Cover Page

Title of Design: SimpliFlight

Design Challenge Addressed: Airport Management and Planning Challenge

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SimpliFlight

SimpliFlight: Making Airport Travel Faster, Safer, Easier

ACRP AIRPORT COOPERATIVE RESEARCH PROGRAM

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Executive Summary

The following report frameworks the process used to conceptualize an application (app) that will make airport travel less frustrating for passengers needing extra assistance as well as their families/caregivers. This app presents a solution to the Technical Design Challenge of Airport Management and Planning for the 2016-2017 Airport Cooperative Research Program University Design Competition.

To address this challenge, our team at Binghamton University-State University of New York created an app, SimpliFlight. Usually when a loved one travels, their families wait anxiously for a text or call indicating that they have boarded the plane. Our app will utilize location services and a series of yes/no questions that will serve to determine whether the passenger has reached certain checkpoints in the airport (ex. Security, check-in, gate etc.). Additionally, the application provides the user with tips for what to do at each checkpoint to prepare them. SimpliFlight will communicate with Google servers and FlightAware servers to collect indoor mapping and flight time/ location data, respectively. The app provides (1) a user friendly User Interface (UI), (2) the ability to notify loved ones of the user's current progress in boarding the plane, (3) timely updates about flight delays, (4) simple intra-airport navigation, and (5) airport tips.

Currently there are a considerable number of pre-existing applications which allow users to track flights, keep itinerary on their phone and/or locate airport concessions. However, no communication with the caregiver of the traveler has ever been utilized. Our app is specifically geared towards those with additional needs such as the elderly, children, or passengers who do not speak English. The main purpose of this app is to aid travelers of all ages and background in navigating into airports as well as to provide relief and reassurance to worried caregivers.

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Problem Statement:

a. Federal Aviation Administration Goals

The FAA is constantly trying to make airport travel more efficient and safe. In the FAA's *Destination 2025,* a document that outlines the FAA's plan to create the most efficient aviation system in the world, five major aspirations are declared: To increase safety, create an innovative workplace, improve the flying experience to match public needs, reduce aviation's energy impact and progress global connectivity. SimpliFlight would help the FAA meet these goals through the third aspiration, "deliver aviation access through innovation" and ensure that the airport is "matched to public needs" [1].

b. The Problem

With huge airports such as John F. Kennedy International Airport covering 4,930 acres, it is no surprise that people find the vastness of airports confusing to navigate [2]. This difficulty is increased for those who may require additional aid while traveling, including seniors, children, people with disabilities, and non-English speaking travelers. Moreover, when such individuals travel, their loved ones constantly worry whether they have made it onto their flights or not. Just recently in March 2017, an elderly couple was wheeled by Allegiant Air employees onto the wrong flight out of Fort Lauderdale, Florida, and ended up at the New York – Ontario border instead of western Michigan [12]. This is just one example that displays the difficulty of travelling through airports, and more importantly the need to create a form of aid to ensure safer and simpler flying.

c. Current Methods

Currently, there are two options for getting through airports: following signs or using an application. Signage is more of a problem in larger airports where there may be an overwhelming number of signs. The signs in most airports are often confusing and sometimes misleading if you are not familiar with the airport already [3]. Conversely, while several applications which allow

users to track flights and itineraries exist, they are intimidating, buggy, and difficult for the special needs passengers to use. These apps help navigate people through airports, update them on changing flight information, and estimate Transportation Security Administration wait times. Current applications have so many features they can be overwhelming and difficult to manage for the elderly or non-English speakers. None of the existing applications have the feature of notifying loved ones of their progress.

d. Moving Forward

SimpliFlight, designed to keep both passengers and caretakers updated and informed throughout the overwhelming airport travel process, is aimed to ease some of the associated anxieties. By helping passengers navigate through each step of an airport using indoor mapping and a series of basic color-coded "yes" or "no" questions asking if they have reached certain areas, their concerns of getting lost or missing their flight can be relieved (Figure 1). When the passenger answers the "yes" or "no" questions, the caretakers back home get notified, keeping them confident that their loved one is safely on their way to their destination. SimpliFlight hopes to ease the caregiver's anxiety by keeping them informed while their grandparents, children, or loved ones are flying alone.

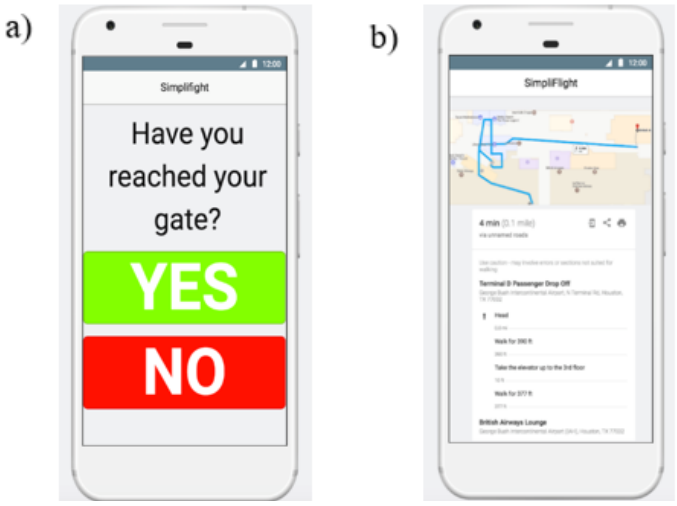

Figure 1: App Screens a) clear color coded yes or no questions b) intra-airport navigation screen

Summary of Literature Review

a. The Airport Cooperative Research Program University Design Competition

The Airport Cooperative Research Program (ACRP) annually sponsors a competition for students in universities to tackle some of the issues regarding airports. This program is funded by the FAA, which divided the competition into several categories including airport operation and maintenance, runway safety, and airport management and planning. The goals of the ACRP Design Competition are to raise awareness of the ACRP and airports in terms of the national airspace system infrastructure, to get the academic community more involved in addressing the issues pertaining to airport operations, to involve students in thinking about and developing solutions to the issues airports face, and to create an interest in airports as a career opportunity [4].

b. Existing Airport Wayfinding Applications

By 2014, the usage of mobile apps increased by 76% [5]. Whether it may be for business, leisure or some other activity, travel is also increasing; over the last five years, at John F. Kennedy International Airport, there was an increase of 9% in passenger volume [6]. Travelling to domestic and international airports where the passengers have never been before may create a problem in terms of finding where to go within the airport. The main problems that arise can be broken down into four categories as per the ACRP: Wayfinding, Fatigue, Technology/Equipment, and Amenities [7]. These are pressing issues seen in many, if not all, airports around the globe. Thus, creating a wayfinding smartphone app will be the most efficient way to address the first category by helping people find their way around the airport and locate the key parts of the terminal.

There are many apps created to help the travelers find their way around airports. However, recent studies have shown that, “45% of the users are dissatisfied with the features and functionality that airline apps currently offer” [8]. The apps that are currently in the market, such as airline-specific apps for Delta and American Airlines as well as third party apps like

FlightAware and flightSpeak, offer times, delays, and tracking of flights. These applications lack passenger tracking and do not have direct connection and communication between the caregiver and the passenger [9].

c. Wayfinding and Passengers with Additional Needs

Approximately 50% of people retire by the age of 65, and will therefore be more likely to travel. Airports can often be complex and difficult to navigate, especially for the elderly population. As the traveling elderly population grows, the biggest problems they face are unfamiliarity with the, "complex airport environment," unclear signage and information, and/or understanding the meaning of the signs. Passengers may walk greater distances than necessary trying to find checkpoints like baggage claim and security. This may be solved with SimpliFlight as it will locate direct routes to desired destinations [7].

When focusing on helping elderly passengers in airports, most of the problems seem to stem from issues with communication regarding directions to the airport terminal, transportation from the airport, on board flight information, information broadcasts, flight delays/cancellations, special services for the elderly, and information on emergency escape routes and protocols [10].

Although airport operators are generally aware of the needs of senior travelers and are trying to accommodate them, the airport's efforts are often halted by the lack of a well-coordinated policy, the constraints presented by existing buildings, and the costs of implementation both in terms of capital investment and increased staffing [11].

Besides the elderly, this app can be used by minors flying alone, another growing demographic of travelers. For example, a 9-year-old Canadian boy was stranded for eight hours at Chicago's O'Hare International Airport after a United Airlines employee forgot to retrieve him from a kids' lounge in time for his connecting flight. Delta Airlines mixed up two kids' itineraries,

sending a boy who was supposed to go to Boston to Cleveland and a Cleveland-bound girl to Boston instead [10]. This app will help minimize these types of occurrences.

d. Intra-Airport (Indoor) Mapping and GPS Service

Signs and information booths in airports lead people to their destination, but can also cause confusion. Google Maps is working on implementing indoor maps, which could be used to help ease the confusion the signs alone may create. As the Google site itself says, "with indoor Google Maps, visitors can spend less time searching for building directories and more time discovering new points of interest" [13]. Google Indoor Mapping will also be available through the Google Maps Application Program Interface (API). As of right now, only limited areas are covered, but adding more areas to Google Indoor Mapping would be easy. To upload the building's floor map, lining the map up with satellite images and then submit it to the Google Maps website [14].

e. Application System Services

A modern app comprises of three parts, the backend or database (also called model), the UI called the view, and programming logic (the controller) that controls the interaction between the view and the model. This method is referred to as MVC architecture. In a smartphone application, the view represents the front end created specifically for the application and the model frequently resides in a remote server, accessed over the internet. "A server is a computer designed to process requests and deliver data to other (client) computers over a local network or the internet" [15]. This means that the application code (controller) will take the request originating in the UI and send it to the server as a data request using standardized APIs. The data returned will be

formatted and sent to the UI for display. The interaction between the model controller and view is shown in Figure 2.

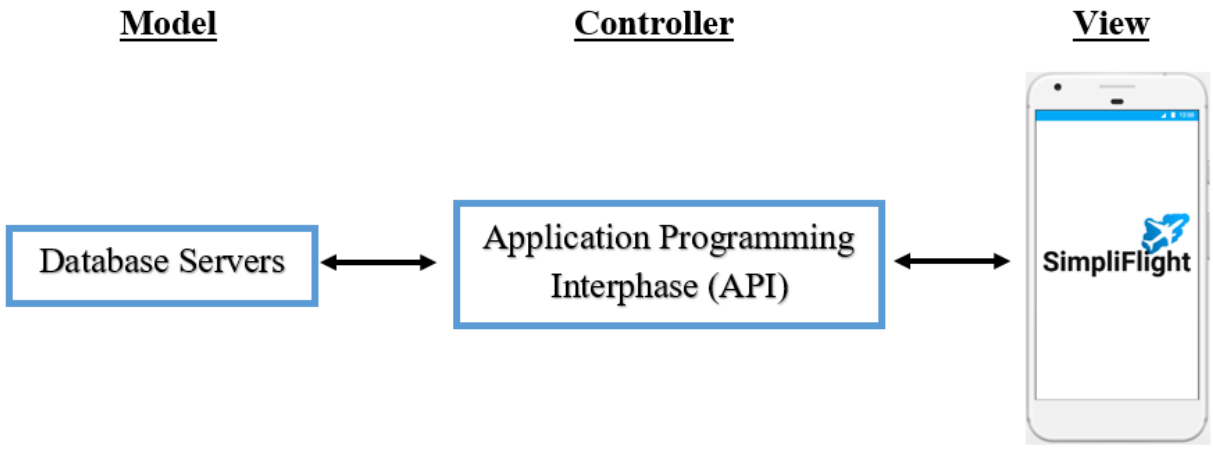

Figure 2- Application Services: A database server is a computer system that provides database services to other computer programs. An API is software comprising routines, protocols, and tools for building software applications. The API is the middle man between the Database Server and the UI

f. Privacy and Protection of GPS Data

Two major issues that arise concerning the mobile phone application are data leakage and mobile phone hacking over open airport Wi-Fi and Geographic Information Systems (GIS) exposure [16]. The process of using the airport GIS to illustrate the internal parts of the airport must be given to many different organizations, for example, "FAA, National Geodetic Survey (NGS), National Airspace System (NAS), to validate, verify, and allow for safe use" [17]. It is vital to protect individuals by keeping patterns of travel behavior secure at all times. In a study, 56% (n=25) of women reported being stalked by the use of mobile technology to track their location and 17% (n=7) reported being tracked by GPS on tracking applications such as Find My Friends [19]. The app must be able to keep the travel information data secure, which would require encrypting the data [20]. There are a few ways to make individual travel data more difficult to access besides using encryption. These include using obfuscation of point data, specifically grid masking and random perturbation [21].

Previous studies have shown that a cellular device can still store GPS data even when the device is not on. “Many modern vehicle tracking devices combine both active and passive tracking abilities. When a cellular network is available and a tracking device is connected it transmits data to a server; when a network is not available the device stores data in internal memory and will transmit stored data to the server later when the network becomes available again” [22]. While on a flight with a cellular device turned off, flight data can be transmitted via flight tracking systems that use either radar or automatic dependent surveillance broadcast (ADS-B) signals. These data can be used to track planes and share that information using radio signals even when there is no cellular data available. “ADS-B Out is a surveillance technology for tracking aircraft–it’s what [air traffic control (ATC)] needs to manage traffic. It reports your aircraft’s position, velocity and altitude once per second” [23].

Most of the FAA wayfinding guidelines concern signage and other physical wayfinding devices rather than protection of data, however, there is a section concerning use of technology. In terms of making travel more accessible, the guidelines state, “[the] flexible software of a modern [multi-user flight information display (MUFIDS)] and/or wayfinding signage controller system enables the user to display data to passengers with disabilities and to comply with any [Americans with Disabilities Act (ADA)] requirements” [18]. As far as a third-party application goes, the only guideline that seems to apply is to, “[establish] test beds to support full testing of any new software, firmware and hardware… to identify and eliminate problems causing system instability prior to installation” [18].

Problem Solving Approach

First, the team became familiar with the ACRP Design Competition guidelines. After obtaining a firm grasp of the competition, the team came to four potential topics for research (Figure 3). Each team member was assigned a minor research paper on one of the individual topics. As a result, each team member had greater background knowledge that could be shared with other team members to see if the idea was a viable topic.

With this knowledge obtained from individual research, the team conferred the different topics for possible project ideas. The four topics were narrowed down to wayfinding within the terminal. Within this topic, the team had to decide whether to focus on wayfinding for the everyday airport goer or wayfinding for users with additional needs. The team strongly considered the degree to which an everyday airport goer would need a wayfinding app, considering the existence of more general maps, signage, and airport websites that were already frequently utilized by these users.

Topic	**Idea**	**Why Idea Was/Was Not Pursued**
Airport Emergency and Active Shooter Events	An app that allowed users to send pictures or video clips of suspicious activity in airports to authorities.	The potential for users to distract from actual danger, which would ultimately make airports less safe, made the team decide against this idea.
Cybersecurity for General Aviation	To implement a better training program to educate staff on maintaining the safety of data stored in technological devices.	The difficulty of keeping up with the creation of new viruses and technology, created the necessity for any training program to be updated too frequently for the team to create something that would be effective in the long term.
Rubber Removal	To create a system that would make rubber removal from runways cheaper and more efficient.	Any proposed innovations would be more expensive than existing methods, which are functioning and non-problematic.
Wayfinding Within the Terminal	An app that would help users navigate airports more smoothly and without confusion	Team decided that a wayfinding app was a feasible idea that had the potential to be marketable.

Figure 3- Table explaining the different topics ideas explored, and why they were/were not pursued.

For this reason, the team decided to focus on users with additional needs, particularly the elderly, creating an app that made information concerning airport flights more readily available and would connect users with caretakers.

After discovering an airport application that was created for generic wayfinding within the terminal, flightSpeak [24], the team further emphasized that the wayfinding app they were creating was oriented toward users with additional needs, such as the elderly, children, and non-English speakers. flightSpeak was created for the average consumer [24], creating a distinct difference between the team's application design and goal and flightSpeak's application design and goal.

After clarifying the app's purpose and why it was unique, the team split into smaller groups, each with a specific task throughout the duration of the course. These teams were as follows: the Design Team, the Engineering and Graphics Team, the Risk Assessment Team, and the Strategies and Approach Team. The Design Team was given the responsibility of addressing the technical aspects of the app and how it would work. The Graphics Team was given the responsibility of taking pictures of the problem-solving process and creating graphics for other teams, primarily the Design Team. The Risk Assessment Team was given the responsibility of addressing risks associated with the app. Finally, the Strategies and Approach team was given the responsibility of documenting the team's problem solving approach and interactions with industry officials in creating the innovation design.

Figure 4- The team meets with Tony Shuba and asks questions about app design.

Throughout the course, meeting with industry experts to ask questions about application design and learn more about airport operations proved to be fruitful experiences. Tony Shuba, a software engineer from McFarland Johnson, was one such industry expert. The

team asked Shuba several questions about designing the app, such as issues concerning cost and revenue, the restrictions of using an app during flight, and protecting GPS data. Mr. Shuba also pointed out that the design of the application should accommodate the application's intended users and the importance of manual triggers to account for human error. The team, especially the Design Team, found the interaction with Mr. Shuba to be helpful in creating SimpliFlight. The team also made a visit to the Greater Binghamton Airport and met with Deputy Commissioner Mark Heefner. Mr. Heefner answered a number of the team's questions, and pointed out several matters that the team had not yet considered. Mr. Heefner pointed out the security concerns in making public the whereabouts and layout of secured locations like TSA areas and customs and border protection areas. Mr. Heefner also called attention to some of the more realistic concerns of the elderly in airports, such as the locations of bathrooms and wheelchairs, as opposed to what the team originally focused on, which were the locations of eateries and comfort stops.

Interactions with industry officials was invaluable to the design process and helped create a more thorough app construction. The app was decided based on the team's research and interaction with industry experts. Mr. Shuba gave critical information about implementing data from existing APIs and Mr. Heefner provided his expert opinion on what features (ex. tips section) could be helpful for the elderly in an airport. Ultimately, the Group Leader then took each group's completed tasks, and compiled them into a final paper for submission to the ACRP University Design Competition.

Figure 5- The team meets with Deputy Commissioner Mark Heefner and asks questions about airport operations.

Technical Aspects

a. Overview

SimpliFlight will serve three main purposes: sending notifications to the caregiver of the passenger's location, providing the passenger with flight information, assisting the passenger through the airport terminal via intra-airport navigation to reach his/her destination in an orderly fashion. When creating an app one must fully think about the app creation before developing the app, and look at all the resources available that will be necessary in the app. If the resource is not available, there may be a need to adjust development of the app to account for the resources that are unavailable. For the wayfinding app, there is going to be an assumption that the phone will be on and with Wi-Fi or cellular data available to send relevant information from the passenger to his/her caregiver. Once the passenger is on the airplane, however, they must switch off their Wi-Fi connection/cellular data due to the airline rules and regulations. Nonetheless, the information from the application will still be collected on the local phone itself. Thus, when the Wi-Fi connection/ cellular data connection is established again, the information will be sent to the caregiver then.

b. Pre-Existing Technology

There are many pre-existing technologies which SimpliFlight will be able to utilize. Technologies such as geolocation (which most smartphones are capable of), Google Indoor Maps, and the FlightAware APIs will be most used by SimpliFlight. Geolocation is key to the design of SimpliFlight, since the app needs to be able to locate position accurately in multiple airports. Using the geolocation hardware inside of current smartphones is better than other options explored, such as Radio Frequency Identification (RFID) scanning. RFID scanning uses a small chip with a certain frequency, that when the chip is read it will send a signal to the scanner telling them what chip was scanned. However, this technique has large issues such as implementation and overly

complicated UI for a large portion of the target demographic. Thus, pairing the geolocation with Google Maps will make it feasible to plan a path throughout nearly all airports, including gates, security, restrooms, and baggage claim. Information from flights is readily available through the application FlightAware [25], which would be linked to the database of SimpliFlight through their API. By using databases from applications such as FlightAware, SimpliFlight would be able to easily track changes in flight information and update the user promptly. By utilizing these various technologies, the implementation and creation of SimpliFlight would be facilitated greatly.

c. Data → Indoor Maps / API / GPS Coordinates

The success of the particular proposed wayfinding app is dependent heavily on the availability of accurate and extensive data. In order to send information from the passenger's mobile to the caregiver's mobile, the location data should be available for the passenger. This means that the passenger should have sufficient access to Wi-Fi to be located within an airport accurately. Thus, tracking the passenger inside a building may provide some problems. However, the wayfinding app will combine its location data with the data that the Google API provides to arrive at an accurate and precise location inside the airport terminal. The Google API provides maps for certain indoor buildings such as the Hartsfield-Jackson Atlanta International Airport and the San Francisco International Airport [26]. However, as of right now, only limited areas are covered under Google Indoor Maps. Certain airports that the passenger is travelling to may not be available at the time. Hence, in order to ensure the success of the SimpliFlight app, the app will need to connect to each of the different airports and have them get connected to the Google Maps API.

Uploading the indoor map onto the Google API is fairly easy to do. The programmer will upload the floor plan of the airport onto the Google Maps site, line the plan up with the satellite

images, and finally submit the map. When uploading the map, there will be spots where to drag and drop pins at specific places describing precisely what the location is. For example, a specific building may have a Starbucks inside, thus when dropping the pin inside that location, one could pin the Starbucks as a notable location. Each airport has a master plan which contains the floor plan for the airport which is easily available. Hence, the connection to be made between the indoor mapping and each specific airport is not difficult, making the data for the building available to the application. SimpliFlight will also exploit a benefit that Google API provides, a UI that allows one to put in their destination address. Google Maps will guide him/her to that specific location from his/her current location. This feature is also available for the indoor maps. Thus, the passenger will be able to use his/her current location and get to their destination (baggage claim, security check-in, gate, etc.). The feature will also show him/her where the nearest, for example, restrooms are. SimpliFlight will be able to give helpful tips based on the user's location within the terminal, such as taking your shoes off at security, and other tips non-frequent flyers would find useful (Figure 7F). Using Google Indoor Maps and the location service that the smart phones provide, SimpliFlight will be able to track the process of a passenger.

d. Creating App

To build a functioning application, the developer needs to deal with both the front and back end of the application [27]. The front end of the application is the UI portion of the app. This is the portion where the user of the app is directly able to interact with the screen. Each "click" on the screen will send a request to the server of the app which will call the back end of the application. The requests to the server are made each time the user interacts with the application. In order for the server to process the request, the server then calls the back-end part of the application which provides back to the server any necessary data as a response to the request made by the server. The

server then delivers this data back to the front end where the information gets displayed. In order to create the front and back end, and deal with the different data, various languages are needed for each of the different parts of the process. For example, in order to create an Android application, the back end language will be written in Java, whereas the front end will be written in XML based languages. These languages will differ when creating an application for a different operating system (OS) such as Android, iOS, and/or Windows. In order to write code, an integrated development environment (IDE) is very helpful. An IDE is a, "software suite that consolidates the basic tools developers need to write and test software [28]." Applications will most always require existing code that other developers have created. Developing any app from scratch is unnecessary and will consume large quantities of time. This is why software developers try to write code that is easy to reuse in any program. The reusable code is generally written as a library for other applications to use. All the developer needs to do is include these library files in his/her own code. In order to display the specific libraries in the application, an API is used. "An API is a set of commands, functions, protocols, and objects that programmers can use to create software or interact with an external system. It provides developers with standard commands for performing common operations so they do not have to write the code from scratch" [30]. Once the app is built, the application will need to be formatted into its respective file for distribution and installation by mobile phones. Then these files will go out on the store provided with the specific operating system. For example, Android uses an APK file, which will then be distributed to the Google Play Store.

e. App Process → What the App Is → Graphics

SimpliFlight is to be used by those who need some sort of extra assistance in airports, which isn't always readily available to them. The largest demographics that this app tries to connect with is the elderly, and those who do not speak any of the languages supported by a particular airport. Upon opening the application and signing in, the user is met with a language drop down bar, in which they can select the language that they wish the app to be in. After this menu, the user is presented with two options: passenger or caregiver. In the caregiver portion of the app, the caregiver is able to enter the passenger's flight number off their ticket which syncs them up with the flight information from the FlightAware API. After this, the app will go into a checklist (Figure 6F / Figure 6E), which is shared with the passenger.

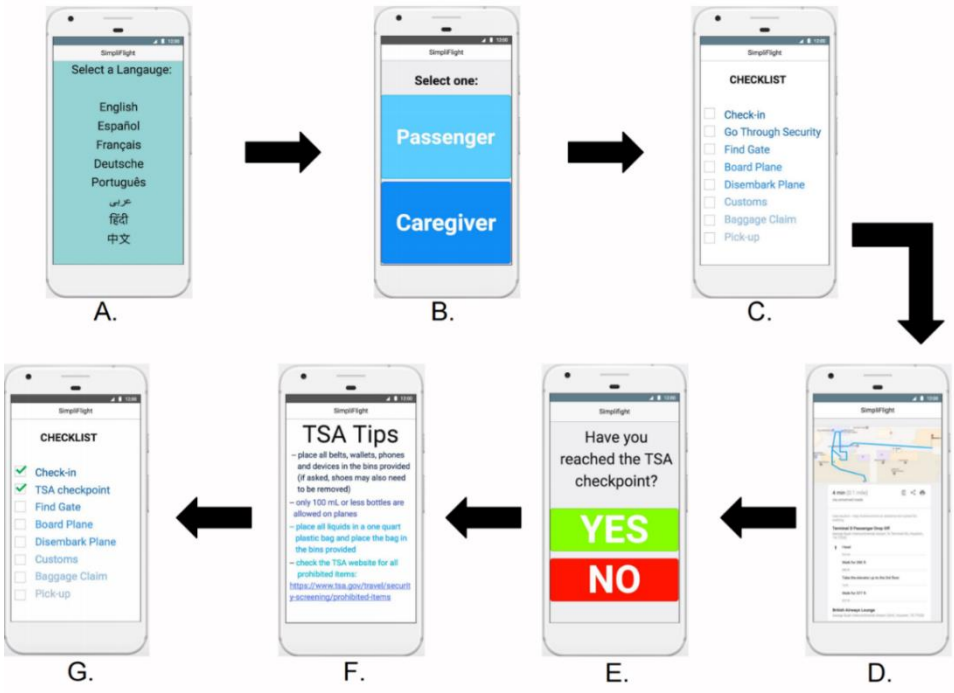

Figure 6: Passenger View- The application is intentionally simple for gaining acceptance by many of the elderly user who may not be comfortable with technology. Screen for A) selecting a language B) identifying passenger/caregiver and then log in (not shown) C) the checklist of airport checkpoints D) intra-airport navigation to next point on checklist. E) The user has been located at the TSA checkpoint, but as a redundancy check the user will be promoted to check whether they have truly reached their location. F) once the user's location is confirmed, tips for that location will appear on the screen to prepare the user. G) Progress is marked on checklist.

In passenger mode, the application will provide mapping from certain locations in the airports, such as security to a certain gate, or other important information such as the location of restrooms. After getting to certain key places in the airport, and most importantly on the plane, the passenger will be presented with a screen (Figure 6E) stating if they have made it to this point or not, and when they select the answer, a notification is sent to the caregiver. A reminding alarm will beep to prompt the user to check 'yes' or 'no'. This will allow the passenger to easily navigate the airport while also letting the caregiver know their location and status of well-being, creating a better flying experience for everyone involved in the process.

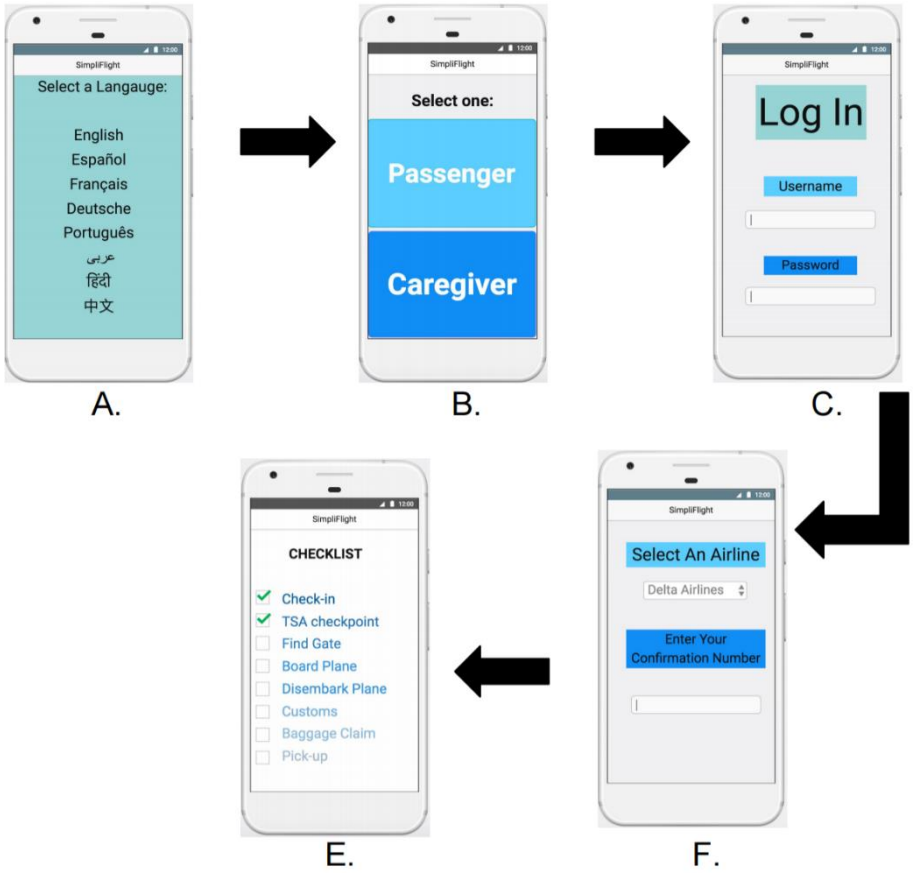

Figure 7: Caregiver view – Screen for A) selecting a language B) choosing whether you are the passenger or caregiver C) log-in D) enter flight information for passenger E) caregiver to see the passenger's live checklist. The caregiver will be notified whenever the passenger makes progress in the checklist.

f. Future

With time, more floor plans will be created and uploaded to Google Maps, and GPS tracking should become more fine-tuned. SimpliFlight will become better as these key components improve. In its initial stages, not all airports may be fully supported, and airports may change; thus, it is important to adapt a GIS based system using Google Maps. The implementation of SimpliFlight may be somewhat slow initially, but due to the ease in which the indoor mapping for Google Maps can be done when paired with the floor plans in the master plans that all airports are required to have, the app should grow quickly. Every application has flaws, and not all flaws are visible from an outsider's viewpoint, so as the app is used more, it allows for flaws and imperfections to be reported and fixed. There will also be newer versions released as time goes on, as is true in regards to all applications, allowing a better application to be created over time.

Safety and Risk Assessment

The FAA Safety Management Manual states that its mission is, "to provide the safest, most efficient aerospace system in the world", which can be achieved using the 5-step Safety Risk Management (SRM) approach. The SRM stages consist of describing the system, identifying hazards, analyzing the risks, assessing the risks, and treating the risks [31, 32].

When considering making an application, we need to make sure all user data are safe, especially since we are dealing with so many at-risk populations. While the FAA guidelines do not have any specific guidelines for data tracking or third party cellular applications, there are still steps that app developers need to take regarding the sharing of location data, which are outlined in the SRM.

Besides protecting user data, it is very important to make sure that the airports remain secure. For this reason, we would only be able to include a blue-line-type navigation system (Figure 7D) which is commonly used for Google Maps, and we could only use the less specific

blueprints that are readily available online to gather data for indoor mapping. It would be a breach of security to include photos of secure areas within the airport, and it is especially necessary to make sure our app does not include any behind-the-scenes type photos of the baggage transfer or anywhere not generally accessible to the public, including security and customs, in order to maintain a safe airport environment [33].

Another safety concern for the airports includes the user forgetting to turn off their mobile device during the flight and leaving the app running. Assuming they are on in-flight Wi-Fi, this would not pose an issue. If, however, the device was not on airplane mode or turned off and continued using cellular data for the duration of the flight to transmit location data, it would not be ideal, but the signal from one mobile device would not be powerful enough to pose an issue with transmittance for the aircraft [33].

Additionally, if the user does turn off their phone, they must remember to turn it on again or else the application will not be able to provide guidance, tips or notifications to the user and caregiver. Even though geolocation data can be collected even when the phone is not connected to a network, it must connect to a network later in order to send this information to the caregiver. Thus, if the phone remains in airplane mode, the caregiver will no longer receive immediate updates of the passenger's progress; ultimately defeating the purpose of the app.

Besides the airport safety that has been outlined above, it is also important to take user safety into account. Our app, SimpliFlight, does not pose many risks to the user in terms of getting them to the terminal and alerting loved ones that they got there, however, we still followed the SRM steps in order to ensure that we had outlined and addressed all potential user safety breaches.

Step 1: Describing the System

SimpliFlight is designed to be a mobile accessibility app for less able populations, such as the elderly and minors that has wayfinding properties within the airport. It also relays information such as reaching the correct terminal to loved ones who are not physically at the airport, but still want to make sure the user is safe and in the right place.

Step 2: Identifying Hazards

The main hazard our app poses is sharing of private location data with a third-party that consists of either the user, the caretaker or other intended recipient of the location, nor the secure app server. The other relevant hazard is airport and app liability for the whereabouts of the passenger in the case where the passenger uses the app and misses a flight or is brought to the incorrect location.

Step 3: Analyzing the Risks

In the case of sharing location data with an unintended recipient, the data may be used to stalk the user, inform a third-party company of general population or individual movement nationally and eventually internationally, rob the user, or steal his/her identity [34]. This is especially a concern with children, since they are a highly at-risk population for situations such as kidnapping.

The other risk, airport and app liability, would only be relevant in the situation that the user does not reach the correct gate or misses the flight due to some malfunction with the app. All airlines appear to have different policies concerning missed flights, however, there seems to be a general consensus that as long as the passenger has checked in on time, a later flight can be arranged as per the unofficial “flat tire rule”, which deals with all mechanical issues outside of the passenger’s control, however, it is entirely up to the airline and does not concern the airport [33,

35]. The air carrier is not legally required to grant the passenger a later flight, which may result in needing to pay for a new ticket. For example, JetBlue has a no-show policy where, as long as the passenger calls the airline to cancel the missed flight on the day of the flight, they can be scheduled for a flight to the same location later that same day with a change fee [36]. Additionally, American Airlines now has a late arrival standby policy where passengers who come to the airport up to two hours after the original flight departure time can get on the next available flight to their intended location with no additional fee, or get a confirmed seat on a later flight for a $75 fee [37]. With our app, the passenger would already be checked in and at the airport, so it would be likely that they would be able to talk to a representative of the airline and work out a later flight, perhaps with a small change fee, in the case that they miss a flight due to the app not getting the passenger to the correct gate on time [38].

Step 4: Assessing the Risks

Since all location data will be encrypted and a login with a password will be required for anyone wishing to track the user, the risk of hacking is low to medium based on the risk matrix provided by the FAA [29]. Before use of the application, risk of data leakage was assessed as similar to with the use of the application. An additional measure that can be taken would be to encrypt the password and username as well, which would lower the risk even further. Also, the data would not need to be stored for an extensive period of time after the user has made his/her trip, so the data would be even more secure since they would only be available for a brief period of time as necessary.

The risk of missing the flight would also be low to medium based on the same risk matrix since the user would already be in the airport and the indoor mapping would directly correspond to the blueprint layout of each airport, so the severity is minimal to minor and the likelihood is

Figure 8: Risk Matrix as provided by SMS manual through the FAA [29].

remote to probable [32]. Before use of the app, the liability of the airport was the same risk according to the risk matrix. The user would already be checked in to the flight, and if there was any confusion, the user could speak to an airline representative in the airport. Despite all this, in the case of a missed flight, the loved ones tracking the user would be able to tell that they did not make the flight and could call an airport representative to schedule a later flight or request a standby ticket, or the user could speak to a representative and have the same options.

Overall, risk associated with the use of this app is expected to be low to medium (X). Compared with the risk of data leakage and airport liability before use of the app, risk is not expected to change (Y).

Step 5: Treating the Risks

After talking to Mark Heefner, the team determoned that some of the steps that can be taken to make the location data more secure are full disclosure to the user about what the data are used for, requiring consent before collecting data, only retain location data for a set period of time, make the data, and protection of all data with reasonable security [33]. As Mr. Shuba informed our group, the most secure way to deal with location data is to encrypt it. That makes is possible for only the intended recipient to access the data and it is not easily accessible for any hackers or private companies.

In terms of making sure the user does not miss the flight, the app can continuously update the indoor mapping as airport layouts change. If the user misses the flight, loved ones who are not at the airport will be able to tell and can handle getting new tickets over the phone, which should not be difficult to arrange since the user is already at the airport and through security. Overall, the app would not reduce the odds of getting to a specific location as the existing signage and procedure are still in place.

Interaction with Airport Officials

a) Industry Official Tony Shuba Visits Binghamton University

Tony Shuba, a software developer at McFarland Johnson, visited the team at Binghamton University on February 21, 2017 to answer questions about software applications. His professional advice helped to resolve issues with the design and clarified the process of programming a mobile application like SimpliFlight.

Figure 9: The team and Tony Shuba met at Binghamton

After presenting an overview of the project's design and goals, Mr. Shuba answered the questions from the team. Mr. Shuba's advice helped to solve the two issues: updating the caregiver when the passenger's phone is on airplane mode and to ensure the passenger remembers to turn flight mode off after the flight. He explained that airports could upload their floor plans to SimpliFlight and then specific destinations, such as security check-in and gates, could be geotagged to track the passenger. Mr. Shuba also notified us of the importance in using security measures like encryption when tracking individuals such as minors through a mobile app. The team learned how a mobile application goes through the approval process for iPhones and

Androids, and the revenue source for distributing it. This information was valuable for the cost/benefit analysis.

b) The Team Visits the Greater Binghamton Airport

Figure 10: The team meets with Mark Heefner and visits the Greater Binghamton Airport

On March 9th, 2017, the team travelled to the Greater Binghamton Airport (BGM) and met with Mark Heefner the Deputy Commissioner of Aviation. He provided insight into how an airport runs and how SimpliFlight would impact airports, the team also took a tour of the airport to see potential areas that would be identified in the app, such as baggage claim and gates. After the team gave a presentation about the project, Mr. Heefner introduced BGM. It currently has service from three airlines with approximately 100,000 enplanements. Since BGM is small airport, additional needs passengers are more likely to get the additional assistance they need from the staff than from larger airports. SimpliFlight would be more valuable to major airports that tend to have less friendly customer service and more confusing layouts. Funding for the application can come from those major airports and organizations that represent a number of airports.

Mr. Heefner gave advice on which functions the application should focus on. Some common struggles he has observed in aging passengers were that signs are too confusing and there is a lack of accessibility to areas of rest. A component that can be added to SimpliFlight in the future is informing passengers the additional services in their airport. This will be helpful if the user is not technology savvy, and it will ensure that if they encounter a problem the app cannot solve an airport service could be there to help them. Another potential addition is to list airport

procedures, such as printing out their ticket, taking off shoes a security check and not taking liquids.

One of the risk factors that Mr. Heefner identified was the potential that the user will not turn off cellular data during the flight, which can cause signal interference. He also reported dangers in mapping the airport. The application should not indicate the locations of secure areas, such as security or customs and border offices, and the maps should be kept vague (limited pictures and no 3D satellite imaging). There also may be problems in receiving a signal inside the airport because it has thick walls.

Projected Impacts

a.FAA Goals

One of the priorities included in the FAA's Strategic Priorities is to, "deliver benefits through technology and infrastructure". SimpliFlight will be able to improve airport navigation for the users by creating more sound and efficient ways of wayfinding, and reducing confusion throughout airports. SimpliFlight will use a mixture of FlightAware, Airport GIS, and Google Indoor Maps libraries to help at risk passengers with wayfinding, while also being able to put their caregivers at ease. It will provide step by step instructions to make the navigation through the airport easier. This app will also send notifications to the caregiver with the information of where their loved ones are in real time. This will create less chaos, making it better for every party involved.

b. Commercial Potential

The SimpliFlight app gets its commercial potential from its simplicity. All the elements necessary in order to develop this app already exist. The application itself will need to access the Google Indoor Maps' library and the database used in FlightAware. The networks to connect the passenger's phone and the caregiver's phone would be delivered by the given cellular company

such as AT&T or Verizon. Finally, the software needed to produce the route given to the passenger, already exists, and will be given by the combination of using the Google Indoor Maps and the location services that each smartphone has access to. These routes may need to be updated due to changes in airports, or the airports may even need to be added onto the Google Indoor Maps' library.

Installing the application would be fairly simple. The caregiver, would simply download the application from any given application store, such as Google Play Store, on both the caregiver's phone and the passenger's phone. Then the caregiver would need to simply connect the phones by entering a confirmation number provided by the passenger's phone (Figure 7F).

In terms of use, SimpliFlight is be designed to be easy to navigate with a friendly UI. The home screen contains a menu for the specific languages so that user can easily understand what he or she must click to get to the right screen and follow the app as needed. Since this application is targeted towards the elderly demographic, all text/buttons are in large font and color coordinated on the screen to be easily readable. The map for the passenger would have an interface similar to Google Maps, a platform that many people are familiar with. Also, this application requires very little maintenance over time. The only updates that would be necessary would be to include changes in the airports or the inclusion of more airports in the Google Indoor Maps library.

SimpliFlight allows caregivers to become less concerned about their loved ones when they are travelling by air. As a result, the application is geared towards families with elderly travelers or children who are travelling alone. The application will work the same way for the caregiver and the passenger who is a child or anyone else who needs additional assistance in airports.

c. Financial Analysis

Item	**Description**	**Quantity**	**Cost**
Smartphone	Needed as platform for application use	2 per User Unit	$300
Data & SMS Charges	To send text messages, the smartphones will need to be connected some network providing company.	1 per Smartphone	$90/mo. - AT&T $80/mo. - Verizon
FlightAware API	This allows the application to access each of the Flight's status and data.	1 per Application	$0.0079-$0.0013/each/mo. (multiplied by the number of usage) [2]
Application Store Registration Fee	This is a onetime fee for the developers to release their application out in the public store for installation and use.	1 time fee to register on the specific store	$25 - Google Play Store $99/yr. - iOS App Store
App Developer Team	This team will create the app for Android, iOS to other stores, and release it to the public market.	1 per Application	Around $159/hr [7]

Figure 11 - Cost Analysis for SimpliFlight.

Year	Projected # of Users [51]	FlightAware Data/yr. [52]	Maintain and Update App [53]	CPM (Cost/1000 impressions) [54]	Income from Ads/use [55]	Total Income from Ads	Net Income
2017	1,000	$1,638.12	$152,640	$4.68	$0.13	$130	-$154,152.80
2018	50,000	$1,638.12	$30,528	$234	$0.14	$7,000	-$25,400.12
2019	150,000	$1,638.12	$30,528	$702	$0.16	$24,000	-$8,868.12
2020	250,000	$1,638.12	$30,528	$1,170	$0.17	$42,500	$9,163.88
2021	500,000	$1,638.12	$30,528	$2,340	$0.18	$90,000	$55,493.88
2022	700,000	$1,638.12	$30,528	$3,276	$0.19	$133,000	$97,557.88
2023	1,000,000	$1,638.12	$30,528	$4,680	$0.21	$210,000	$173,153.88
2024	2,000,000	$1,638.12	$30,528	$9,360	$0.22	$440,000	$398,473.88
2025	3,000,000	$1,638.12	$30,528	$14,040	$0.24	$720,000	$673,793.88
2026	4,000,000	$1,638.12	$30,528	$18,720	$0.25	$1,000,000	$949,113.88
2027	5,000,000	$1,638.12	$30,528	$23,400	$0.27	$1,350,000	$1,294,433.88

Figure 12: Projected Costs and Income

SimpliFlight is very cost effective as seen from the data in Figure 11. The largest cost of the app would be using the FlightAware API, as it is priced on a per use basis. There would be other costs, such as servers and maintenance for the application, but as FlightAware would not be something owned or created by us, we would be subjected to the prices they charge. For the families, the cost would only be the cost of the smartphone and the data charges that come along with it. Other than that, all the charges would be the cost for the application developers. Once the application is out on the store, the only charges would include using the FlightAware's API. Currently to install and use the application, the user would not be charged. However, if the FAA or the airports decide, there could be a monetary charge to get income and/or compensate for the charges it took to create the application itself.

The cost to use the FlightAware data is found by assuming that SimpliFlight makes 2 queries to the data set every 5 minutes. Since the SimpliFlight app itself is accessing the FlightAware data and not each individual user, as the number of users increases, there will be no change in cost. To build the application itself, it takes around 4 to 6 months [56]. Thus, if the app developer team works an average of 40 hours per week for $159/hr, it will take $152,640 to make the application. Then, to maintain and update the app after its original release, it takes around 20% of the original money invested; hence, it will take around $30,528 every year to update the app [53]. Finally, if the FAA decides to make profit from this app, then they could incorporate advertisements in the application. To display advertisements, it takes approximately $4.68 per thousand users who see the advertisement [54]. Initially, there will be a significant amount of debt from the application; however, over time there will be a huge income from the application as seen by Figure 12.

Summary and Conclusion

SimpliFlight will help move the FAA towards its goal to, “deliver aviation access through innovation” by 2025. Making airport use easier and more accessible, SimpliFlight opens aviation and consumer flight to those whom travel may have previously been a concern for. By simplifying the airport procedure through the use of the app, daily passenger travel may increase for those who may have previously been considered too young or old to fly alone, as well as people who are not familiar with the local language.

SimpliFlight is meant to be easy to use for both passengers and caretakers. The app’s straightforward layout, displayed directions and location confirmation makes it easy enough for people with little or no prior experience using smartphones, especially the elderly, to travel safely and successfully through an airport. While remaining simple, the app does not lack the features necessary to ensure that both the passenger and the caretaker are eased and comforted as they or their loved one is going through the airport and eventually boarding the plane.

As navigation technology improves, SimpliFlight will be able to provide more precise locations within airports. Also, as the app and indoor navigation expands and becomes more popular, a larger number of airports will support the full use of this technology. Additionally, agreements with airports and airlines could allow the caretaker to be notified as the passenger’s boarding pass is scanned while boarding the plane. In many ways, SimpliFlight can enhance the travel experience for millions of people around the world.

Appendix A. List of Complete Contact Information

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Appendix B. Description of Binghamton University

Binghamton University, pictured in Figure 13, is a New York State public institution located in Vestal, New York [39]. It is ranked as the 86th best university in the United States according US World and News [39] and is also named one of the 610 smartest universities in the United States [40]. Binghamton University also boasts a respectable rating from Forbes, having been ranked as the 15th best value for university tuition in 2017. Forbes has also ranked Binghamton University as the 43rd best public college in the nation and 81st best university in research [40].

Figure 13- Binghamton University [41]

Binghamton University was founded in 1946 for the education of veterans returning home from World War II. It began as a branch of Syracuse University in Endicott, but in 1950 it became an independent, official State University of New York. In 1961, the institution, which had been renamed Harpur College, moved to its current location in Vestal, New York. In 1965, the university was formally named the State University of New York at Binghamton, but is now more commonly referred to as Binghamton University [43]. Binghamton University now has 16,695 students in its student body and is currently comprised of seven different schools: Harpur College of Arts and Sciences, the College of Community and Public Affairs, the Decker School of Nursing, the Graduate School of Education, the School of Management, the Thomas J. Watson School of Engineering and Applied Science, and the School of Pharmacy and Pharmaceutical Sciences [39].

The setting of the campus includes a 190-acre nature preserve that is used for both recreational and academic purposes, such as hiking and ecological research [39]. Binghamton has plenty of other opportunities for students as well, including a Scholars Program, NCAA Division

I varsity teams, and hundreds of clubs to choose from. The rewarding college experiences provided by these opportunities have led Binghamton to have an exceptional freshman retention rate of 91.7%, a testament to university's quality of campus life [39].

Appendix C. Description of Non-University Partners

a) Greater Binghamton Airport, Johnson City, New York

The Greater Binghamton airport (BGM) is 8 miles north of Binghamton, NY. The airport is owned by Broome County and operated by the Department of Aviation [43]. BGM has only one airline, Delta, that offers direct flights to Detroit daily. American Airlines used to run flights from BGM in 2016 but all flights through that airline ceased on February 16, 2017 [44]. In a 12 month period, ending November of 2015, BGM performed a total of 16,144 flights [41]. It provided 2,325 scheduled flights in the year 2016 [46]. After serving as Deputy Commissioner since 2006, David Hickling is now the Commissioner of Aviation as of January 2015. The current Deputy Commissioner as of May 2015 is Mark Heefner [43].

b) McFarland Johnson, Inc.

McFarland Johnson (MJ) is a consulting firm that deals with multiple disciplines such as, "transportation, site/civil, structural, mechanical, electrical, plumbing, fire protection, and sustainable design services, as well as planning, environmental, hydraulic/hydrologic and construction inspection/administration" [48]. MJ was founded in 1946 with the intent of creating a company that focused on its employees and clients. The firm is completely employee owned and aims to create a rewarding environment that promotes creativity and commitment [49]. MJ also consults with aviation facilities across the east coast completing and planning "environmental, engineering, and construction administration projects". MJ has worked with the Greater Binghamton Airport on the "Greater Binghamton Airport Master Plan & GIS Infrastructure / Drainage Plan" [49].

Tony Shuba is an employee at MJ, he visited our team to clarify any questions we had about the process of programming an application. He previously worked as a senior software

engineer at multiple companies. Shuba specializes in computer software applications and has experience working with airports through Miller Aviation Corporation. [50]

Appendix E: Student Evaluation

1. **Did the Airport Cooperative Research Program (ACRP) University Design Competition for Addressing Airports Needs provide a meaningful learning experience for you? Why or why not?**

The ACRP University Design Competition provided a meaningful learning experience for us as it allowed us to come up with our own solutions to airport related problems in a team setting. The competition really opened our eyes to the process of teamwork and interpersonal communication. We saw that working with a ten-member team can be a difficult and new task for some people. The competition was great exposure to such an environment. The collaboration was not only beneficial in the sense that we learned teamwork skills. Many of us did not know each other beforehand, and working together for months on a common goal resulted in the creation of strong acquaintanceships and friendships.

Along with the teamwork aspect of the project, we gained knowledge of the process of an airport. It was very interesting to learn what goes on in an airport and general information about airports, airplanes, and the flying process in general, as many of us, if not all, had flown on an airplane before but did not have much knowledge regarding airplanes, airports, and its needs. This expansion of knowledge in this field has even resulted in a few team members' desire to look into a major change or future career change into the field of airports and flying.

2. **What challenges did you and/or your team encounter in undertaking the competition? How did you overcome them?**

Our team had some challenges with the technical aspects of the project since we did not have a strong background in either aviation or computer science. We overcame this by speaking to industry experts, like Tony Shuba, and by performing an extensive literature review. We also

had one team member who is a computer science major, so we frequently communicated in order to develop a better understanding of what we were creating.

At the beginning of our project, we also faced the challenge of making sure our idea was both novel and feasible. We did a lot of research on existing programs to make sure our idea was original, and we also talked to industry experts about the feasibility of creating the proposed app, as well as if it could overcome airport restrictions. We made sure the technology we wanted to use was available by researching Google and indoor mapping, which is a very new technology.

3. **Describe the process you or your team used for developing your hypothesis.**

In order to develop our hypothesis we began by looking at the ACRP website and picking topics based on the numerous issues people face day-to-day in the airport. We brainstormed what was most interesting to us and then narrowed down our ideas as a group before voting on the top two most viable projects. We conducted research to make sure we were filling gaps in existing knowledge and then voted again which resulted in the idea of SimpliFlight. We then continued by reading past papers and researching how to develop an app to make sure our idea would work within the project guidelines. We then designated members to make more specific design ideas and to analyze the risks and overall impact of the proposal.

4. **Was participation by industry in the project appropriate, meaningful and useful? Why or why not?**

Having the expertise of industry officials was very helpful especially in cases where we lacked experience and knowledge. Although we did not require as much industry feedback as previous projects, we still had a lot of specific questions that were best answered by industry

experts. Tony Shuba helped us understand the process of making an app and sharing data, as well as other technical aspects necessary for formatting the app. Mark Heefner helped us recognize where our app would be most useful and which aspects to build off of for future directions, and also how to involve Google indoor mapping in an airport environment. They both were catalysts in our research process.

5. **What did you learn? Did this project help you with skills and knowledge you need to be successful for entry in the workforce or to pursue further study? Why or why not?**

Overall, we felt that this project provided us with the opportunity to develop our own original idea from scratch. We worked as a team to make sure the project was not overwhelming, and we also had the guidance of experienced professors. Teamwork is a skill that can be applied to future projects not only in school but also in the workforce in the future, so it is extremely helpful to begin learning these skills now. It also prepared us to learn leadership skills and network with industry experts, especially for those of us who are going into computer science. This competition allows students to produce and carry out their own original work based on their own ideas.

This project also helped us learn more about both airports and applications, but most importantly, it helped improve our multitasking, organization, and communication skills, which are very necessary in the workforce. We learned how to delegate tasks and how to enforce and meet deadlines, as well as how to work with each other and create professional drafts.

Faculty Response

1. **Describe the value of educational experience for your student(s) participating in this competition submission.**

The ACRP University Design competition provides a unique opportunity for our students to work in a group-setting to help identify solutions to real world problems within the aviation industry. This type of experiential learning is an increasingly important aspect of the educational experience for students as they transition from school to the workplace, and this type of opportunity is not typically incorporated in the curriculum for most freshman and sophomore students. Through this program, our students have started from scratch, with very little previous aviation knowledge, and have worked to identify a problem, research the problem, and develop a proposed solution to the problem. Through the development of the solution, the students have had to not only identify how to rectify the problem, but also assess cost considerations for development, as well as any risks that may occur because of implementation. Through their work, the students have completed research to solve a problem that could have wide ranging utilization for passengers at airports across the United States.

2. **Was the learning experience appropriate to the course level or context in which this competition was undertaken?**

Yes. All of the students on the team are undergraduates, with nine in the second semester of their freshman year. The tenth student is a sophomore. Many of these students have had limited opportunities to work in a team setting, as many introductory courses available to freshman have a much higher enrollment. The ACRP University Design Competition was utilized to bring this small group of students together to work in teams. This effort encouraged and required increased

communication and cooperation to ensure documents are submitted that meet the requirements of the course. Further, as these students were enrolled in a spring semester course, the ability to meet timelines was crucial. These ensured that not only were the teams working cooperatively, but that they were properly managing their time to ensure all deadlines were met or exceeded. These are key elements to the learning experience that will be useful for these students as they proceed with their education and move into professional fields.

3. What challenges did the students face and overcome?

There were numerous challenges for students to overcome as they completed their proposal. Most students within the course had limited to no knowledge of the aviation industry, which required additional research to ensure comprehension of key topics associated with the proposal. In addition, of the ten students participating, nine students are in the second semester of their freshman year, with the tenth student in their sophomore year. This type of research is not typical for students at the beginning of their college careers and included topics and requirements that may not have been covered in many of their previous courses. The ACRP University Design competition also maintains a strict deadline that required the project leader to ensure that the schedule for submissions that was set was adhered to by all members of the team. The team leader frequently checked-in with team members and set up portals for team members to share work efficiently. This enabled the leader to review work with each of the teams, as well as ensure that the development of all components of the proposal was cohesive. In addition to the deadlines, the students also had to work within the University Calendar, including two breaks prior to the submission date as well as winter weather that led to university closures. The students worked

effectively with these hurdles and ensured submissions were made, as necessary to keep the project moving forward, in advance or during these breaks.

4. **Would you use this competition as an educational vehicle in the future? Why or why not?**

Absolutely. The format and structure of this competition is ideal for utilization in this course at Binghamton University and has been utilized for several years. This project allows students to not only work on an academic exercise, but to work on an exercise that has real world applications that will be valuable to the students as they move into the workforce.

5. **Are there changes to the competition that you would suggest for future years?**

The ACRP and FAA have ensured for years that the suggested research topics (or focus areas) have remained relevant and we recommend that this practice continue. The aviation industry continues to evolve with new hot topic items available each year. In the 2016-2017 competition, the research topics included emerging issues including virtual/remote towers and effective uses of social media. It is important that the University Design Competition includes new, relevant, and interesting topics each year to prevent overlap of research submissions, and to enable students to contribute to providing solutions to modern day problems.

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