OPTIMIZING PEDESTRIAN FLOW IN AIRPORTS

by

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ABSTRACT

Denver International Airport has expressed interest in discovering innovative techniques to optimize pedestrian flow in its massive airport which contains upwards of 53 million passengers each year that travel through the airport. The goal of this project is to provide DIA with an application that allows a user inputted flowchart to be adjusted and have the airport processes from the flowchart be modeled visually for increasing efficiency of pedestrian flow. Adobe Animate will be employed for creating the visual model and Adobe ActionScript 3.0 is the programming language that will be utilized for writing the interactivity of the application. Several factors can be adjusted to show the processes affecting the overall operation of the airport. This simulation will present various scenarios of pedestrian flow in the airport.
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CHAPTER 1

INTRODUCTION

For this masters thesis we are going to use pedestrian traffic at the Denver International Airport as a basis to prove the viability of overcoming the challenges in the thesis. The hypothesis of this thesis is that even though there are challenges interacting Flash with third party documents if Flash can read ActionScript 3.0 (AS3) then we can use Flash to interact with third party documents and create third party controlled graphics on Flash using AS3.

1.1 ARTICULATING FLASH

Adobe Flash Professional is software that allows the creation of interactive content, animations, and applications for desktop, web, and mobile devices. Web designers employ Flash for creating animated and interactive content. Developers use this application for writing ActionScript, debugging, testing, and building applications. Animators utilize Flash for character and object animation, visual effects, and creating environments.

The history of Flash begins with its creator Jonathan Gay. He grew up with an interest in architecture and when he was a teenager he realized he did not have opportunities to construct the houses he designed. After beginning to program using his Apple II computer, he discovered that with computer software you can design something, build it, and see it work and respond to you. [1] Using Apple II Basic, he wrote his first game which was a clone of Space Invaders. Shortly after he changed to
Pascal from Basic and wrote his first graphics editor. He entered this application in the science fair at his high school which did very well. He later received a Macintosh and was taken by his dad to a Macintosh Users Group. Here his dad boasted to Charlie Jackson, the group organizer, about his son’s programming skills. Jackson sought to initiate a Macintosh software business, did not have abundant funds to pay programmers, and owned a $10,000 Lisa computer. Jonathan wanted to use a Lisa computer and since he was a high school student he did not require a paycheck until later when the applications began selling. Jackson called the Macintosh software business Silicon Beach Software.

Jonathan started working by writing games. He initially made Airborne! and then his second game, Dark Castle, which was a great success paid for him to complete college. A significant part of his computer education came from writing games since he gained knowledge about digitized sound, animation, and syncing the two. He most importantly learned software that is quick and responsive is enjoyable to use. He later went back to making graphics editors in which he added to the Macintosh product, SuperPaint II, PostScript style drawing. After graduating college, he designed an upgraded drawing program for Aldus called Intellidraw. He decided to start his own company when he realized Intellidraw was designed for moderate success.

During that time, pen computing was a popular new concept within personal computing. Pen computing allowed one to use an electronic pen for writing on the screen instead of a keyboard. Since an operating system was being built by a company named Go for pen computing, Jonathan was able to convince Jackson to devote some
money and they began FutureWave Software to lead the market for pen computer graphics software. He discovered after his work on Intellidraw that learning complex features was difficult for users. He also learned it was more awkward and slower drawing on the computer than drawing with a pencil on paper. He envisaged the improvement of using a pen to draw on the computer screen and therefore pursued building the software, SmartSketch, to make drawing on a computer screen more intuitive than one drawing on paper.

Jonathan and Robert Tatsumi wrote the code for this software at their homes. During this time, Go was purchased by AT&T. In January 1994, their product was about to ship but AT&T stopped Go and left them without a market. They saw making their software compatible on Macintosh and Windows as their only opportunity. After completing this, they now had the competition of FreeHand and Illustrator. During 1995 at SIGGRAPH, turning SmartSketch into animation software was the feedback they received from conference attendees. They began to learn about the Web and the Internet which seemed plausible to them that people would be interested in sending animation and graphics over the Internet due to it becoming popular enough. This caused them to include animation in SmartSketch. During this time, Java was the only way a Web browser could be extended to play animation. Using Java, they wrote a plain animation player which was unpleasantly slow. In the fall, the Web browser could be extended with decent performance since Netscape’s plug-in API came out.

To put more focus on the animation capabilities, FutureSplash Animator became the new name of the software due to their approaching shipping time. Not having
considerable funds to spend caused exhaustion of running the business which started them attempting to sell their technology. Following an ineffective pitch to Adobe and refusing an offer from Fractal Design, FutureSplash Animator was shipped in May 1996. In August 1996, they gained large success in which Microsoft was developing MSN and they wanted to make the greatest TV-like Internet experience. Having become enthusiasmists of FutureSplash, Microsoft adopted the technology. Disney Online was their other prominent client who used their software to create the user interface and animation for Disney Daily Blast. Since Disney was collaborating with Macromedia Shockwave, Macromedia was aware enough about FutureSplash and in November 1996 they approached them about working together.

After four years of running FutureWave with a $500,000 total investment, it appeared to be a good idea to have the resources from a larger company help FutureSplash get established. In December 1996, Macromedia bought FutureWave Software and FutureSplash Animator developed into Macromedia Flash 1.0. Flash 5 was released in 2000 with added support for ActionScript. ActionScript provided Flash developers the ability to write and make more sophisticated interactions and interfaces. In 2005, Macromedia was purchased by Adobe and Flash joined the Adobe’s Creative Suite.

Flash Professional works by allowing the use of its workspace and Timeline to make tweened animations. Tweening is the process of creating intermediate frames which are put between two images for making it appear that the initial image changes to the second image. Flash also allows one to have motion presets applied to selections
that are on the stage. Motion presets are pre-made animations that can be applied to an instance and can be used for further modification. The software as well lets users animate instances using ActionScript code.

CHAPTER 2

PEDESTRIAN FLOW MANAGEMENT

As the United States’ fifth busiest airport with an average of 146,500 passengers traveling daily through it, managing pedestrian flow becomes a challenging task for Denver International Airport. DIA recently announced that nearly 58.3 million passengers passed through the airport in 2016 – a major milestone in Denver’s aviation history that shatters the previous all-time passenger traffic record by more than four million passengers. [2] With passengers required to go through check-in, luggage check-in, security, finding their gate, and boarding the aircraft, several issues arise that affect pedestrian flow. This growth is motivated by strong demand for travel to and from Denver, large increases in airline capacity and DIA’s effort to secure new airlines and destinations around the world. [2] Increasing airline capacity refers to the available seat capacity which can be expanded by acquiring additional carriers. The subsequent sections discuss areas pedestrian flow becomes problematic and techniques for resolving it.

2.1 SECURITY SCREENING LINES

Increased pedestrian traffic can occur at security checkpoints. Particularly, there are regular 60-90 minute wait times for passengers flying from DIA during peak periods.
The process of security screening involves passengers walking through metal detectors, pat-down procedures, inspecting baggage, and having all items from passengers be screened through an X-ray belt. The Transportation Security Administration mentions the layout of DIA which has a lack of screening lanes as the source of the problem. Projected volume would require 37 security screening lanes but the (DIA) layout is physically limited to only 30 screening lanes with capacity for approximately 55,000 (departing) passengers per day. [3] Other issues involve needing additional employees to help with nonsecurity tasks which are guiding passengers through the lines, answering questions, and moving bins.

2.2 TICKET COUNTERS

Ticket counters are areas where high pedestrian density can occur. Flight delays and cancelations can lead passengers to rebook their flights which are part of the reason for long lines to form. Weather impacts scheduled flights becoming canceled. If most of a specified carrier’s crew is held in the city of the affected airport, weather will greatly influence the amount of flights that can be completed. Since airlines do not have to supply food and rooms when there are weather-related delays, some passengers who cannot pay for another flight only have the option to stay in the airport. Having insufficient workers at the ticket counters will impede pedestrian flow as well. Other factors are stranded crews located in different cities and the flight time limits of crews have been met.
2.3 RESOLUTION TECHNIQUES

To help remedy long security lines, all the available screening lanes can be opened, staff can be added through overtime, staffing shortages are accommodated, and nonsecurity related functions can be managed by other personnel. Also, lines are able to move faster when preparation is done by passengers in which carry-on bags have been removed of liquids and laptops and passengers’ boarding passes are ready to be shown.

2.4 RESEARCH TECHNIQUES

In Hoogendoorn’s scholarly paper he presents the discovery that the trajectories show the volume of the bottleneck is determined on the pedestrian’s behavior. This narrow bottleneck case demonstrates that the pedestrian flow within the bottleneck becomes effectively separated into two lanes. These lanes appear to be ‘zipped’: pedestrian effectively follow the pedestrian straight ahead at a median time-headway of approximately 1.22 seconds, while paying little attention to the pedestrian diagonally in front (although the latter is nearer in terms of distance). [4] It also mentioned the pedestrians’ adaptive behavior during congestion from the narrow bottleneck case. They found the pedestrians’ needed amount of space depends on the pedestrians’ speed. Pedestrians occupy a considerable amount of space based on their speed when they are distant from the bottleneck. Pedestrians do ponder obtaining personal benefits by standing nearby the other pedestrians within their direct proximity. When approaching
the bottleneck, the speed remains approximately the same but the density (and thus the required space) increases: when pedestrians approach the bottleneck, they will start ‘pushing’ in order to increase their personal benefit. [4] Wenbo Ma’s study presented that passengers normally spend amply more time utilizing discretionary facilities. Discretionary facilities are relaxation facilities, technological self-service kiosks, information kiosks, currency service, communication service, dietary places and shopping places. [5] One can conclude that managing pedestrian flow in discretionary facilities would be a targeted area for developing efficiency. Another method they gave was the possibility that certain service facilities are chosen by passengers rather than comparing to standard passenger flow models that have the probabilities pre-assigned. Lin’s paper offered that when two opposite streams come together, narrow paths can initially be formed. As time flows, pedestrian streams will become wider in order to reduce “friction” from the opposite direction which will get people on the same side to move faster and more fluently. [6] A pedestrian that is unaware of the terminal environment and unsure about selecting routes will be unable to keep confidence in his judgement and perception. He will take the mass’s judgment and perception as his grounds. For the sake of increasing accuracy, people have the preference to be by other people. Congestion is often caused at the exit because of this accordance. Helbing’s study gave that pedestrians prefer to walk with an individual desired speed, which corresponds to the most comfortable, i.e., least energy-consuming walking speed provide that going faster in unnecessary in order to reach the destination in time. [7] Airports implementing moving walkways allows
pedestrians a means of reaching their destination in a way offering lowered energy consumption. Pedestrians may be impeded by others who block them from passing. However, the moving walkways at Denver International Airport have two lanes which notably helps solve this issue.

2.5 PERSONAL METHODS

My approach to optimizing pedestrian flow was implementing simulation software in which airport employees could have a visual representation of how adjusting airport operations would affect pedestrian flow and could manage this more efficiently. To offer a realistic simulation the Denver airport layout was created according to scale based on one of their documents. The application allows the user to read in a .csv file which contains the names of the airport processes and their operational status. The user can set a process to inactive which would change how the pedestrian flow interacts with that process.
REFERENCES


