quickly and safely as possible.

Airports in the Digital Age

Airports, today, especially the major global hubs, have fully embraced the digital age and are ever adapting and changing with new technology to better serve the over 4 billion annual

global flyers ("Passenger air traffic each year"). Many airports are transitioning away from “Airport 2.0”, which focused on self-service and process efficiency to “Airport 3.0”, which emphasizes using digital technology to optimize flow monitoring and passenger processing (Jarrell, 2018). Singapore’s Changi Airport has even taken this principle to a whole new level by automatizing an entire terminal (Baker, 2018). The level of technology that Changi’s newly opened Terminal 4 has reached is so impressive that passengers are surprised to see an actual human employee (Baker, 2018).

With the huge amount of types of new technology constantly being rolled out, airports have a wide variety to select from and implement. Out of all the airports interviewed by Jarrell of the International Airport Review (2018), the technologies cited most frequently were cloud computing, big data and analytics, smart machines and robots, virtual modeling and simulation, and the Internet of Things. The power of cloud computing enables airports to more easily simulate and analyze passenger flow data, allowing them to better know when and where to allocate resources to adapt to changes in demand between peak and off hours (Jarrell, 2018). Moreover, the centralized nature of cloud computing allows airports to scale up or down their technology easily depending on demand since the technology lies elsewhere rather than directly at the airport ("Why airports are investing in automation", 2019). Automation and self-service have also helped make passenger processing more easy. One of the newest examples include self-service bag-drops. They allow passengers to quickly drop off their bags at their own convenience, helping relieve congestion during peak hours at the check-in desk and improving passenger flow through the airport ("Why airports are investing in automation", 2019).

There exists a lot of pressure for airports to continue to expand and grow the types of technologies they have. Airports are ultimately businesses, with a need to improve revenue

streams while keeping expenses low to run efficiently. Digital technologies help reduce cost by speeding up processes, preventing delays, and simplifying tasks (Jarrell, 2018). Moreover, digital technology greatly improves passenger experience by limiting queues and the stress that comes with long airport lines. There is a direct correlation between passenger satisfaction and the propensity to spend more money once past security, whether it be at the duty-free store or restaurants, greatly increasing the revenue of an airport (Jarrell, 2018). Lastly, fewer delays and better management of baggage will result in less complaints and overall work for airports, especially to track and locate lost baggage (Jarrell, 2018).

Despite how convenient technology has become, there are many difficulties for airports as they transition to become more and more digital. For starters, airports form an important part of critical national infrastructure. Because of the importance of airports, they generally are more conservative in experimenting with new technology in fear of failure and the ramifications that such failure might have nationwide ("Why airports are investing in automation", 2019). There is also a lengthy bureaucratic process that airports must go through to acquire and implement new IT products or solutions (Jarrell, 2018). Moreover, there are many resilience and connectivity issues between systems, especially when airports transition from a pilot program to full rollout (Jarrell, 2018). Lastly, regulations differ from country to country on issues such as security and privacy ("Why airports are investing in automation", 2019). With the large amount of different countries one airport may provide service to, it may be very difficult to meet the varying security imperatives each country may mandate.

Automation in Air Traffic Control

Air traffic control (ATC) has already been historically rather dependent on the newest technology in order to be up to date and provide the safest options for all the planes flying across

our skies. This role has become increasingly important as the number of flights and people flying continue to grow ("Passenger air traffic each year"). Not only does this increase the workload for air traffic controllers, it also increases the amount of pressure placed upon them to minimize accidents (Baker, 2018). “If you’ve got a very high workload, then you are more likely to make a mistake, miss information or do something that you shouldn’t do,” says National Air Traffic Services head of human factors Neil May. This is where technology steps in to provide assistance. With the rapid growth and change within technology recently, air traffic control too has also been able to greatly expand its operations thanks to new technology. Technology has been able to provide air traffic controllers with more accurate information earlier, increase visibility at airports, and enhance communication between airplane pilots and traffic controllers, all with the end goal of keeping the skies as safe as possible (Baker, 2018).

One of the biggest aids technology has provided to air traffic control is increasing visibility to aid in the tracking of aircrafts. ATC tower windows have traditionally served as the main source of information for controllers to grant clearance to planes arriving and taking off at the airport (Baker, 2018). Something many airports have introduced is a virtual control tower, which uses video sensors to replicate the view and tracking capabilities of a traditional control tower ("Three digital technologies that are about to reshape aviation", 2016). Airports can now erect camera masts with microphones that transmit data to a remote data center where the view of the entire airfield is stitched back together as a live image and augmented with other operational data such as tags for individual aircrafts or closed runways (Baker, 2018). Much of this work can now be automated at this remote location, which reduces the workload for air traffic controllers at the local airport, relieving them of some pressure (Baker, 2018).

Australia has recently introduced a satellite-based tracking system called Automatic Dependant Surveillance Broadcast (ADS-B) ("New Air Traffic Control Technology Improving Safety"). ADS-B allows both traffic controllers as well as other pilots to track nearby aircrafts twice every second without the need of conventional radar ("New Air Traffic Control Technology Improving Safety"). This greatly increases safety in non-radar airspace as now both ATC and pilots can see where planes are in real-time and provides increased access to different flight levels, allowing for more pilots to use their preferred flight routes ("New Air Traffic Control Technology Improving Safety"). "ADS-B allows air traffic controllers to see us on their screens when we are in remote regions of northern Western Australia. It has made any off-track diversions a lot shorter and tracks to our destinations much more direct," said Michael Bleus, Chief Pilot of the Royal Flying Doctor Service of Western Australia, Western Operation ("New Air Traffic Control Technology Improving Safety"). While there are concerns that pilots could become distracted due to the additional information they are presented by ADS-B, this risk is offset by the fact that they will have real-time traffic information and new standards in monitoring the broadcast of this data ("Human Factors and ADS-B: Automatic Dependent Surveillance Broadcast", 2018).

However, while all this new technology has the end goal of helping make air traffic controllers' work easier, it is very important for designers of such systems to not decrease the cognitive demand of the job for controllers as well. In a dynamic and complex environment such as that which ATC have to work in, situational awareness is a very important factor in terms of the decision making process needed for the job (Endsley, 1995). Situational awareness is extremely important in this job so that controllers can maintain up-to-date assessments of the rapidly-changing environment that is the busy airspaces over our heads (Endsley, 1995). In a

study conducted by Ashley Nunes of the University of Illinois at Urbana Champaign, it was determined that for air traffic controllers that were not provided predictive assistance, they were better able to first understand the problem, then problem solve the given challenges over time (2003). It is believed that since they were not given aid in prediction making, these controllers had to develop their own strategy to solve the complex puzzle that is air traffic control (Nunes, 2003). On the other hand, controllers who were given this predictive assistance never had to develop their own method of critical thinking, thus explaining why their scores stayed constant over time, compared to those of the baseline group whose scores increased as time went on (Nunes, 2003).

One example of technology that takes into account air traffic controllers' situational awareness is the implementation of advanced display information onto existing ATC radar display. With new technology such as Free Flight which allows pilots to be able to better route their own aircrafts and maintain safe separation distances comes a reduction in the role of ATC from actively dictating where planes should be to a more passive role that only steps in if two planes come too close together (Endsley, Sollenberger, Nakata, & Stein, 2000). This results in a loss of situational awareness for ATC as they are no longer actively involved in the flight paths planning of many planes, making it more difficult for them to respond to instances where two planes do violate separation minimums as they are less knowledgeable of the situation thanks to their passive role. Advanced displays on existing ATC displays mitigate this problem by communicating to ATC when a pilot intends to change their flight route, displaying the pilot's intended heading, altitude, airspeed changes, etc. until after the change has been completed (Endsley, Sollenberger, Nakata, & Stein, 2000). The results of Endsley et. al.'s study showed that the advanced displays dramatically increased situational awareness of ATC (2000). The

downside to the displays, however, was that it increased ATC workload as they now had more information to monitor (Endsley, Sollenberger, Nakata, & Stein, 2000). However, studies such as the one conducted by Endsley takes a big step in ensuring the implementation of technology does not impair the mental models for ATC too much so that it actually decreases their efficiency.

Airliner IT Outages

With so much moving into the digital realm, the aviation industry has found itself increasingly reliant on its IT systems. When IT systems go out, it can have dramatic effects on an entire network that relies on the system. One case study that will be explored is that of airliner IT outages and the effects they can have across a wide array of actors involved with the aviation industry. The study was conducted by the Government Accountability Office to determine the roles of the United States Department of Transportation (DOT) and Federal Aviation Administration (FAA) in regards to airliners IT outages as well as their effects on passengers ("Information on Airline IT Outages", 2019).

Currently, airline IT systems directly affect passengers through relating to passenger reservations, travel-booking sites, and the check-in process ("Information on Airline IT Outages", 2019). Indirectly, passengers are also affected by the fact that airlines use IT systems for flight planning, coordination with other airlines, and staff dispatch ("Information on Airline IT Outages", 2019). Lastly, airliners also use their IT systems to provide information to the FAA, whose main job is to ensure the safe and efficient operation of the National Airspace System ("Information on Airline IT Outages", 2019). In general, airliner IT systems operate in a very dynamic, data-intensive environment that must work around-the-clock and be able to provide real-time information so long as the airline has planes in the sky ("Information on Airline IT Outages", 2019). Because of the important nature of IT systems, airlines must maintain and

ensure their systems are always in tip-top form to be used, which can be hard as it can be hard to take a system offline for maintenance or repairs when information is needed 24/7 ("Information on Airline IT Outages", 2019). Thus, some airlines have found it helpful to outsource their IT network to a third-party provider, who would have more expertise with running IT systems ("Information on Airline IT Outages", 2019).

In general, the GAO's study found that both the FAA and the DOT have a limited role in regards to airliner IT outages ("Information on Airline IT Outages", 2019). Airliners can request for a groundstop from the FAA should they experience IT outages and the FAA will help them reintegrate flights back into the skies when they are ready, but the FAA does not directly oversee airliner IT systems ("Information on Airline IT Outages", 2019). Similarly, the DOT simply ensures airlines adhere to their contracts with passengers, but there are no specific mention of how airlines should respond to IT outages and their effects ("Information on Airline IT Outages", 2019). Likewise, it was difficult to determine the effects IT outages have on passengers as there is no specific category for airliners to report IT issues as a cause of delays or cancellations ("Information on Airline IT Outages", 2019). Moreover, airline obligations documents are extremely long and convoluted and vary greatly from airline to airline, prompting many consumer advocacy groups to claim airlines can get away very easily with not providing adequate compensation for IT outage-related delays or cancellations ("Information on Airline IT Outages", 2019).

Actor-Network Theory Framework Analysis Approach

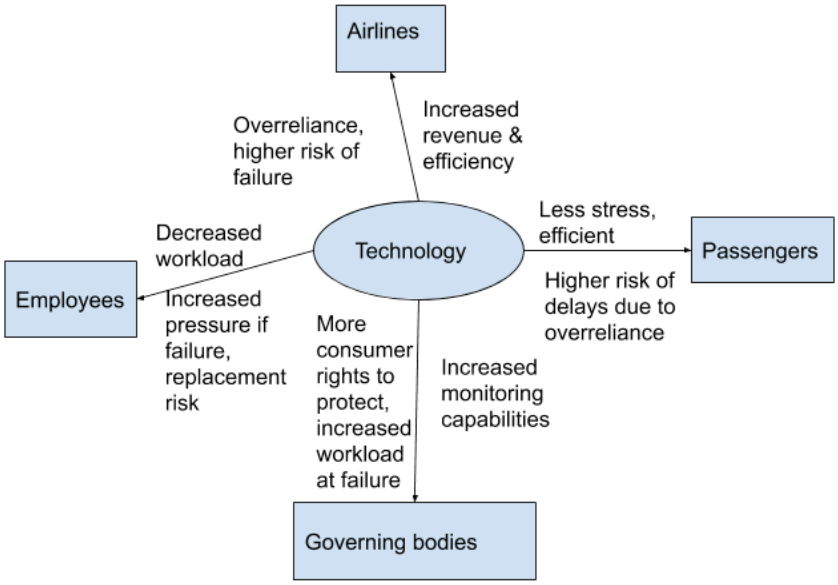

Fig 1. Actor-Network Theory Diagram

The situation in regards to the introduction of technology into the aviation industry and its effect on all those with stakes in the industry fits neatly into the framework of Actor-Network Theory. There are many influential actors within the network that is the commercial aviation industry. The core of the network lies with airlines, who supply the planes, staff, and the capability for the network to actually take off. This actor can further be broken down into the corporate office and flight crew, who each may have differing goals, especially demonstrated during times of pilot or flight attendant strikes. Another important actor in this network is paying customers, who provide the revenue for airlines to operate. This is also the actor that airlines must serve and appease in order to continue to be able to fly. Next up are government regulators, such as the FAA and the U.S. DOT, who maintain national airspace, regulate airliners, and ensure passenger protections are followed. Last but definitely not least are the air traffic controllers, the people who ensure that all air traffic safely makes its way to its destination.

The introduction of new technology has different effects on every single one of these actors. The increased efficiency brought by technology benefits airlines greatly by reducing their expenses as well as helping them improve their reputations amongst customers by having less delays or cancellations. Similarly, technology makes passenger experiences much more enjoyable and helps governments and ATC better regulate and keep airspaces safe. On the other hand, reliance on technology can become a risk for airlines and passengers, who could all suffer long delays and even cancellations when the tech fails. One recent example of this occurred in March 2019 when Sabre, a company many airlines uses for online reservations and check-in, saw computer issues that led to nationwide outage of check-in systems, leading to long lines with wait times up to two hours at many airports for passengers who were not able to check-in at home and obtain their boarding passes (Lazo, 2019). A month later, IT failure at AeroData, a software used to calculate weight and balance of flights across North America before takeoff, caused widespread delays for United, Delta, Southwest, JetBlue, and Alaskan Airlines (Bostock, 2019). Providing data to 50% of all North American flights, AeroData believes that just five minutes downtime of its own systems could result in over 100 delayed flights ("AERODATA, INC. IMPROVES CUSTOMER AGILITY AND AVAILABILITY WITH COST-EFFECTIVE VMWARE NSX SOLUTION"). With the number of flights it provides data to expected to rise to 85%, it is of utmost importance that AeroData does not fail lest even more flights may be delayed or canceled across the continent, affecting even more passengers and aviation employees than ever before. Likewise, increased automation has always had the risk of taking away jobs from actual humans and this fear persists within aviation as well due to calls for full automation of the industry (Wendover Productions, 2018). Lastly, it is also important to consider the mental

effects technology may have on these employees and whether or not these effects could increase or decrease the efficiency of employees.

Cognitive Science Framework

The field of cognitive science developed in the mid-1950s as a way to study the mind and intelligence, embracing many other fields including artificial intelligence (Thagard, 2018). One effect of technology on the aviation industry that was raised by Ashley Nunes is how increased technology in the ATC realm can affect the mindset of air traffic controllers (2003). For example, while improved technology may give more freedom for pilots to choose their own flight paths, by decreasing the role of ATC, this decreases their situational awareness of events and lowers their effectiveness in making quick decisions in the fast-paced environment that is aviation. In addition to affecting air traffic controllers, the increased decision making role that is presented to pilots also has major cognitive effects on them as well. Historically speaking, pilots have always been directed onto which flight path they should take by ATC as ATC were the ones who had all the information about the skies and where other planes were. With technology, pilots now have more freedom to pick and choose their own routes. However, there are many concerns that this may increase the workload and burden on pilots (Gui, et al., 2015). Many feel this may affect pilots mentally, affecting their decision-making, attention skills, as well as spatial orientation in a negative way, all very important cognitive skills needed to safely fly a plane (Gui, et al., 2015).

Besides effects on employees within the aviation industry, technology can also have effects on airline passengers. Flying can be very stressful for many, especially when one arrives late to the airport and sees long lines leading out of everywhere, from check-in to baggage drop to clearing security. By speeding up all of these processes, technology can reduce this stress for

passengers. Increased passenger satisfaction or just simply arriving at the gate sooner than anticipated can be a very relaxing feeling, making that nearby restaurant or stores much more attractive to passengers, increasing their propensity to spend within the airport (Jarrell, 2018). Moreover, many studies show that being at high altitudes with low humidity and temperatures, as is the situation in planes, can lower the amount of oxygen in people (Gray, 2017). This is known to have many cognitive effects on people, leading to them, for example, being more emotional or anxious (Gray, 2017). There is definitely a possibility that technology would have an effect on additional human cognitive functions. For example, passengers would now be boarding planes much less stressed than before due to a more streamlined airport experience. This would already lead to them having a different cognitive state entering the aircraft than in the past. More technology can also be integrated into plane cabins to further affect the cognitive state of humans. A prime example of this is the mood lighting that Boeing introduced on its new 787 Dreamliner, which changes color throughout the flight to help trick the body's inner clock to adjust to the destination's time zone (Kundu, 2016). Technology can definitely be used to manipulate the cognitive state of passengers to make the flying experience as seamless as possible.

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