Personalized Wayfinding System for Airport Navigation

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ABSTRACT

The objective of this thesis is to study people's navigation flow throughout architectural spaces and to provide a further observation of how user's notions and senses tend to guide their spontaneous movement within a space. This study explores the use of "smart", self-personalized digital signage and wayfinding system using existing technologies (AGPS, RFID, Face Detection, QR codes, and Augmented Reality) to locate and navigate users through space to their intended destination without the interference of other misleading information. Specifically, the implementation focuses on assisting in travelers' navigation to their required destination in international airports.

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DEDICATION

To my mother and father.

1. INTRODUCTION

Within the field of signage and wayfinding, we have reached a turning point in design where there is a need to shift from basic signage applications that are failing to serve the complexity of today's architectural spaces, to a more targeted digital signage solution that can provide clearer navigation through wayfinding systems better suited to the complexity of these environments. The role of people as users of built spaces will be shifting from the current passive form into interactive systems influenced by concurrent technological ecologies. Signs alone are not sufficient to guide wayfinding behavior in complex environments; the architectural internal layout and its set focal points play a major role in the wayfinding mission as well. I am proposing to deviate the signage and wayfinding system from its current passive form, embedded in the architectural body itself, into an interactive one that is handheld by users.

How can navigation within an environment be lead by the architectural space itself without any addition of further solid elements into that space? How could users be lead to their destination with minimal distracting information encountered? How could I propose a more precise wayfinding system within complex environments? How could digital signage operate only when needed? Could this system become a "smart" self-learner that would deduce its further functions from previous usage sequences? How could the relation between users and signage shift from passive and static signage to interactive, user-based systems? How could a digital wayfinding system provide more than directional guidance in terms of linking the user to the space's facilities and services and beyond the built space to the city?

This paper addresses how wayfinding systems can potentially adapt to users' navigation needs to guide them easily to their intended destination within public spaces like transportation hubs generally and within international airports specifically. While the air transport industry has continuous workflow based on mobility through the complex and dynamic model, there is a remarkable gap, with many processes on the ground being static, paper-based, and not as efficient as they could be (SITA, 2011).[1] My extended exposure to the field of signage and wayfinding, as both a user and a designer, has given me a clear understanding of the inadequacy of static signs to fully address users' needs in complex architectural spaces. Designing signage and wayfinding systems for large scale projects such as office buildings, hospitals, campuses, city developments, and airports has lead me to realize that fixed signage elements can only carry primary, general information and have to omit secondary, detailed messages. It is impossible to communicate all relevant informative and directional material when implementing fixed wayfinding elements in built environments. Reliance on fixed wayfinding elements has allowed wayfinding problems to proliferate as noted by Paul Arthur and Romedi Pasini: "Wayfinding problems are real; they are neither imaginary nor the result of willful stupidity on the part of the public, as is so often alleged" (Arthur & Passini, 1992). This paper

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[1] SITA is the leading specialist in air transport communications and IT solutions

addresses how wayfinding systems can potentially adapt to users' navigation needs to guide them easily to their intended destination within public spaces like transportation hubs generally and within international airports specifically.

2. PROJECT GOAL

‘Traveler Wayfinder’ is a proposed design project that aims to facilitate a more efficient environment for travelers within airport spaces through the use of a personalized wayfinding system. By customizing and assembling existing technologies, ‘Traveler Wayfinder’ will allow travelers to experience personalized navigation within airport spaces by offering a simplified digital signage and wayfinding system.

In a time when airports have become stressful environments due to constant surveillance, users’ tension increases especially when they are viewed as “automated bodies in a controlled state” rather than independent users of a transport station (Orvar Lofgren, 1999, p. 17). This tension creates difficulties for travelers in analyzing and interacting with the space around them; they often depend on assistance from other individuals around them to get answers for their inquiries. ‘Traveler Wayfinder’ will enhance communication between users and the environment, which in this case are the traveler and the airport. When stress and tension rate decrease among travelers, then airports will not be conceived as tense environments anymore.

3. OBJECTIVE

This research investigates users' navigational behaviors in built spaces and aims to enhance wayfinding experiences in public spaces by offering users control over personalized. This study defines a set of objectives to which this design project responds. These objectives respond to issues encountered by travelers through their journeys in airports including: personalized user experience, simplified airport navigation, efficient time management, and multilingual communication.

The primary objective is to create a personalized travel experience throughout the airport terminal space. During travel, passengers are exposed to vast amounts of information through flyers, forms, announcements, screens, and signs. This information includes all the possible instructions relevant to all different kinds of passengers passing through a specific point in the airport. Travelers, therefore, are required to filter this information to extract the relevant fraction of information that addresses their immediate needs. This project aims to address each user individually to communicate the relevant, requested information at each stage of the navigational journey through the use of a digital wayfinding system. While each traveler has different needs at different points in a travel journey, this system offers a new layer of personal experience that, while not replacing traditional signage elements, explores a new understanding of spatial interaction.

Another intent of this project is to offer simplified airport navigation so that travelers will have access to the information they require at all times of their journey. As such, individual travelers will have the choice of revealing customized information only when requested. Instead of searching for directional signage within the space, travelers will be guided throughout their journeys to their intended destinations. Beyond directional guidance, this project attempts to also provide travelers with needed information regarding the services and facilities of the airport.

Travelers' time efficiency is another targeted objective of this project. Changes of gates, delays in departure times, flight cancelations, and other alterations are common inconveniences that happen on a daily basis at airports, interfering with travelers' plans and time efficiency. If travelers could access a customized navigation plan identifying important times, alerts, and notifications during their travel journey, then they could avoid arriving too late or too early at certain destination points. Their efficiency could also be improved if they were reminded of gate opening times, boarding times, walking distances to required gates, waiting times at certain line ups, and countdowns for these times.

To overcome language barriers between travelers and the airport space, this project will attempt adaptations to a range of languages, customized to every traveler's need. In this way, communication in airports will become possible for all travelers, whether they are or are not familiar with the local city's language.

Finally, when objectives of personalization, simplicity, efficiency, and language diversity are achieved, this project's future targets will address the connection between the traveler and the city. Once travelers are assisted in navigation through the airport, they will also be guided to connect with friends, family, or colleagues at the reception areas of airports, as well as to transit options, car rentals, hotels reservations, etcetera. Overall, the main objective of this project is to provide travelers with an enhanced travel experience. This experience can also be later implemented within a variety of other public built spaces.

4. RESEARCH

4.1 SPACE

As ports of entry, airports are sites of surveillance policing control, but they are also "places for good news" (Stephen Graham, 2002, p. 7). At least, we should try to maintain them as joyful spaces for the expression of national identity and facilitators of international mobility. At the same time, they remain potential spaces for experimental technological and social control. It is thought that wayfinding problems are emerging in parallel to the increased complexity of today's architectural structures and cities. Yet as Arthur and Passini have suggested in their book *Wayfinding: People, Signs and Architecture*, while there is no doubt that these difficulties have been amplified within these contemporary layouts, wayfinding problems existed before these complexities arose. Wayfinding difficulties are the result of misleading, ambiguous, and unorganized signage systems and architectural layouts. Architects and designers often overlook the fact that they are designing for users and not "superusers," where understanding what and how wayfinding works for the majority of the public is essential (Arthur and Passini, 1992).

Observational research was conducted in the form of two studies, one at YVR airport in Vancouver and the other at Shinjuku station in Tokyo. Both revealed wayfinding difficulties that travelers and visitors encountered in these vast and complex transportation hubs. The difficulties these travelers have in corresponding smoothly and quickly with the implemented wayfinding system indicates the failure of fixed signage in accurately communicating wayfinding messages throughout these architectural spaces. Fixed signage has existed in the same form and concept for an extended period of time; it has not adapted to new technological advancements at the same pace as the architectural structures in which it is embedded. Chris Calori states in *Signage and Wayfinding Design*: “As cities grew and mobility increased, making the built environment more complex, people’s need for information to better understand, navigate, and use their surrounding also grew” (Calori, 2007). This is very significant in airports, where the major horizontal expansion of terminal extensions is occurring in parallel to a cities’ development. This means that the user’s mission of getting from a current location to an intended destination in a smooth and timely manner has become a more difficult task to achieve.

Several attempts have been made by architects and designers to address the concerns of signage and wayfinding. These ideas have been both proposed and implemented in built environments. One example is digital screens displaying directional information, which can adapt to multiple users’ needs. An example of this approach is a ‘touchless wayfinding system’ designed by D-sign Interactive, a digital media company located in Vancouver. In this project, the design team installed screens throughout YVR airport that enable users to find their way to nearby locations like food and drink, lounges, amenities, and retail, as shown in figure one below. This system requires travelers to stand on an iconic map facing screens and then, through hand gestures, to interact with the interface displayed on the screen facing them, as shown in figure two below. A limitation for using such a system in a busy airport space is that it is not available for all travelers because they have to wait in line to individually interact with the screen.

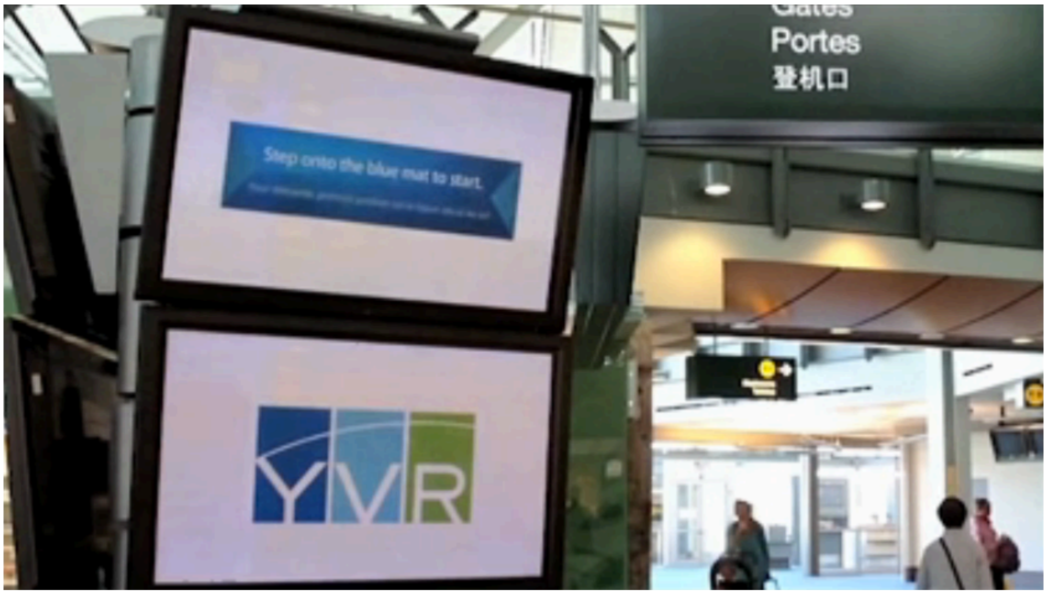

Fig 01: D-sign, *YVR airport*, 2010. YVR Touchless Wayfinding System. Photo: Snapshot from D-sign's project brief video.

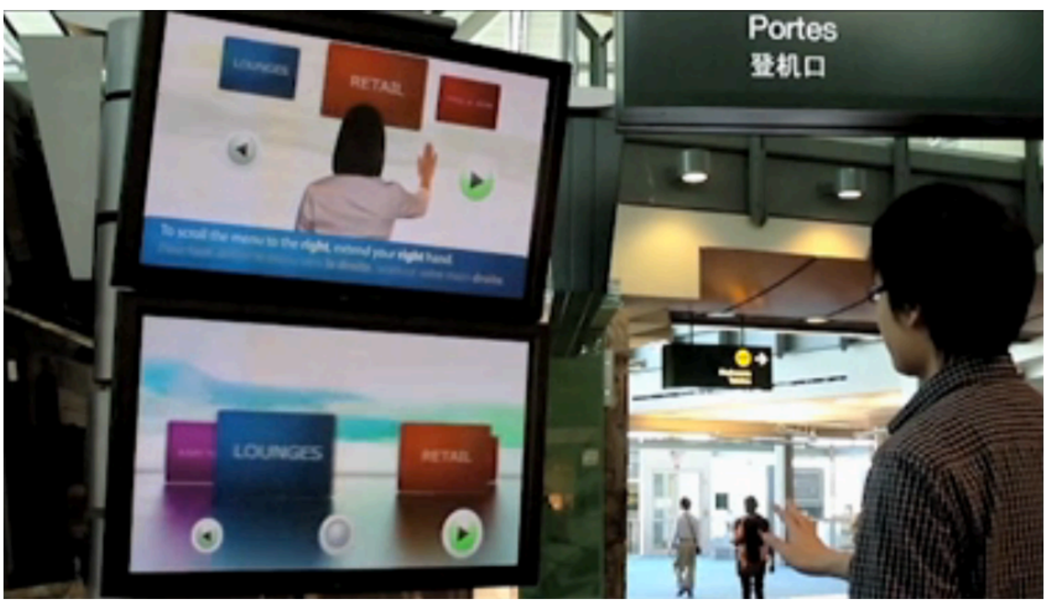

Fig 02: D-sign, *YVR airport*, 2010. YVR Touchless Wayfinding System. Photo: Snapshot from D-sign's project brief video.

Another attempt at using a digital signs is shown in figure three, below. Observations conducted at Shinjuku station in Tokyo indicate that the implementation of digital screens through out the space does not change the behavior of users. Although digital signage has been introduced to replace ad-boards, the experience these animated signs provide the users with is regarded similarly to that of static printed ads: people reacted to both digital signage and static signage in the same manner. In the same study, it is also shown that during their waiting times, people are more engaged in interacting with their handheld smart devices where they can find a more personalized and relevant interaction.

Fig 03: Sirine Hawari, *Shinjuku Station*, 2011. Passive influence of digital signage on passengers versus active engagement with hand-held devices. Photo: Malek Anouti. Used by permission of the artist.

Other attempts by architects and designer to communicate wayfinding are through considering the interaction between users and the surrounding environment. These attempts included integrating landmarks that act as wayfinding features within built spaces, so that users can be guided into focal points of the space without depending on directional signs. Through graphic walls, patterned flooring, color-coding, or other features and landmarks within the interior architecture, users will be assisted in navigating their surroundings. Masaaki Hiromura is a leading Japanese designer, who studies and implements environment identities, signage, and wayfinding. His approach embeds wayfinding elements within the architectural space itself. As shown in figures four, five and six below, the Koto-ku project in Tokyo is a condominium and shop facility that illustrates how Hiromura used a colour coding strategy as a tool for wayfinding throughout the whole built space by Riken Yamamoto architects. In this space, users follow the visual sequence indicating the colour of their destination, rather than having to read signs at every decision point.

Fig 04: Masaaki Hiromura. Shinonome Canal Court CODAN, *Koto-ku* Tokyo, Japan 2003.
Photo: Nacasa & Partners Inc./ Satoshi Asakawa

Fig 05: Masaaki Hiromura*.* Shinonome Canal Court CODAN, *Koto-ku* Tokyo, Japan 2003.
Photo: Nacasa & Partners Inc./ Satoshi Asakawa

Fig 06: Masaaki Hiromura Shinonome Canal Court CODAN*. Koto-ku* Tokyo, Japan 2003.
Photo: Nacasa & Partners Inc./ Satoshi Asakawa

A key factor behind the success of Hiromura's wayfinding implementation in built spaces is that it is part of the architecture itself, and was studied, designed, and implemented in parallel to the architectural concept study, design, and completion. Yet the usual distinction between architectural and graphical work for these spaces means that Hiromura's work is an exception. Arthur and Passini support this when they state: "Having a graphic designer "do the graphics" for a building after the architect has already designed and constructed it is not what wayfinding is about." (Arthur and Passini, 1992). Built spaces should be designed in a way that incorporates wayfinding studies of users behaviors. A user's journey within a built environment should have a logical sequence that they can relate to, and which is assisted by static signage, rather than wayfinding elements that have been added on to an already built space.

In 1970s came the emergence of what Chris Calori calls "architectural graphics," "architectural signing," and "architectural graphic designers." These people designed architectural graphics that articulated communication between users and the space within built environments. Since the birth of The Society of Environmental Graphic Design (SEGD), the term *environmental graphics* replaced *architectural graphics* (Calori, 2007), giving the field a level of significance for its essential presence at the design stage. Attempts to overcome wayfinding concerns were approached through trial methods that attempted to simplify the process of deciphering the physical built space, locate fixed signs and communicate them in relevance to their surroundings. The main focus was on maintaining information content through a graphic and hardware system. Yet, these varied attempts are still explorations operating at the same layer of minimal user-space interaction.

According to Arthur and Passini, wayfinding has a critical and important role within built environments. It affects the emotional state of the users, touches on issues of efficiency and therefore monetary value, and addresses public safety issues (Arthur and Passini, 1992). Users often get lost in finding their way through a space, as if they are navigating without the existing signs. This happens for several reasons: either signs are so small that users do not see them; signs are big, but messages are unclear, so users can not make sense of them; signs are poorly located and users cannot find them; or users prefer asking others about directions as a more reliable source than reading signs. When failing to navigate a space correctly, users tend to blame themselves, feel stupid, frustrated, and anxious, and get angry that finding the way has been a difficult task to accomplish. As clearly evidenced, wayfinding studies have been ignored for sometime by architects, designers, users, and even clients and investors. These groups are collectively aware of the presence or absence of public art in built spaces, while they neglect to recognize the priority of wayfinding within their surroundings. Arthur and Passini have uncovered two basic reasons for this negligence towards wayfinding. The first reason is society's negligence of a clear wayfinding system, where people would rather ask a passerby for directions, even when they have just read the same information on the sign facing them. The second is the architect's concern in creating the nicest architectural designs and the designer's focus on typographic compositions (Arthur and Passini, 1992).

4.2 USER

Air travelers' psychological needs and reactions throughout their journeys are being neglected, according Robert Bor in *Passenger Behaviour*. With the rapid increase in the number of travelers over the past years, there should be a raised awareness of passengers' needs in airport spaces, from the employees, security procedures, and, most importantly, wayfinding mechanisms.

Furthermore, as Bor explains, passengers experience different behavioral states during travel including motion sickness, jet lag, increased alertness, stress, fear of flying, homesickness, and security concerns (Bor, 2003). These are difficult conditions without the addition of the navigational difficulties a traveler may encounter in finding their way through an airport environment. It can be postulated that due to high anxiety levels, travelers are not as capable at communicating with their surrounding spaces and its contained wayfinding system. Yet, for these same reasons, signage and wayfinding at airports should communicate clearly to travelers under such conditions.

According to Kevin Lynch in his book *The Image of the City*, the environment or the image of the environment – being a city or a built space – is constructed by the user through several phases: legibility, building the image structure and identity, and imageability (Lynch, 1973). Familiarity with surroundings is built based on present sensations and visual memories. From these, the user draws a logical wayfinding organizational pattern printed as a mental image. When certain landmarks are repeated throughout a space, the user builds an understanding of the space with respect to the location of these repetitive landmarks, and navigates accordingly. At YVR airport, for instance, the installation of major artworks at waiting areas and meeting places points encourages travelers to build a mental image that allows them to read these art pieces as landmarks marking major areas of the airport and create memory of the sense of place accordingly. Two examples of those artworks at YVR airport within meeting or waiting areas are displayed in figures seven and eight below.

Fig 07: Bill Reid, *The Spirit of Haida Gwaii: The Jade Canoe*. YVR airport, Vancouver 1996. Photo: Sirine Hawari

Fig 08: Joe David. *Clayoquot welcome figures.* YVR, Vancouver 1996. Photo: Sirine Hawari

Lynch further discusses the importance of wayfinding in mitigating the sense of anxiety and terror caused by the situation of getting “lost.”. Getting “lost” within today’s vast and complex architectural spaces is due to a deconstruction of the previously mentioned mental image that users create, causing them to seek alternative reliable methods of navigation within their surroundings. In an airport space for example, travelers had become accustomed to a certain sequence of events, starting with a counter check-in and baggage drop-off process, to retrieval of a printed boarding pass, followed by security control scans and customs, to finally get to a duty-free area and boarding gates. Currently, however, the process has shifted toward online check-in or self check-in at the airport, followed by independent baggage drop-off, with boarding passes substituted entirely by a QR code [2]displayed on the user's smart device screen. These changes might cause travelers to fear the possibility of 'getting lost' while they navigate these new steps. They might be concerned about fulfilling all of the required tasks on this journey the right way without missing out any important procedures, creating a sense of anxiety associated with the airport space.

[2] Quick Response (QR) codes are a type of data matrix barcode.

4.3 TECHNOLOGY

We have reached a time where mobile communication is rapidly increasing. Cisco calls this era “the rise of mobile communications,” noting that the international adoption of mobile technology through mobile phone subscriptions has reached five billion worldwide at the end of 2010, with more than one billion mobile devices having access to the internet. It is also suggested that over the next five years, internet access will be occurring via mobile devices rather than through personal computers, as shown in figure nine (Cisco, 2010).

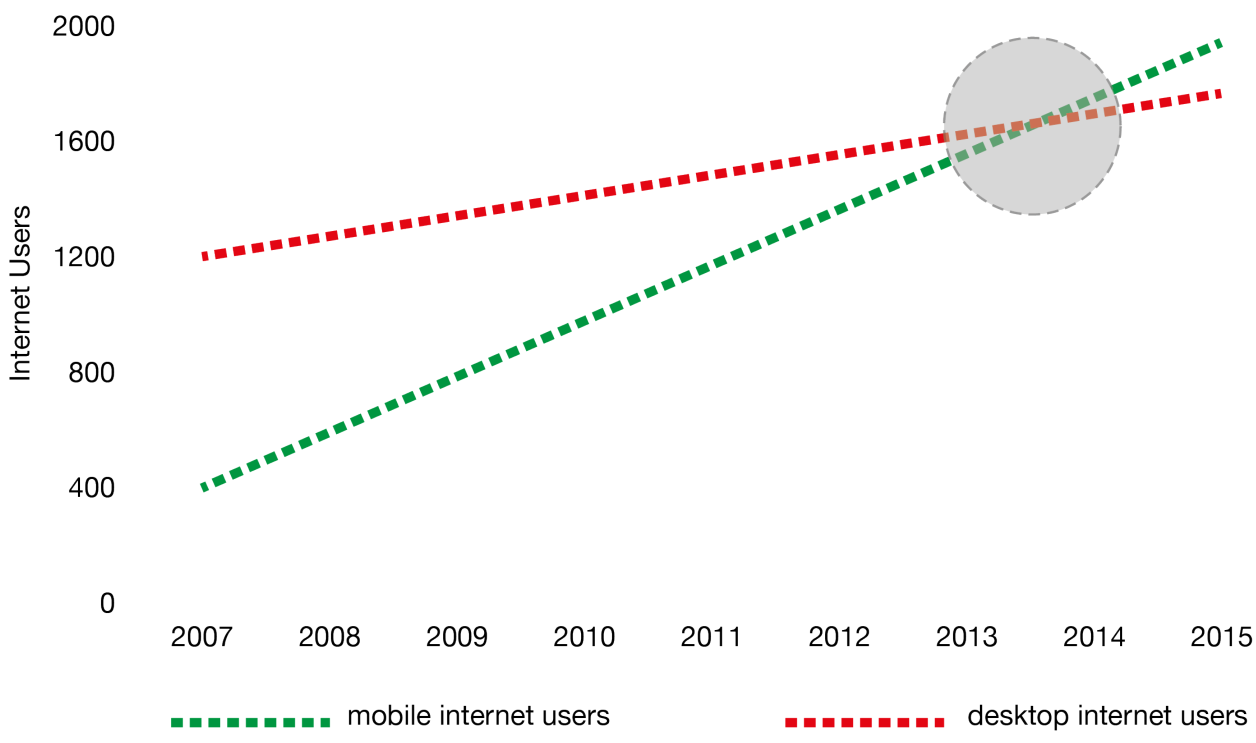

Fig 09: Morgan Stanley, 2009. Internet Use via Mobile Devices Versus Desktop PCs, 2007–2015 (estimates). Reillustrated by Sirine Hawari.

Cisco notes that the increasing adoption of mobile devices "makes the mobile phone a critical platform for developing new services and content that improve interactions and operations, increase personalization, and empower both passengers and employees." (Cisco, 2010) This potential will boost the focus on mobile services, where users' interactions will be mainly communicated via smart handheld mobile devices.

Airline services in particular benefit tremendously from mobile devices due to their innovation in the fields of operations and services. Via applications provided by smart handheld mobile devices, airlines have increased passenger mobility, created new passenger experiences, and developed capabilities to deliver relevant and personalized services (Cisco, 2010). The most common innovations are online booking, online check-in, and digital boarding passes through QR code scans at security points.

Airline business models are increasingly considering the growth of mobile devices, with many airlines experimenting with the implementation of personalized services through the use of mobile devices. According to an annual survey on airline IT trends[3] co-conducted by SITA[4], the adoption of specialized mobile aviation applications has grown remarkably over the past couple of years, with double-digit growth for digital solutions such as customized websites for mobile screen optimization and bar-coded boarding passes sent to smartphones. Passengers can now use their mobile phones from booking to boarding,

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[3] 12th annual survey by SITA and Airline Business magazine. The Airline IT Trends Survey underlines the strategic importance of information technology (IT) within the airline industry.
[4] SITA is the leading specialist in air transport communications and IT solutions

inform friends of their location on Facebook, and even check the status of delayed luggage using 'WorldTracer.'

Based on this same survey, SITA also states that by the end of 2010, mobile phone-based boarding will increase by 24 percent, and other existing processes such as paper baggage receipts, card access to premium lounges, and cash and credit card payments will also be replaced by mobile applications (SITA, 2010). Tyler Lessard, the vice-president of Blackberry Global Alliances and Developer Relations at Research in Motion, stated in a talk entitled 'Opportunities in a New World of Ubiquitous Mobile Computing' that smartphones are replacing wallets and that in the future they will become a tool for paying, checking in, accessing public transit, etcetera with smartphones being the only thing you need to take with you from home (Lessard, 2011)

In the same talk, Lessard also discussed how mobile applications are becoming hyperactive, engaging and integrating user's experiences and creating further valuable experience. He adds that today's applications and super applications of the future are offering proactive settings with contextualized and personalized functions that are efficient and intelligent. This potential could be reflected in the implementation of 'Traveler Wayfinder' as a tool for travelers, which will give travelers a greater control over every aspect of their travel anytime, anywhere, through any smart device.

By shifting the airport space into a more mobile adaptive environment, a wider range of customized and personalized services and applications become possible in that space, such as travel assistantship, digital marketing, mobile services, and digital payments.

Through a digital personal travel assistant, passengers can be notified with relevant alerts throughout their travel journey, including drive times to the airport, flight times, security line statuses and others. Shops, restaurants, and other airport services could use this tool for marketing purposes, promoting offers and discounts. When smartphones are considered a secure e-wallet, travelers can process mobile payments using the same device. This real-time intelligent mobile tool for airports and airlines creates a context-rich environment for passengers throughout their travel experience.

In this same realm of mobile app world emergence in a travel environment, the travel experience is becoming a smarter one. TripIt for instance that developed three different smart apps that would work for ipad / iphone, android and blackeberry facilitated a trip planning for a wide population of business travelers. By forwarding their travel confirmation to TripIt, the travelers' trip is organized into one master online itinerary, including maps, directions and weather with the option to book restaurants, theatre tickets, activities and more. In this case TripIt is arranging the travel journey before and after travel itself where Travelr Wayfinder completes this experience with the airport environment in terms of organizing the traveler's time and things to do within the airport space. Furthermore, just like TripIt is using social media to promote and share experiences among users, Traveler

Wayfinder can be linked with facebook, twitter, linkedin and other social media networks where friends' tags and recommendations within airport spaces can be shared as experiences within the app itself. Many travelers try to plan their waiting time especially when long connecting hours are within their flight schedule; for that Traveler Wayfinder will become useful in this case when through the same app it is feeding users with other travelers' feedback, tags and recommendations of the same which will also be a beneficial tool for the airport's retail and commercial use.

5. FIELD WORK AND CASE STUDY

5.1 SHINJUKU STATION FIELD STUDY

Railway-technology.com, a railway industry website, stated in its *Top Ten Record Breaking Stations* that Shinjuku Station is the main connecting hub for rail traffic between central Tokyo and its western suburbs on inter-city rail, commuter rail and metro lines. It is actually several station located next to each other, and serves as the second-largest train station in Japan (after Nagoya Station), including an underground arcade, and well over 200 exits. The station is used by an average of 3.64 million people per day, making it the busiest train station in the world in terms of number of passengers, as registered with Guinness World Records.

Shinjuku station is a perfect example of the use of horizontally expanded architecture for a key transportation hub. Users' rhythm is often high paced, where stopping to decipher signs might cause an interruption of passengers flow, as shown in figure 10. This fieldwork noted an obvious distinction between regular users of this station versus new comers, who are not familiar with the station layout or the language. Figure 11 shows how the fieldwork found that walking behind the heavy crowd present throughout the station, one cannot easily see signage, for it is mostly covered from several perspectives. Thus, irregular users of Shinjuku station need to pause in the middle of the crowd to be able to find their way to the intended platform, causing interruptions to the passengers' high paced flow. Figures

12 and 13 below point out distractions that also interfere with the visibility of signs. CCTV cameras, clock, screen ads, and a digital time board are placed at the same level as the signage, which makes it even harder for travelers to find relevant directional information. In order to have a clearer view of the signage placed throughout the station, the primary researcher had to take this picture from a low angle, as shown in figure 14, where the quantity of information, colors, numbers, arrows, icons cannot be viewed from a distance. Even though the gate numbers are large enough, as shown in figure 15, there is no information telling passengers which gate is the right one to link them to their intended platform. Finally, when the general wayfinding map was located in a dark corner of the station, it was presented in an even smaller format than the ads flooding the space, as shown in figure 16.

Fig 10: Sirine Hawari, *Shinjuku Station*, 2011. High paced flow. Photo: Malek Anouti. Used by permission of the artist.

Fig 11: Sirine Hawari, *Shinjuku Station*, 2011. Heavy crowd covering fixed signage. Photo: Malek Anouti. Used by permission of the artist.

Fig 12: Sirine Hawari, *Shinjuku Station*, 2011. Distracting elements interfering with signage visibility. Photo: Malek Anouti. Used by permission of the artist.

Fig 13: Sirine Hawari, *Shinjuku Station*, 2011. Distracting elements interfering with signage visibility. Photo: Malek Anouti. Used by permission of the artist.

Fig 14: Sirine Hawari, *Shinjuku Station*, 2011. Low shot of faded out signage. Photo: Malek Anouti. Used by permission of the artist.

Fig 15: Sirine Hawari, *Shinjuku Station*, 2011. Large gate numbers do not reveal information about the linked platform. Photo: Malek Anouti. Used by permission of the artist.

Fig 16: Sirine Hawari, *Shinjuku Station*, 2011. A small wayfinding map stands in a dim corner of the busy station while surrounding ads are emphasized in size and light. Photo: Malek Anouti. Used by permission of the artist.

It might be unnecessary for regular users commuting the same path everyday to notice the signage, as they become accustomed to visuals and sounds, and filter them unconsciously. It is very challenging, however, for a new visitor, even if they are fluent in Japanese, to find directions to their intended destination, especially with all of the distractions that interfere with the flow of finding one's way. A space where the ceiling is relatively low and loaded with cameras, large scale ads, and overload of colors and information all add to the stress of not being able to find the right way, missing a train, and getting lost squeezed among the crowds. The wayfinding journey here could end up being a remarkably unpleasant experience. Apparently in parallel to the expansion of the city, Shinjuku station expanded, adding more and more signage until that signage has become a misleading feature, rather than a tool for finding one's way within the existing labyrinth (the city, the station, and the signage). Several attempts have been implemented in Shinjuku station to overcome these navigational difficulties, including color coding the environment's identity and adding digital screens to replace verbal announcements. Still, the same old methods of static signage are used, though in different forms – but it is still failing.

5.2 CASE STUDY AT VANCOUVER INTERNATIONAL AIRPORT (YVR)

YVR's website states that Vancouver International Airport (YVR) is Canada's second busiest airport. It had over 16 million passengers in 2009, and facilitated around 260,000 aircrafts with take-offs and landings, while handling approximately 200,000 tons of cargo. Since 1992, passenger traffic has increased by more than 78% to 9.9 million passengers.

During this study, I made frequent visits to YVR as an airport employee, a traveler, and a visitor. These varied perspectives of user, observer, and designer have given me a further understanding of the relation between the user and the space.

Imagine yourself on a journey as a traveler connecting for the first time at a certain airport after a long hectic flight, when you are not familiar with that city's language, and making it to your next gate in half an hour is a must. Most likely, you will be faced by several wayfinding challenges as you navigate through the airport. This visual case study conducted through this research at YVR airport, supported by Arthur and Passini's view in *Wayfinding: People, Signs and Architecture*, indicates that you would The outcomes of the YVR observational case study highlight the typical experiences of various travelers in different airport spaces. It demonstrates several concerns at various points of travelers' attempts to find their intended destination within the airport space. At first glance, users fail to understand the space, even after attempts have been made to create an organizational principle that indicates the consecutive functional areas. Travelers eventually find it impossible to identify their current locations with respect to the overall airport layout. It becomes harder for travelers to determine whether they have been wandering in circles or have ended up in a completely different terminal of the airport due to the repetitive identical layout. At this point, travelers will question if they have missed a useful sign or overlooked it, due to not understanding the written language on the signs. Seeking help from the multilingual information booth becomes their only source for the required directions, but these customer service booths are closed for flights arriving after midnight. Trying to decipher a directory plan is complicated, due to the use of illegible fonts and icons and the dark color palette choices on dark backgrounds. Travelers' attempting to read the series of screens identifying flight information are at risk of becoming hopeless, due to rapid change of overwhelming amounts of information, especially when the ceiling light is directly projected on those reflective screens. At critical times, deciphering the alert messages next to particular flight numbers becomes impossible for some travelers, who are concerned about misinterpreting the message and thus being misled. By following the architectural layout, the travelers might end up reaching a different sign that contradicts their flow and eventually leads in an opposite direction. The presence of lots of information is not helpful either in figuring out which piece of information relates directly to a certain personal situation. Announcements in foreign languages are totally incomprehensible, especially when the ambient noise is louder than the information announced. Looking at the stress in this journey of attempting to find the right path from point A to point B illustrates Chris

Calori’s point that “...even the most carefully conceived sign program can’t solve all the problems of navigating...” (Calori, 2007).

Figures 17 to 23 below show a possible journey that traveler might take upon arriving for the first time at Vancouver International Airport (YVR). This observation shows potential navigational difficulties one might encounter in such a space.

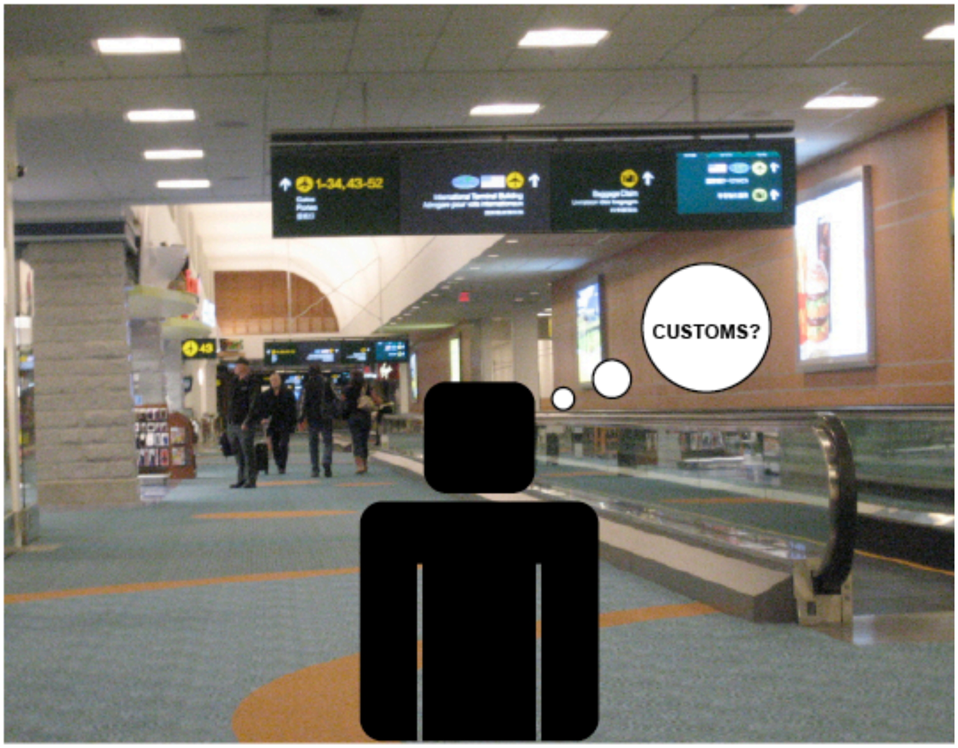

Fig 17: Sirine Hawari, *YVR airport*, 2010. Traveler unable to view the customs sign.
Photo: Sirine Hawari.

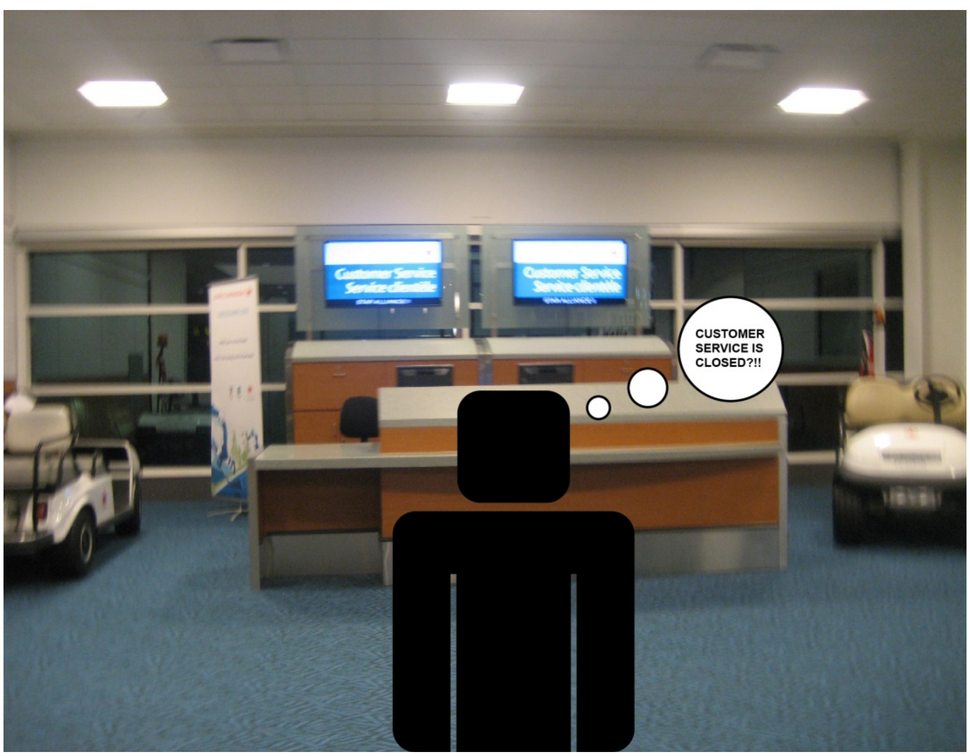

Fig 18: Sirine Hawari, *YVR airport*, 2010. Traveler finds customer services closed.
Photo: Sirine Hawari.

Fig 19: Sirine Hawari, *YVR airport*, 2010. Traveler cannot read screen text while on the moving belt. Photo: Sirine Hawari.

Fig 20: Sirine Hawari, *YVR airport*, 2010. Traveler incapable of finding his flight information, since language is changing every two seconds. Photo: Sirine Hawari.

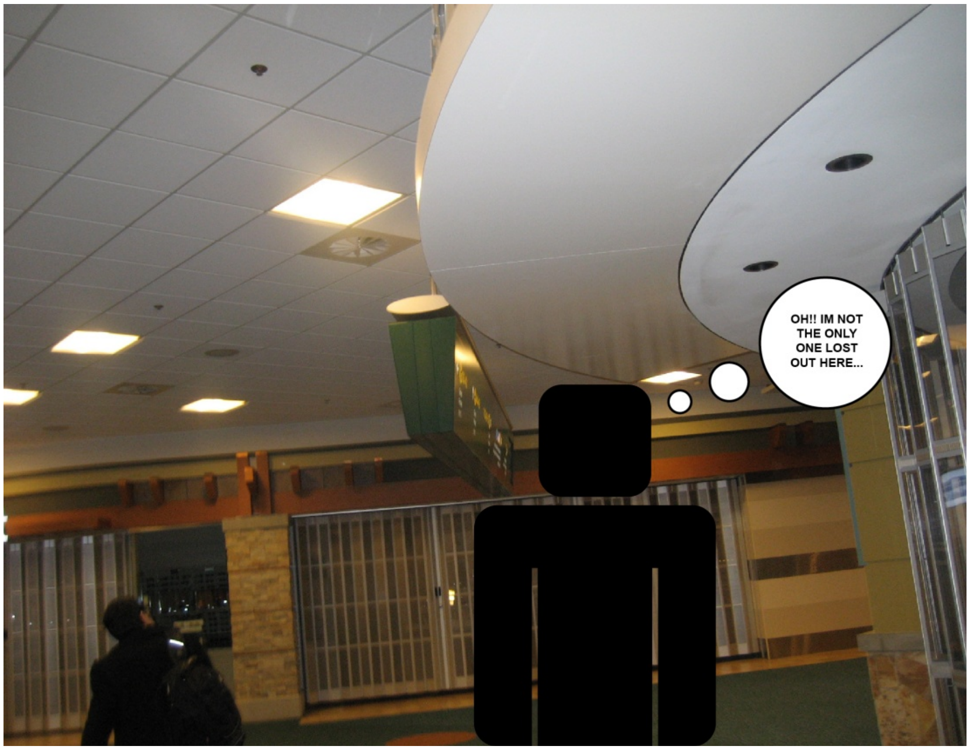

Fig 21: Sirine Hawari, *YVR airport*, 2010. Traveler skips a sign without noticing it.
Photo: Sirine Hawari.

Fig 22: Sirine Hawari, *YVR airport*, 2010. Traveler going with the flow to reach a focal destination.
Photo: Sirine Hawari.

Fig 23: Sirine Hawari, *YVR airport*, 2010. Traveler can view six different signs from his standing point without any indication of the order of priorities. Photo: Sirine Hawari.

6. PROJECT

6.1 CONCEPT

The research team suggests adding a new dimension, exploring the digital layer of the still platform that links users to the built environment and creates accurate communication between the two entities. By using existing technologies, I am proposing to research personalized airport navigation through a customized wayfinding system that responds when scanning the surrounding QR code using the hand-held smart device connected to the airport's wireless network. Here, QR codes act as nodes spread throughout the space, representing landmarks to facilitate a faster response to user needs. By leveraging the airport's existing wireless network and the availability of smartphone technology, the goal is to investigate the role of hand-held devices in solving some of the attendant issues of an airport's internal wayfinding system. Figure 24 below reveals the four layers this project is investigating.

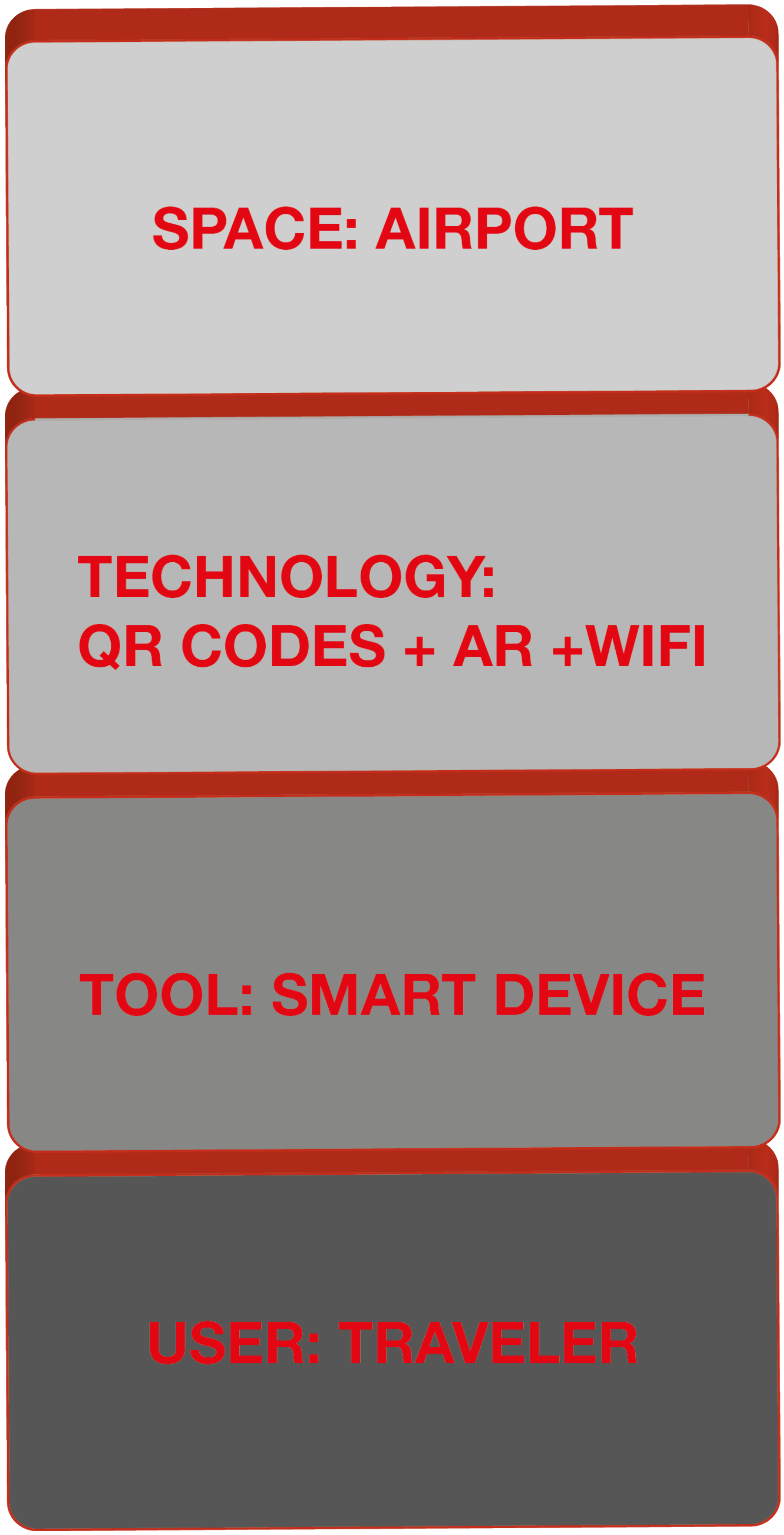

Fig 24: Sirine Hawari, *'Traveler Wayfinder' System Layers*, 2010. The four layers of the project's components. Diagram: Sirine Hawari.

What is ‘Traveler Wayfinder’?

‘Traveler Wayfinder’ is an interactive system designed to personalize people’s airport navigational experience. It consists of two integrated components: an application that runs on the user’s handheld device, and QR codes embedded within the airport space. This system uses an Augmented Reality (AR) interface to overlay navigational data, personalized content, and general-purpose, context-sensitive information.

The navigational data is built on top of the digital schematics of the airport as received from the Airport Authority. Included in this data is the airport’s full floor plan, indicating specific locations of travelers’ Points of Interest (POIs), which include but is not limited to gate locations, baggage drop offs, baggage pick ups, customs, duty-free shops, restaurants, currency exchanges, information kiosks, washrooms, and transit points.

Personalized content is information relevant to the traveler that is collected by backend servers from several information sources and is pushed to the handheld device where it is displayed as a layer in the Augmented Reality interface. Personalized content includes gate and timetable information relevant to the traveler’s itinerary, which is received from the relevant airline’s data sources. It is worth noting that personalized content requires the approval of the passenger to share some of their personal information with third-party systems. The personal identification information can be one of the following: full name and destination, passport number, frequent flyer number, or ticket confirmation number.

Context-sensitive information requires the traveler to scan one of the QR codes scattered around them to reveal content relevant to their precise location. Scanning QR codes also enables ‘Traveler Wayfinder’ to pinpoint the precise location of the traveler, based on the QR codes location database, and thus provide directional guidance to the intended destination with a low margin of error.

Why is ‘Traveler Wayfinder’ useful?

‘Traveler Wayfinder’ provides travelers with a personalized navigation experience that relates only the relevant information to each individual user. ‘Traveler Wayfinder’ is a user-based navigation center, with the information requested by the traveler at hand at all times. It is also a way to receive all relevant alerts and notifications via a handheld device. It is an easier navigational experience that answers the travelers’ needs to find the locations and destinations they are aiming for.

Where is ‘Traveler Wayfinder’ used?

‘Traveler Wayfinder’ is used throughout airport spaces as long as the smart device is connected to the space’s WiFi network. When QR codes are scanned, the precise location of the traveler is also identified. These QR codes are embedded at 20 meter intervals in the airport space, based on decision making points in every zone, representing augmented landmarks for travellers to follow.

When is ‘Traveler Wayfinder’ used?

Travelers will use ‘Traveler Wayfinder’ when trying to get directional or informational data from the airport or airline. It is a digital tool to be used for their guidance throughout airport spaces.

6.2 TECHNOLOGY

How does ‘Traveler Wayfinder’ work?

Initial use of this system requires users to download a free application to their smart handheld device. Once the application is installed, users will be asked to connect to the airport’s WiFi network through a push notification as soon as they enter the airport space. The WiFi connection helps in identifying the traveler’s approximate location inside the airport. Additionally, travelers are requested to identify themselves by providing one of the following pieces of information: passport number, frequent flyer number, or ticket confirmation number. This information enables ‘Traveler Wayfinder’ to serve personalized content including flight information, destination gate, and important times related of the user’s itinerary. At this point, the user may scan any nearby QR code to get context sensitive information and to pinpoint their precise location. The precise location enables the application to serve directional content that guides the user throughout the space using an Augmented Reality (AR) interface which displays screen graphics on top of real imagery of the surroundings served by the handheld device’s camera.

This project proposes a customized technological solution that provides accurate assistance for travelers in navigating participating airport spaces. It consists of software that is compatible with smart handheld devices and uses QR codes installed throughout airports' built spaces to determine location and serve location-relevant information. The software application obtains an traveler's approximate location by triangulating nearby WiFi signals and comparing it to a centrally-managed signal survey of the airport premises. In addition, the application obtains precise user locations when the user performs QR code scans. The precise location is necessary for enabling an augmented reality application that overlays directional and informational graphical display on top of real time imagery of the surrounding space.

The technological challenge faced through realizing this project was finding an alternative to Global Positioning System (GPS)[5] to precisely locate the traveler within the interior space of the airport. GPS requires a clear view of the sky and thus cannot be used in closed areas. In addition, GPS accuracy in exterior spaces is accurate within 30 meters, which works for applications such as street navigation, but it is not precise enough for the intended purpose of this project. Researched technologies that support indoor tracking include Assisted GPS (AGPS), Radio Frequency Identification (RFID) tags, and face detection and recognition tracking.

AGPS combines the triangulation positioning from at least three different GPS satellites with help from the mobile network provider. This provides AGPS with the capability of operating both indoors and outdoors. This solution, however, requires data access to the

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[5] GPS is a satellite navigation system used to determine ground position and velocity (location, speed, and direction).

local operator's network, which is not convenient for many foreign travelers navigating the airport, since they would not have subscribed to a local mobile network provider, and therefore could not benefit from the operator's AGPS infrastructure.

RFID is a technology that uses radio waves to exchange data between a reader within a space and an electronic tag attached to an object for the purpose of identification and tracking. RFID can be used for tracking passengers in airports for wayfinding purposes. Yet, for that to happen, RFID readers need to be planted throughout the interior space to capture all possible tags passing by. Since this technology is wave-based, it risks interference with other wave-based airport security systems. For this reason, airport authorities do not recommended heavy use of RFID technologies in a space like an airport.

Face detection is a computer technology that determines the locations of human faces in digital images. It detects facial features and ignores everything else, such as built features, other objects, and bodies. This technology can be easily implemented in airports since CCTV[6] cameras are located every few meters to keep the space's users under continuous surveillance. This project investigated the possibility of using this technology as a tool for users to locate and track themselves within the airport space. Upon approval of the user, their facial features will be matched with their information request for a specific destination. When navigating the airport, CCTV cameras maintain the user's location and communicate with the wayfinding system that is projected through software into the traveler's smart

[6] CCTV is closed-circuit television

handheld device, revealing information to assist the traveler in reaching the demanded destination.

For the time being, two major limitations inhibit the use of this technology, although it could be a viable option in the future. The first limitation is that such a solution requires a prohibitively high-cost data infrastructure to support the scale of data collection and analysis. This option also requires costly overhead in terms of the specialized human resources required to run such a computationally complex operation. These limitations also contradict one of the aims of this project, which is to use existing technologies already present in the airport space.

Another limitation to using CCTV information in wayfinding was introduced during one of the meetings with YVR Airport Authority, where they explained that the data collected from the CCTV cameras at the airport are the responsibility of a separate security agency that cannot currently collaborate with the Airport Authority in providing this data for uses other than security.

Selected Technology

The ‘Traveler Wayfinder’ handheld client uses WiFi triangulation technology with the help of QR codes for accurate localization. A typical use case is as follows: when travelers arrive at the airport, they connect to the airport’s WiFi network and are redirected to a page where they can download the ‘Traveler Wayfinder’ application compatible with their device. Since the device is already connected to the airport’s WiFi network, the device’s location can be known within a 30-meter range of the airport space. To personalize the data provided for navigation, the user is required to provide one of the identification numbers (passport number / flight and seat number / frequent flyer number), so that the system can retrieve the relevant boarding gate and time. Then, whenever the user scans a QR code that is embedded within the architectural space, the system would have a precise location of the traveler and provide precise directions to the intended destination through an Augmented Reality interface over-layering graphical information on top of the real imagery of the surrounding space. In this manner, the traveler can get directions from his particular starting point to his own intended destination without the interference of other irrelevant information along his journey throughout the airport.

WiFi:

Once a handheld device is connected to the airport’s wireless network, it can transmit the signal strengths of detected WiFi hotspots to the Wayfinder Application Server, which performs triangulation and determines the handheld device’s location based on an existing survey of the airport's WiFi signals and hotspot locations. The Wayfinder Application Server would then relay the location information back to the Wayfinder handheld application, which would be able at this point to plot the user accurately on the airport's digital map, and provide other location-based services.

WiFi triangulation locates the device within an approximate range of 30 meters regardless of being indoors or outdoors. However, location accuracy is improved in areas with a large concentration of WiFi hotspots, such as in an airport. Cisco Systems were pioneers in expanding the use of WiFi in localization purposes by providing advanced location tracking within the WLAN[7] infrastructure.

Tracking devices within the airport space is possible through wireless triangulation. In a typical WiFi network, access points that 'hear' the handheld device's network request signal respond to the request with information regarding signal strength. Triangulation works by having the device send the signal strengths of all the wireless access points that it hears from in a certain location to the central server. The triangulation application in the central server uses a precise survey of all the airport's access points. It draws coverage circles on the map around each access point that hears the device. The device's location is then approximately determined by looking at the intersection of the coverage circles and the access points that the device has detected, taking each access point's signal strength

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[7] WLAN is Wireless Local Area Network

into consideration. The more access points that respond, the greater the accuracy of the final result of the device's approximate location.

WiFi triangulation can pinpoint a location to 30x30 feet (900 square feet), in an indoor area that has no walls or objects that can block a signal, yielding fairly accurate results. This level of accuracy, however, is not sufficient for the 'Traveler Wayfinder' to operate optimally and provide human scale navigation in an interior space like the airport.
For this reason, 'Traveler Wayfinder' utilizes QR codes to improve location precision.

QR codes:
Quick Response (QR) codes are a type of data matrix barcode made up of a pattern of black squares on a white background, with larger squares at three corners. QR codes can be read by specialized scanners, by mobile phones with cameras, and by smartphones. Most mobile phones and smartphones require a reader application to display information associated with a QR code, while many newer phones incorporate a built-in scanner tool. A QR code can be affixed to any tangible object (a piece of paper, a business card, a sign post, a shirt, a building, etcetera), which allows anyone who scans that code to access the information associated with it. QR code technology is mainly used to orient users to certain destinations or to associate text or URLs to certain physical objects. Airport authorities, in collaboration with airlines, are using QR codes as a replacement for previously used paper boarding passes. By scanning the QR code associated with each traveler on a specific travel journey, airport security employees will access the traveler's boarding information

and thus giving them access to secured areas. During travel, these QR codes could be displayed either on the traveler's smart device screen or travelers could print it once they complete the on-line or self check-in.

AR technology:

Augmented Reality (AR) adds information to a real object or place. Unlike virtual reality, augmented reality does not create a simulation of reality. Instead, it takes a real object or space as the foundation, and incorporates technologies that add contextual data to deepen a person's understanding of the subject. AR has the ability to seamlessly and dynamically integrate graphic and other multimedia content with live camera views on devices such as smartphones. Examples of the use of augmented reality include adding audio commentary, location data, historical context, or other forms of content that can make a user's experience of a thing or a place more meaningful. Layar and Junaio are two companies who are creating leading applications using AR technology. Through the use of smartphone's GPS, compass, and accelerator, these applications can identify the user's location and direction, depending on where the camera is pointing. In this way, information relevant to user's position can be displayed, showing their surroundings depending on pre-selected interests. It shows users what they cannot already see, as Layar describes the technology. Figures 25 and 26 below show Junaio's application customized for the San Francisco Railway area, where user groups can tag information within the same channel so that friends can be updated about recommendations in that area as Lisa Murphy, the Junaio Product Marketing Manager explains. She also describes how users get information they need only when needed, so if they are looking for a coffee shop they get information about surrounding coffee shops, or if they are looking for departure times of trains they access only this information.

Fig 25: Junaio, *San Francisco Railway*, 2010. Snapshot from YouTube video showing how Junaio can help locate the nearest train station in San Francisco.

Fig 26: Junaio, *San Francisco Railway*, 2010. Snapshot from YouTube video showing how Junaio can help locate the nearest train station in San Francisco.

7.0 FRAMEWORKS and INTERFACE

7.1 TECHNOLOGY FRAMEWORK

According to Dan Saffer in his book Designing for Interaction, the basic materials required for an interactive design solution should involve motion, space, and time. When the design elements are more conceptual, the outcome elements can be either digital or analog or both (Saffer, 2007). In the case of the 'Traveler Wayfinder' project, the outcome elements can be both, whether software applications are added to already existent smart devices or hardware device that specifically function for airports (distributed and dropped off at airports). The primary focus is the overall system solution that consists of an overall technological framework that communicates data between servers, devices, and the space itself, as shown in figure 27.

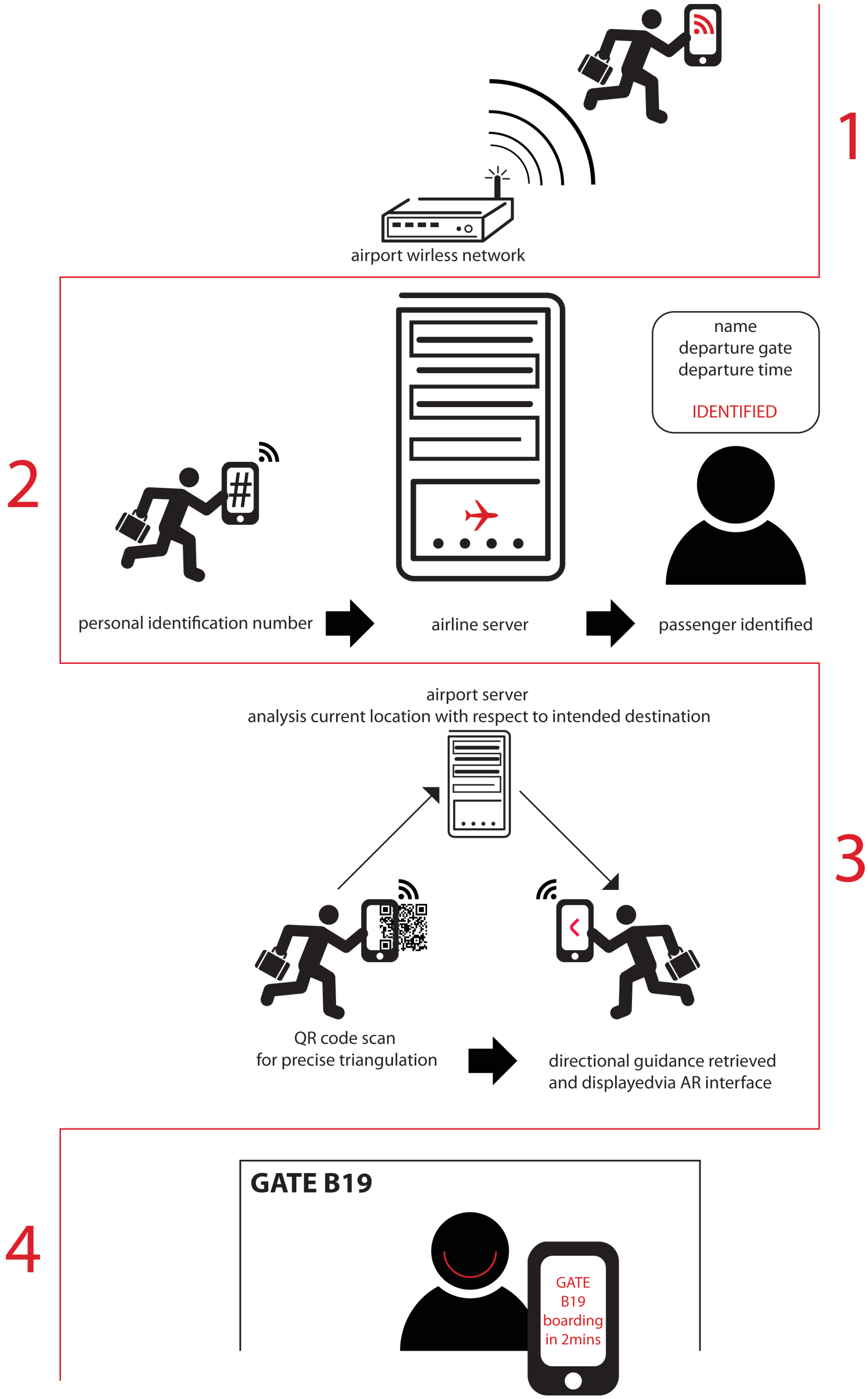


Fig 27: Sirine Hawari, *'Traveler Wayfinder' Technological Framework*, 2011. Technological sequence of the 'Traveler Wayfinder' system. Illustration: Sirine Hawari.

Traveler Wayfinder compiles three different existent technologies to create a tracking / navigation tool on a pedestrian scale in an interior environment. These technologies are Wi-Fi triangulation for approximate device localization, assisted by QR code scans for precise location detection that will reveal navigational graphic information displayed through an augmented reality interface on the smart hand-held device.

Prototyping, testing, iterating and development are the four main stages Traveler Wayfinder should go through to attain technical and visual accuracy in completion. I divided the project approach into two main phases; the general research phase and the particular client phase. In the general phase, Traveler Wayfinder is adapting YVR airport as an academic case study where the outcomes can be modified for the later specific airport client phase where the interface graphics and the environment will be adjusted accordingly.

As shown in the figure 28 below prototyping, testing and iterating the interface and the QR codes separately are completed stages of the general phase. Using Emily Carr University as a testing field environment where user feedback has been taken in consideration from colleagues and professors. The feedback collected concerning interface sequence, button functions and option usages has been adjusted in further interface iterations of the final outcome. The second iteration advanced several parts of the interface mainly the usage of main menu functions, the ‘back’ and ‘edit’ options and the map view button.

Furthermore this project has a number of impediments that can to be overcome once a direct contact with airport authority can be established at the specific client phase. These impediments can be summed up under three main concerns; the airline / airport authority collaboration, the airport / traveler security restrictions and data privacy and the client / budget limitations.

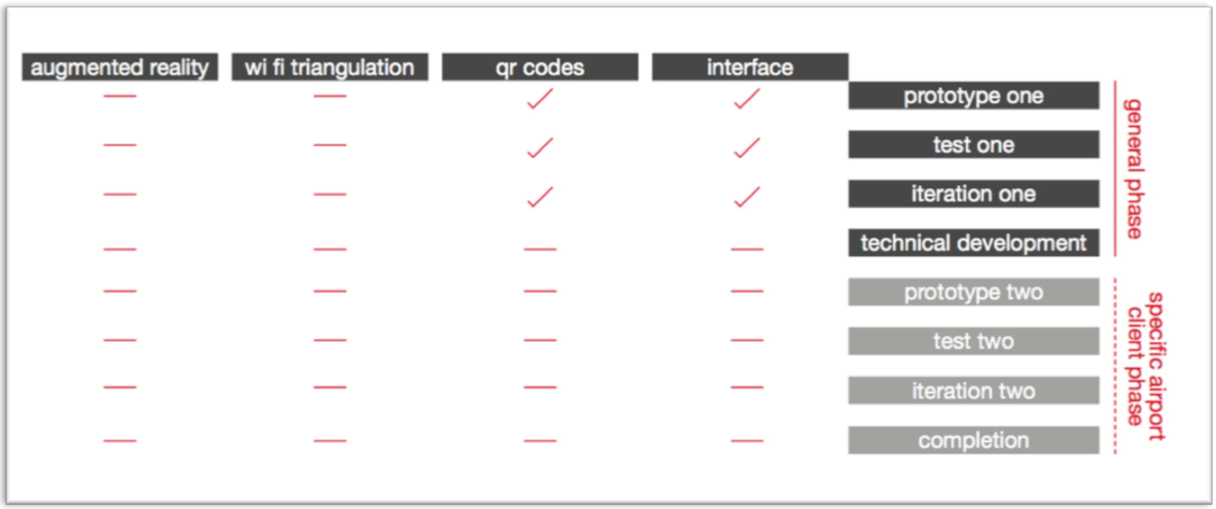


Fig 28: Sirine Hawari, *'Traveler Wayfinder' completion plan*, 2011. Illustration: Sirine Hawari.

7.2 JOURNEY FRAMEWORK

Motion:

Saffer notes that if objects do not move, then they cannot interact. Without any motion, interaction cannot take place, and in order to create communication, interaction has to happen. Interactions will generate behaviors in people as a reaction to other behaviors generated by a certain product they are using. This behavior is the “motion” triggered in accordance with each individual’s culture, attitude, personality and context (Saffer, 2007).

The cycle of interaction starts with motion responded to by action and often again by motion as well. In touching the device's screen to get to a specific destination, the user alerts the interface to act. The interface will then layer arrows on top of the real imagery to guide the user’s navigation where this action is followed by the traveler’s movement to the indicated direction.

Space:

Saffer also states that space provides context of motion, with all interactions taking place in space. Interaction design deals with different dimensions of space, the 2-D and the 3-D, for it involves a combination of the physical space of the user and the digital space of the screen (Saffer, 2007).

An airport navigational interface via travelers’ smart devices controls their movement in the real 3-D airport space. The ‘Traveler Wayfinder’ interface is guiding travelers’ motion in the airport space. In other words, the whole interaction is taking place in ‘space’ that consists of the digital space of the interface and the physical space of the airport.

Time:

Finally, Saffer explains that all interactions happen over a period of time. Usually, digital interactions happen instantaneously, whereas physical interactions take longer periods of time. When interacting with an interface, it should respond immediately, yet when it requests motion from the user, some time has to be involved, as “Movement through space takes time to accomplish” (Saffer, 2007). At the moment a traveler selects the ‘go to the boarding gate’ option, the interface would immediately provide directions, yet getting to that relevant gate might take several minutes.

Figures 30 and 31, below, show the relation between motion, space, and time within an airport environment. The matrix of figure 29 represents all possible points that airport visitors might pass through at any airport space. Excluding employees, airport users could be departing passengers, connecting passengers, arriving passengers, meeters and greeters, or weepers and wailers. All the possible pathways these users might use at Vancouver International Airport (YVR) in particular are displayed in figure 30. This figure also shows the time it takes for every traveler to walk the distance to a specified gate.

Fig 29: Sirine Hawari, *Journey framework matrix*, 2011. All possible location sequences that airport users (excluding employees) might go through. Matrix: Sirine Hawari.

YVR DOMESTIC + INTERNATIONAL TERMINALS MAP

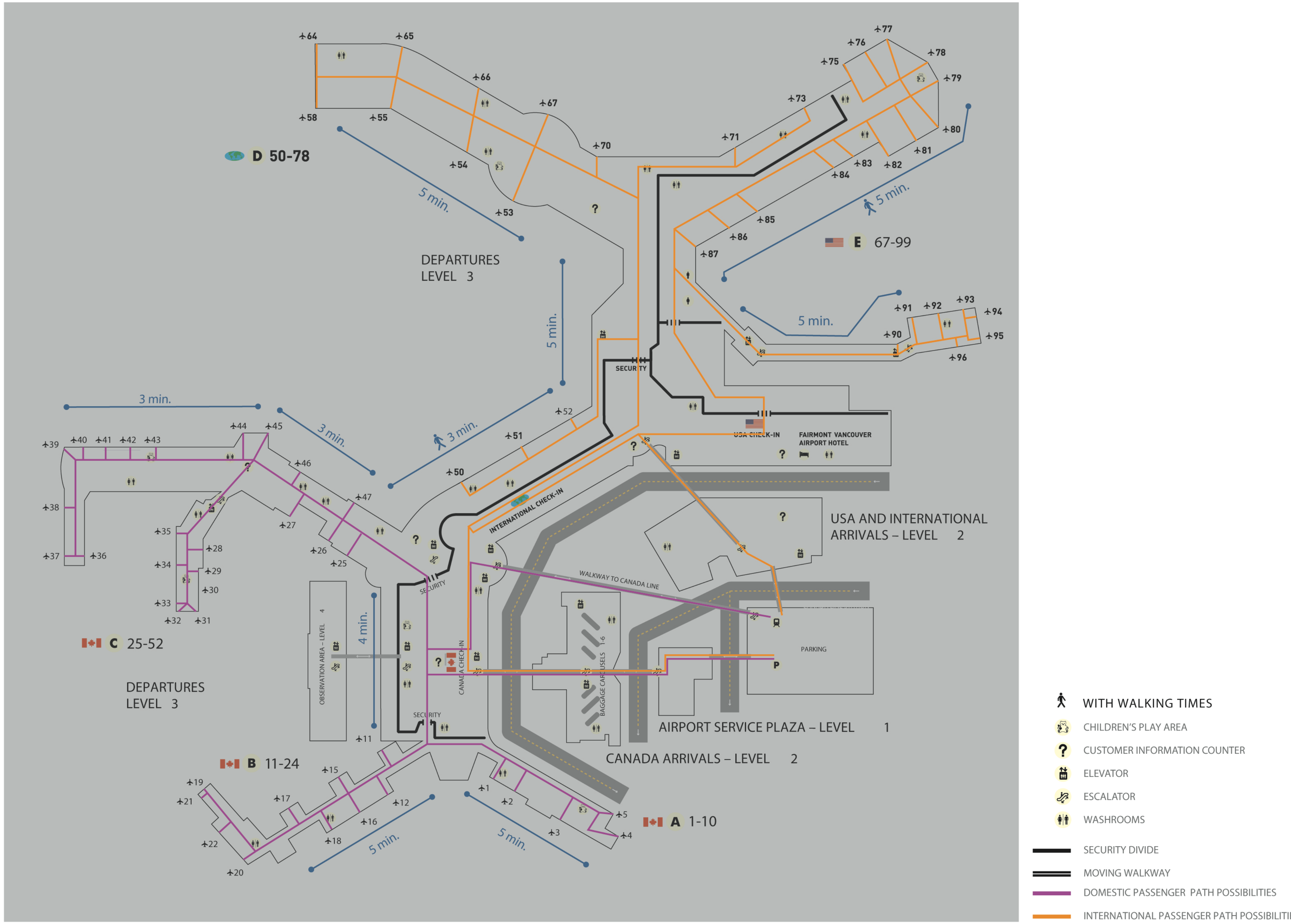


Fig 30: Sirine Hawari, *YVR airport domestic and international terminal maps*, 2011. ll passengers' path possibilities at YVR airport. Illustration: Sirine Hawari

According to Jesse James Garrett in his book *The Elements of User Experience* (2002), user centered design is “the practice of creating engaging efficient user experiences.” He advises that every interactive design solution should be broken down into elements that could be looked at from several perspectives. He suggests five planes for breaking down experience decisions: surface, skeleton, structure, scope, and strategy, to be built up from last to first. “These five planes provide a conceptual framework for talking about user experience problems and the tools used to solve them” (Garrett, 2002).

Figure 31 below shows the implementation of the five planes suggested by Garrett into the ‘Traveler Wayfinder’ project from abstract conception to concrete completion, starting from the strategy layer (A) where user needs and system objectives are identified. The scope layer (B) defines the functional specifications and the content requirements. Then the structure layer (C) is introduced through the interaction design and information architecture. At this point, the skeleton layer (D) is determined through the interface design, the navigation design, and the information design. Finally, the whole system is wrapped up through the surface layer (E) that reflects the visual design of the overall experience.

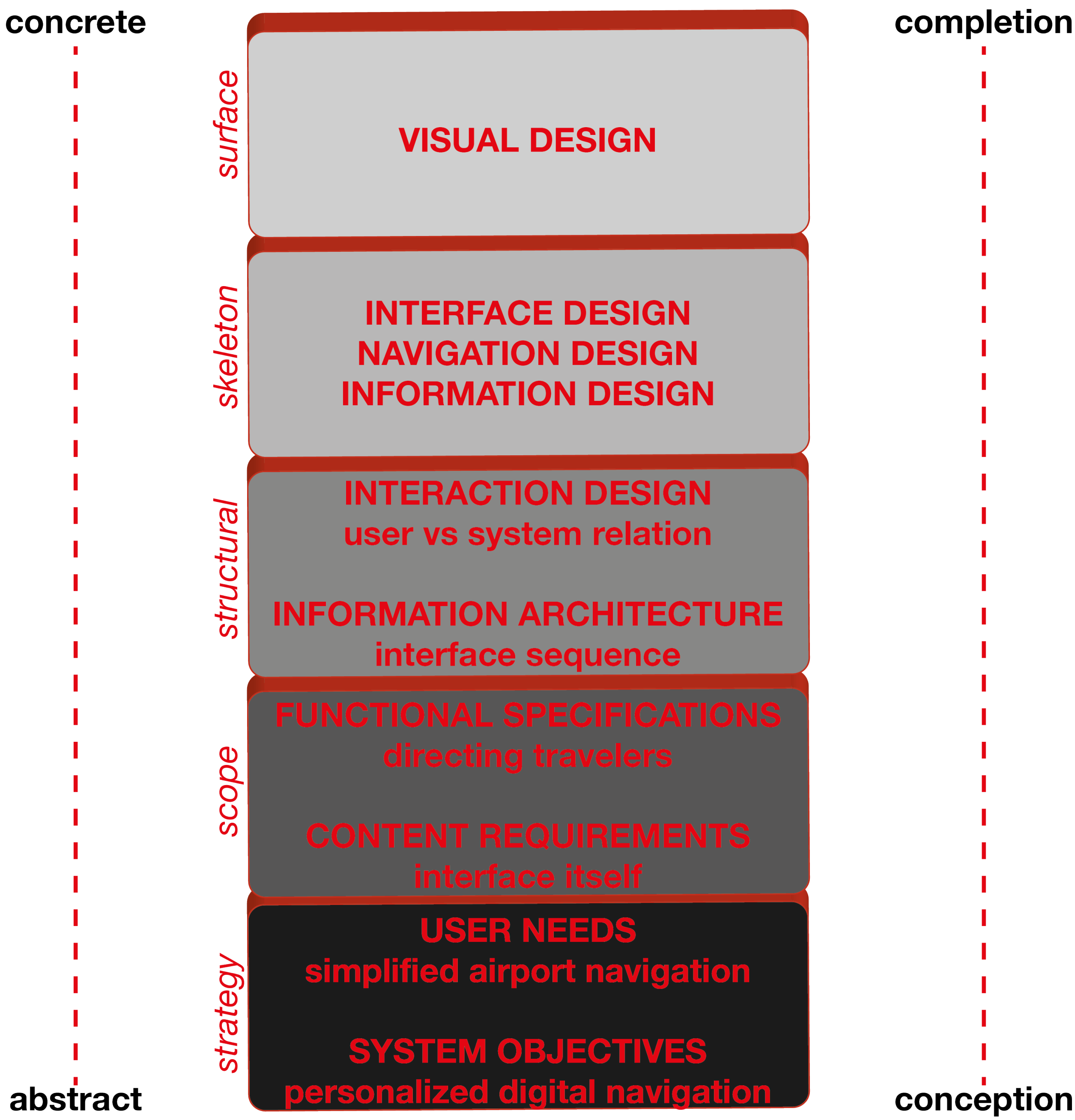


Fig 31: Jesse James Garrett, *Elements of User Experience*, 2008. Adaptation of this project's layers.

A. STRATEGY LAYER

SYSTEM OBJECTIVES:

What is the proposed system?

The proposed system offers navigational guidance through a human-centered interface titled ‘Traveler Wayfinder’ that is based on WiFi, QR codes, and AR technologies.

What are the objectives of this interface?

‘Traveler Wayfinder’’s interface objective is to offer a personalized multi-lingual interaction. This interaction can happen through an easily accessed interface that can be smoothly navigated using clear terminologies that are comprehended by various user groups.

USER NEEDS:

Who are the system’s users?

The main targeted users of ‘Traveler Wayfinder’ are departing, connecting, or arriving travelers who might belong to various age groups which include people with disabilities, children, elderly people, families, or business travelers.

What are the user's needs that are addressed through this interface?

User's needs are addressed through this interface starting with a personalized interactive experience that communicates information that is relevant to the specific user's needs on a particular travel journey, rather than displaying lists of information that cover all travelers' needs for all possible flights. In this way, users experience a clear interaction without getting lost or confused by the overall interface. Travelers are also updated about alerts and notifications that come up during their journey. Finally, travelers are also able to communicate with interfaces that speak their own language, overcoming language barriers when visiting foreign airports.

B. SCOPE LAYER

CONTENT REQUIREMENTS:

What information will users need from this interface?

The main information that users require from this interface is information that will guide them through the airport, including directions to gates, washrooms, information desks, parking, transit, duty-free shops, restaurants, currency exchanges, hotel facilities, and rental car facilities. Travelers also need to be informed about time durations to get to desired destinations, including waiting times at security check points. They also may need to be reminded to start moving toward a certain location in order to make it on time to the intended destination. In addition, they need to be informed instantly about alerts and notifications of changes in boarding gates and departure times.

What form should the information take?

The system uses the Apple User Interface elements for iPhone interactive display. Directional information retrieved is displayed in the form of augmented reality, which is graphical guidance data on top of the real imagery of the airport space gathered via the user's smart device.

What are the elements of this system?

The elements of this system are based on the user being a traveler, the navigated space being an airport, and a smart handheld device that includes a QR code scanner and which is connected to the space's WiFi as displayed in figure 32 below.

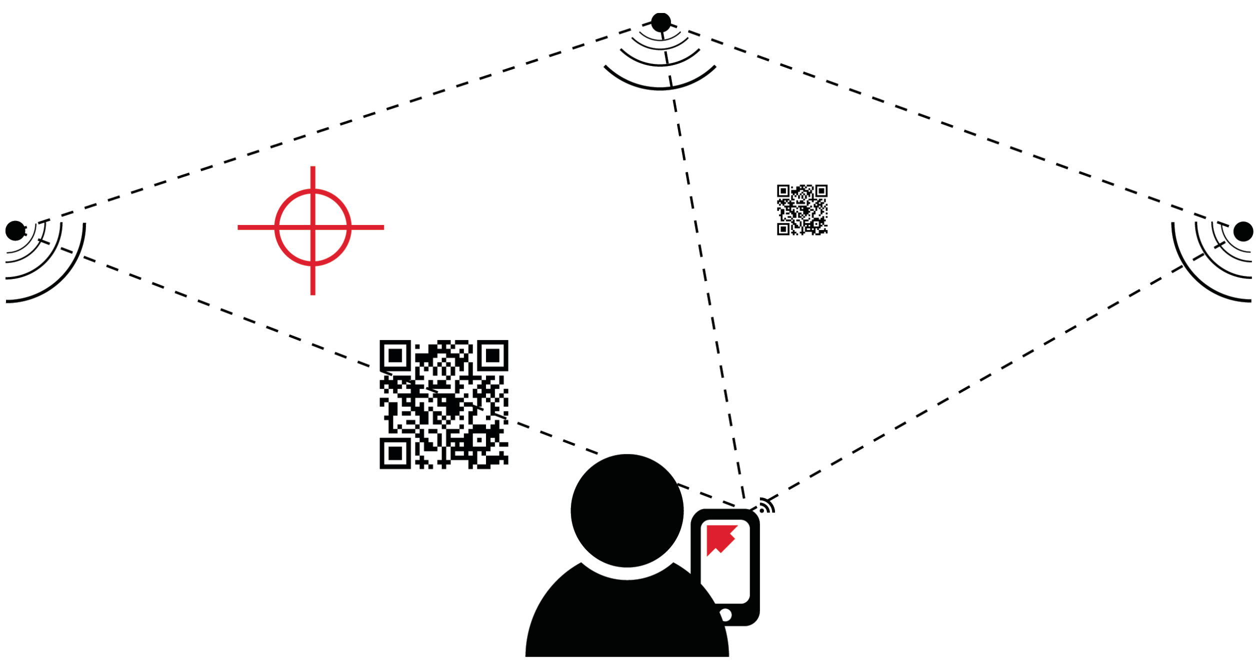


Fig 32: Sirine Hawari, System's *Elements*, 2011.

FUNCTIONAL SPECIFICATIONS:

What does this interface do?

This interface mainly directs travelers through the airport space to their desired destination by providing a graphic layer on top of reality. This interface would give graphical and typographical information that would guide users to their intended destination at the right time.

C. STRUCTURE LAYER

INFORMATION ARCHITECTURE:

How the user moves from one content element to another?

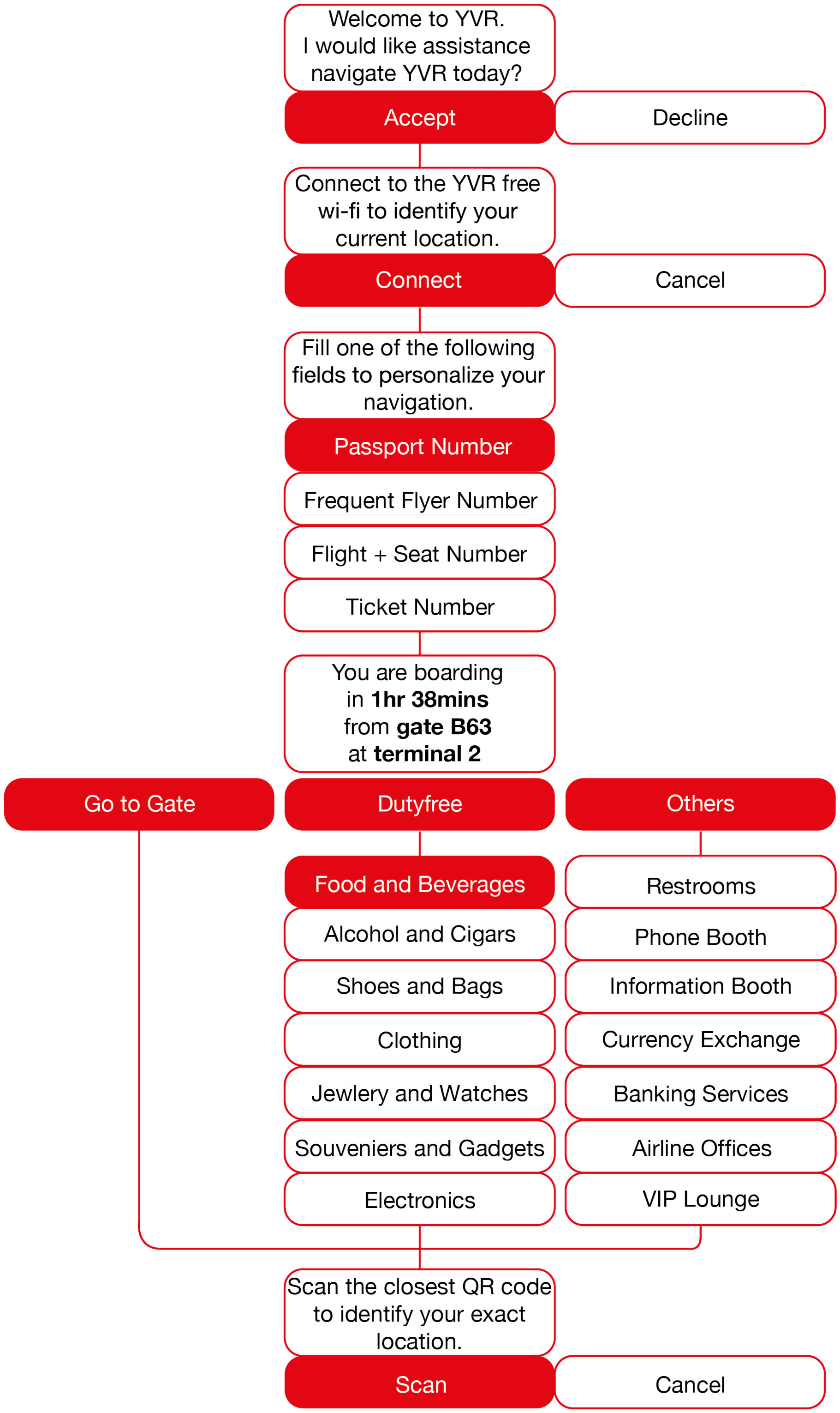
How the information is structured throughout the airport?

The answers to these questions are illustrated in figures 33 and 34 below, which display the user's flow diagram.

INTERACTION DESIGN:

How does the user move from one step of the process to the others?

The user interacts with the system by touching the screen and tilting the device. The system will instantly react by revealing the requested directional information.



** language settings can be changed from the settings menu*

Fig 33: Sirine Hawari, *'Traveler Wayfinder' User Flow Diagram*, 2011. Sequence of 'Traveler Wayfinder' system. Illustration: Sirine Hawari.

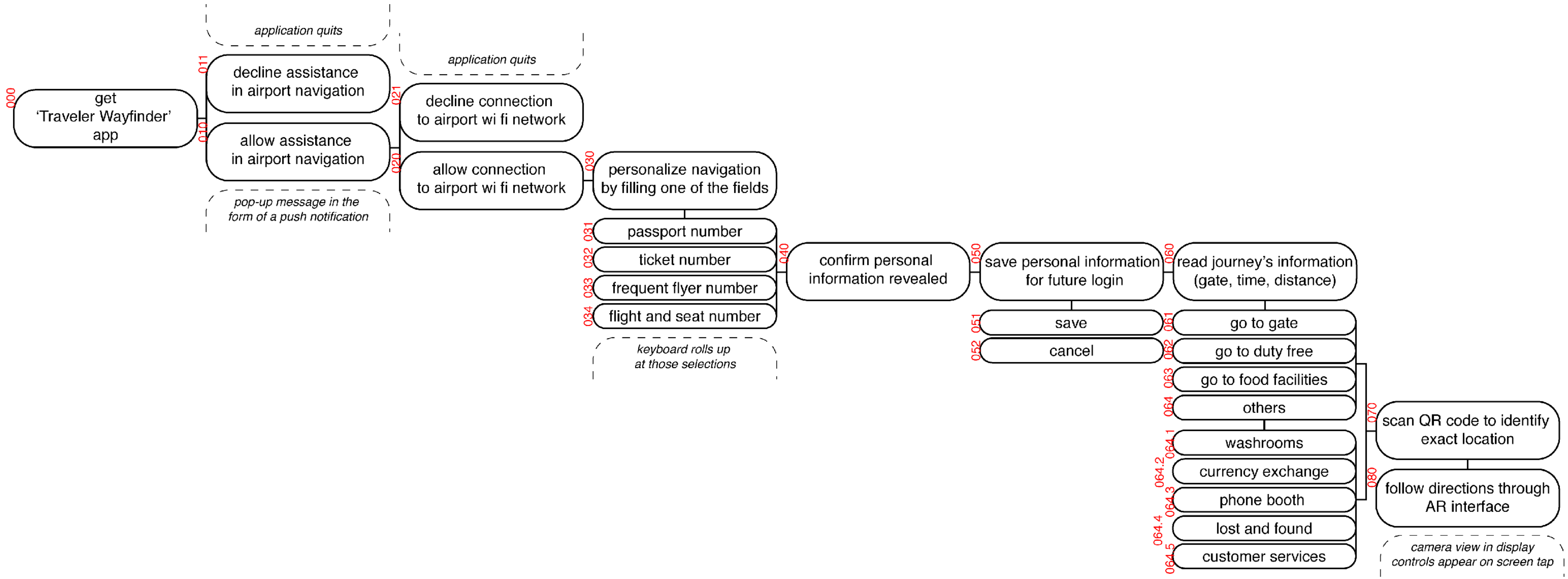
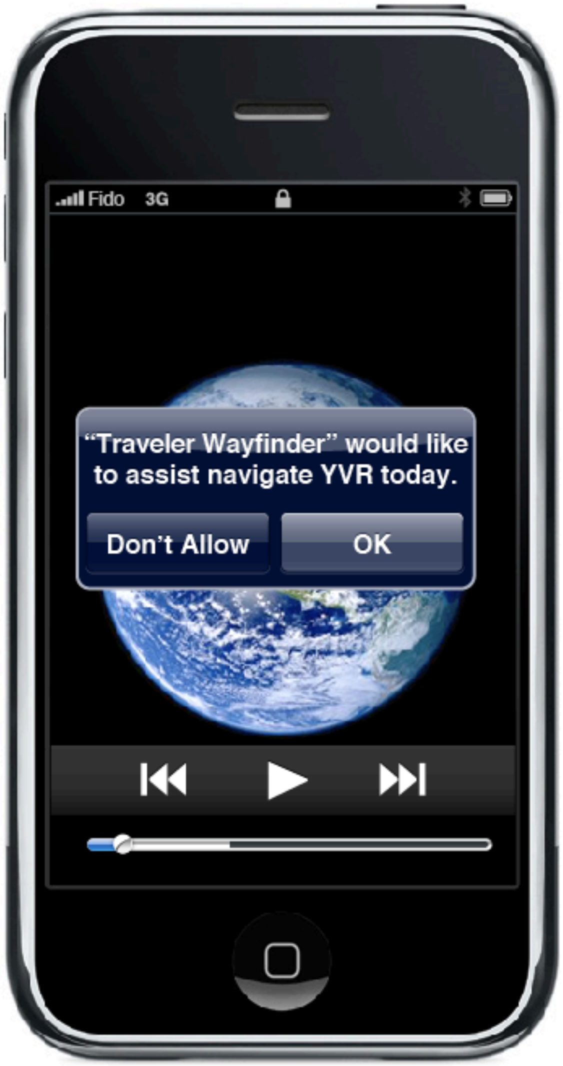
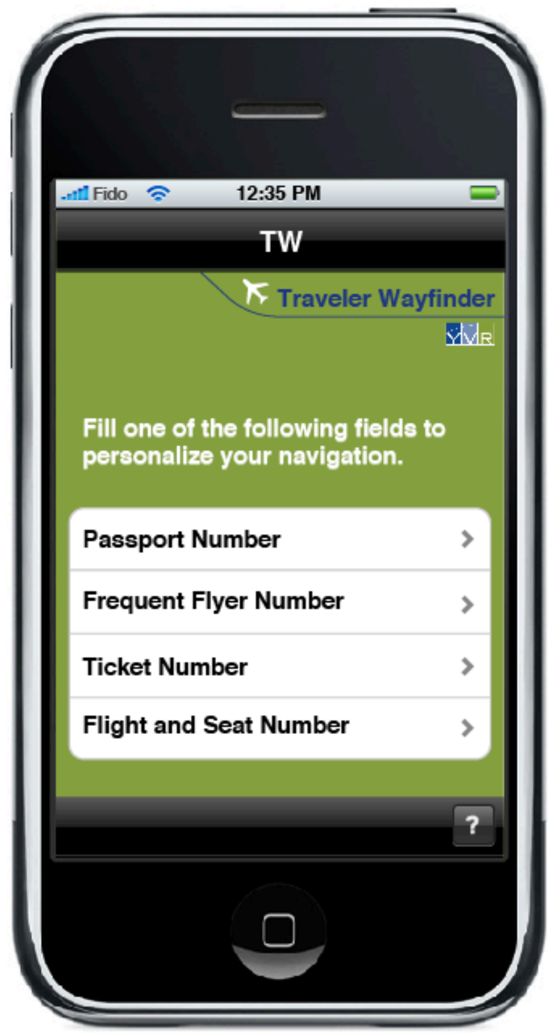


Fig 34: Sirine Hawari, 'Traveler Wayfinder' interface Flow Diagram, 2011

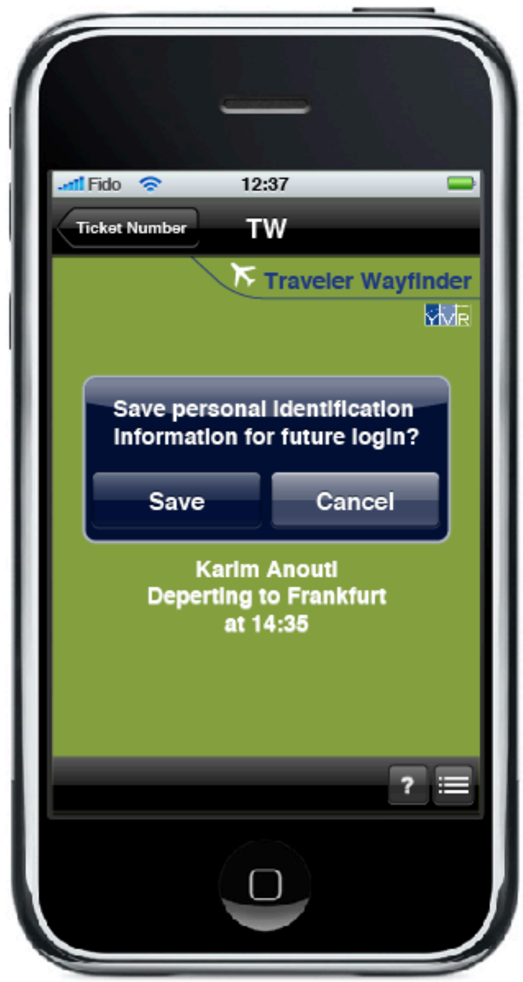


A first time user of ‘Traveler Wayfinder’ who is departing from Vancouver International Airport has the application installed into his iPhone. Upon arrival at the airport, the traveler is asked if he would like to be assisted through his navigational journey at YVR. He agreed.



The Traveler is asked to connect to YVR's WiFi network so that an approximate location of the device can be identified. Once connected, the traveler is asked to personalize his navigation by identifying himself through one of the document number he has.

In this case, he selected the 'Ticket Number' option. The keyboard is presented instantly on the screen upon his selection. He is also provided with the '?' option, where the system will explain why this step is required. Another button on the top right of the screen gives the option to go back to the main menu to change any of the previous selections.



The traveler is asked to confirm if the data retrieved from the provided number matches his profile. The data includes name, flight destination, and departure time. Once the user confirms this information, he is given the option to save this data for future logins.

The traveler is welcomed to the airport and provided with relevant information about his journey including destination city, boarding time, boarding gate, and walking time to that gate. Then he is provided with options for how he might spend the remaining time by either starting to walk to the gate right away or by visiting duty-free shops or restaurants. The 'Others' option provides direction to washrooms, currency exchanges, ATM machines, and public phones. The 'Others' option may vary according to each airport's facilities. Once a destination is selected, the traveler is asked to scan a nearby QR code, so that his precise location can be identified. In the background, the traveler is shown an image that gives him a visual connection of the code he is looking for.

The camera lens is automatically activated, as it will also work as a QR scanner. Once it is passed over a QR code, directional data including an AR interface where graphical information is overlays real imagery of the space surrounding the user will be revealed, thus acting as a digital guide to the requested destination. Once the screen is touched again, the user will be given options on the lower end of the screen as displayed in previous steps. These options are a map view of current and intended destinations, the main menu, and information about this step of the interface.

8. CONCLUSION

This project investigated rising problems in navigating complex architectural spaces, where static signage is becoming inefficient when communicating complete messages for wayfinding within those same spaces. This situation is especially acute in airports, where the terminals' architectural structures are expanding horizontally, in accordance with the expansion of the cities they serve. Signage gesturing left, right, up, and down can no longer serve travelers' needs for finding their intended destination in such vast, complex airport environments. Additionally, travelers are being provided with information that is not relevant to their specific journey.

This paper proposes a customized, digital wayfinding system that adapts to users' navigation needs to assist them in easily getting to their intended destination within public spaces like transportation hubs in general and airports, specifically. This system uses existing technologies and assembles them to provide an enhanced user experience. In this system, travelers will interact within their own informational space, which will provide what they need at the time they demand it. This system is not a replacement for existing signage, but is a tool to enhance travelers' experiences in airport spaces. It goes beyond mere directional guidance; it manages travelers' time by suggesting and connecting them to the airport's facilities and further connecting them to other people and the city.

The next steps of this project include three separate mock-ups each testing a certain aspect of the completed product (the interface, the technology and real client environment testing). The first step is an interface mockup in an airport environment for user testing and feedback. This mockup will include the full clickable interface displayed on an iPhone device. The test group consists of volunteer travelers who have four or more hours of transit wait time. These travelers will be asked to navigate throughout their travel journey using the TW app interface. Although the mock-up interface will not be identifying real information, yet the test group will be capable of navigating the interface and identifying its usability defaults and suggest further useful option requirements noticed through their navigation. Other than the interface sequence and layout itself this testing outcomes will also investigate whether the app is enhancing efficiency, time management, and personalization of travelers within the airport.

In parallel to interface testing, technology prototyping is planned to be in process. In collaboration with computer engineers, technology testing will include trials on combining QR code scanning with Augmented Reality display assisted by Wi Fi triangulation for human scale indoor navigational purposes.

The last step will be adapting the interface and technology for a real case airport environment where redesign of the interface graphics will be adapted to the client's corporate image in terms of line quality, design language and color scheme. At this stage thorough study for branding and promoting the app will be proposed to communicate to travelers, employees and visitors of this particular airport whether through on-line airline websites and ticket confirmation emails, on-flight airline magazines, tubes connecting airplanes to airports, airport's advertisement space, airport's taxis, or other city's touristic and public spaces.

The user experience provided by the proposed system offers simplified navigation using a personalized approach for a stress free and time-managed journey which engages users in the airport space and connects them to other related individuals, transit, and the city. Through a user-centered interface, this system helps travelers overcome language barriers and complete their intended task with few steps of interaction. In other words, it shifts navigational experiences from passive interaction with fixed signs to active interactions that speak to every particular user through smart, handheld devices.

Beyond airport spaces, this system can also serve touristic functions in the city, with the airport navigation as the initial contact point of a prolonged journey into the city. Similarly, it can be the connection between the user and the city's facilities and services using the GPS tool.

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