Simplifying information for an indoor wayfinding system

Project Report

This project report is submitted to the Auckland University of Technology for the Degree of Master of Design.

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Abstract

The purpose of this research was to explore how to simplify information in wayfinding systems through information design, with a focus on combining emergency evacuation procedures and an indoor wayfinding system. That focus differs from normal wayfinding system design. Qualitative research involving an heuristic methodology, observational method and literature review assisted this project to develop an approach to improve effective information transmission. The research developed this approach on how to simplify information using a series of designs such as outdoor wayfinding maps, floor plans of the navigational signage and digital 'application' design. The processing of simplifying the required information was divided into three steps. Firstly, for focus, redundant information needed to be reduced. The second part was to simplify and refine the information, and the third was to synthesise the information and optimise the data for use. In addition, this research considered the information transfer between the physical world and a virtual platform such as a smart phone. Thus, the QR code become a relevant tool because it can transfer real-world information into the digital world. An approach was developed for using graphics to simplify complex information to assist users to a more natural understanding of novel environments. Additionally, the approach of transmission information between the physical world and digital world was noted. These two approaches will help the designer to improve indoor wayfinding system design.

Key words: indoor wayfinding system, emergency, information design, wayfinding system design

Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the Acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Acknowledgement

I would like to thank my supervisors, Dr. Peter Gilderdale and Dr. King Tong Ho for their encouragement and support this year and pushing my design practice to new areas of thinking. Whenever I met a project or research problem, they patiently guided me and gave helpful advice that was all invaluable. English is my second language, so that weakness in writing caused some communication difficulties. However, my two supervisors always encouraged me. The confidence that they give me is driving my progress. Thanks also to Dr. Pam Oliver for proofreading this report.

Introduction

Aim & Hypothesis

The purpose of this research was to explore how to simplify information in wayfinding systems through information design, with an emphasis on combining emergency evacuation procedures and an indoor wayfinding system. Boonyachut, Sunyavivat, and Boonyachut noted that wayfinding refers to all the ways people locate themselves in physical space and navigate from one place to another.[1] Primarily, this project investigated an emergency escape wayfinding system. Emergencies are situations where simple information is needed. Thus, emergency situations formed a relevant basis for this research. Information design in wayfinding systems was explored through qualitative research to obtain information about improving the quality and effectiveness of information transmission to simplify physical wayfinding system information and transfer it to a digital wayfinding system.

There were three hypotheses in this project. The first hypothesis was that utilising graphics to simplify complex information assists users to a more natural understanding of novel environments. Secondly, it was predicted that a digital wayfinding system will be better utilised than physical wayfinding, so that it might replace physical wayfinding in the future. The third hypothesis was, where physical wayfinding still exists, how can digital wayfinding be merged with the physical world, and can both approaches be integrated to help the user?

[1] Supawadee Boonyachut, Chai Sunyavivat, and Nan Boonyachut, "Hospital Wayfinding through Directional Sign on Logistics Concept," *The Asian Conference on Arts and Humanities* (2012): 902.

Introduction

Primary research processes

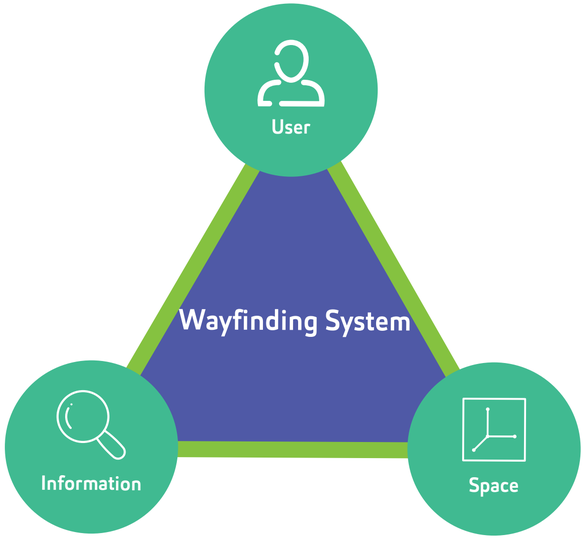


Figure 1. Jonathan Gu (2018).
The three elements of wayfinding systems

To achieve the research aim, firstly, information about basic structural principles for outdoor and indoor wayfinding systems was researched through a contextual review. A prerequisite for optimising this information is the interpretation of the data. With a full understanding of information, it can be simplified, filtered and optimised. Secondly, an application programme for an indoor wayfinding system in the Auckland University of Technology WE building was prototyped through designing an app to explore a virtual wayfinding system. The process investigated how to optimise information utilising different approaches. Thirdly, the pros and cons of the virtual indoor wayfinding system were analysed to determine how to merge a virtual into a tangible wayfinding system. In addition, using wayfinding systems for emergency situations was a key part of this research for development of better wayfinding under constrained conditions.

The relationship between the user, information and space explored by this system is shown in Figure 1. Through this process, the exploration of information transmission was improved by three steps. The first was simplifying existing indoor wayfinding systems information, such as through a floor plan or signage. The second was re-assessing the space to extract further information to streamline the information design of the system. The third was to organise these results to apply to the programme of apps.

Introduction

The rationale of study

With the rapid development of the Internet, billions of bits of information have been produced every minute. However, the speed at which people receive useful information is limited, so the challenge is how to improve the efficiency of transmission for the user to read the message effectively. According to Fuller's research, pictograms or semiotics are effective approaches for an individual to accelerate their reading process.[2] Although people understand a graphic faster than text, the description of the graphic often leads to the loss of precision in the information. Therefore, the challenge is how to improve the effectiveness and efficiency of transmission through an effective graphical language. The premise that reading graphic language is faster than reading text was a vital aspect of this research. Wayfinding system design understands the dissemination and transformation of data, because a wayfinding system is utilised through a public space vision system and is responsible for communicating space information contained in graphics and text. Thus, this project can be defined as the information design of wayfinding systems.

[2] Gillian Fuller, "The Arrow--Directional Semiotics: Wayfinding in Transit," Social semiotics 12, no. 3 (2002): 233-236.

Introduction

Scope of the project

This project included how to improve useful transmission of information and the process of an indoor wayfinding system design. This system utilised different approaches to communication to achieve practical methods of accelerating information transfer. A qualitative research approach was used, together with design thinking, observation and literature review methods. The target audience for the wayfinding system was both the standard user and special populations such as disabled or blind people. Both normal environments and particular environments like emergency situations were considered in the research.

Introduction

Report structure

The report is organised into four parts. The first part provides background information about wayfinding systems and useful transmission data that builds the foundation knowledge for exploring information design in wayfinding systems. The second part details the concept development followed by research methods as outlined above. The third part describes the results and findings for analysing the application programme and whether useful information about the wayfinding system is provided for users. The last part presents an interpretation of indoor wayfinding system design and evaluates the app design used in this situation from different aspects. The research results are discussed in order to extract ideas about how to simplify information, and the potential for future information design research and application scenarios is described.

Contextual review

Overview

In this chapter, the process of how to fit the programme into this research area is illustrated. Three basic elements of wayfinding as the core concepts will be described. The wayfinding system, information processing and user wayfinding behaviour are divided into three parts.

Contextual review

Space-wayfinding systems

A wayfinding system, as defined by the Society for Environmental Graphic Design, is an information system that is utilised for guiding users based on a real environment.[3] Particularly, this system enhances users' experiences and comprehension of environments. Accordingly, wayfinding systems have been applied to complicated architectural environments like universities, museums and healthcare facilities. Wayfinding employs easily identified cues such as symbols, maps and signs to guide users and help them to finish their journeys. In the 1960s, urban architect and planner Kevin Lynch first used the term 'wayfinding' in *The Image of the City*.[4] However, his work did not impact graphics and signage instantaneously. The relationship between information, wayfinding and users was described in the 1992 book Wayfinding: People, Signs and Architecture by Passini and Arthur. The elements designed in wayfinding initially came to be understood in the book. In addition, Passini noted that 'spatial orientation' is the basic concept of wayfinding, and he proposed a wayfinding system design for emergency conditions.[5] These references assist this project in obtaining background information.

Users' subjective experiences play a role in wayfinding. Passini and Arthur state that 'we must credit Lynch as the first person to recognise the importance of "imaging" to people finding their way'.[6] Thus, images may be the most important element that people use in wayfinding. However, building images to navigate users' journeys is problematic. The observation approach can help. Hölscher noted that when the observation method

[3] SEGD, "What Is Wayfinding?," Society for Experiential Graphic Design, https://segd.org/what-wayfinding (accessed 21 Sept, 2017).

[4] Kevin Lynch, *The Image of the City* (Publications of the Joint Center for Urban Studies: Cambridge [Mass.] : MIT Press, [1960], 1960), 4.

[5] Paul Arthur and Romedi Passini, *Wayfinding: People, Signs, and Architecture* (New York: McGraw-Hill Inc., 1992), v.

[6] Ibid.

is applied to wayfinding system design, particularly users' navigation behaviours, where they identify their routes can be recorded by this method.[7] It is important to utilise this method to obtain implementation reference data and improve navigation. Typically, when creating these systems, designers focus on helping users navigate to their destinations. However, although wayfinding design started with normal, everyday situations, including working, travel and entertainment, there has been a lack of focus on emergency situations and helping users evacuate in limited time.

The design process for this project began based on how users might use systems to escape in urgent conditions and then on using those systems under normal conditions. Because of the limited scope of this project, combining emergency evacuation processes and an indoor wayfinding system are important. It is challenging to effectively reproduce outdoor wayfinding under indoor conditions. From the perspective of Montello and Sas, landmarks are effective means of wayfinding navigation because they are a medium for communication between people and the environment.[8] By looking for the landmarks, users can create images in their own memory design wayfinding system. Specific features allow users to navigate to destinations and remember routes more easily. So how can the memory of landmarks be simplified so that they are more easily identifiable by users?

[7] Christoph Hölscher et al., "Up the Down Staircase: Wayfinding Strategies in Multi-Level Buildings," *Journal of Environmental Psychology* 26, no. 4 (2006): 286-287.
[8] Daniel R Montello and Corina Sas, "Human Factors of Wayfinding in Navigation," (2006): 9.

Contextual review

Information processing

An intelligent device recognises the quickest wayfinding system through the current digital navigation system. The Routing algorithm is a fundamental principle of digital navigation developed by Edsger Dijkstra.[9] This technology utilised computer mathematics to calculate the user's high-quality routing. Users achieve the best route by decreasing the routing options. Doing so is vital for the wayfinding system to simplify information provided.

Wayfinding systems consist of a series of navigational information. These components are districts, edges, paths, nodes and landmarks.[10] These five components and the features of the indoor scenario are defined in the present research. These features contain corridors, door walls, windows and indoor landmarks. Although they can provide the outline of the environment, the challenge is to simplify the indoor components for people utilising digital devices or maps. The binary system utilised in the computer or the cytosine (C), guanine (G), adenine (A) and thymine (T) on the base of deoxyribonucleic acid (DNA) coding is an example of such, as numbers or letters that shorten the element can be used to simplify complex information, and this method can be easily understood. The use of signage or icons is another example of outdoor wayfinding systems. Standard graphics like circles, triangles or rectangles are one approach for simplifying indoor characters, as created through the research of Otto Neurath.

[9] Edsger W Dijkstra, "A Note on Two Problems in Connexion with Graphs," *Numerische mathematik* 1, no. 1 (1959): 269.
[10] Lynch, *The Image of the City*, 46.

Figure 2.(1964). Tokyo Olympic Games icons[12]

Isotype was created by Neurath through using graphical information to express text messages.[11] This type of pictogram language was used for the 1964 Tokyo Olympics to help foreigners understand sports information without language (Figure 2). Otl Aicher designed the pictographs used at the Olympic Games.

In international public places such as airports, hospitals and museums, pictogram language can help users to obtain information. Meanwhile, IOS7001 was established as a universal symbol language by the International Organisation for Standardisation (ISO).[13] This has led to the use of global standard symbols to convey information. The designer Hassan stated the graphic elements that are selected to create these hieroglyphs, and whether such symbols are affected by the immediate environment.[14]

[11] Marie Neurath, "Isotype," *Instructional science* 3, no. 2 (1974): 128.
[12] Justas, "The History of the Olympic Games Icons," http://iconutopia.com/the-history-of-the-olympic-games-icons (accessed 18 Oct, 2017).
[13] K. Koyama, "Current Status of Iso 7001 Graphical Symbols Public Information Symbols," *Information Design Journal* 22, no. 2 (2016): 181.
[14] Hassan, Enass Mahmoud Mohamed. "The Semiotics of Pictogram in the Signage Systems." *International Design Journal* 5, no. 2 (2015.4): 308.

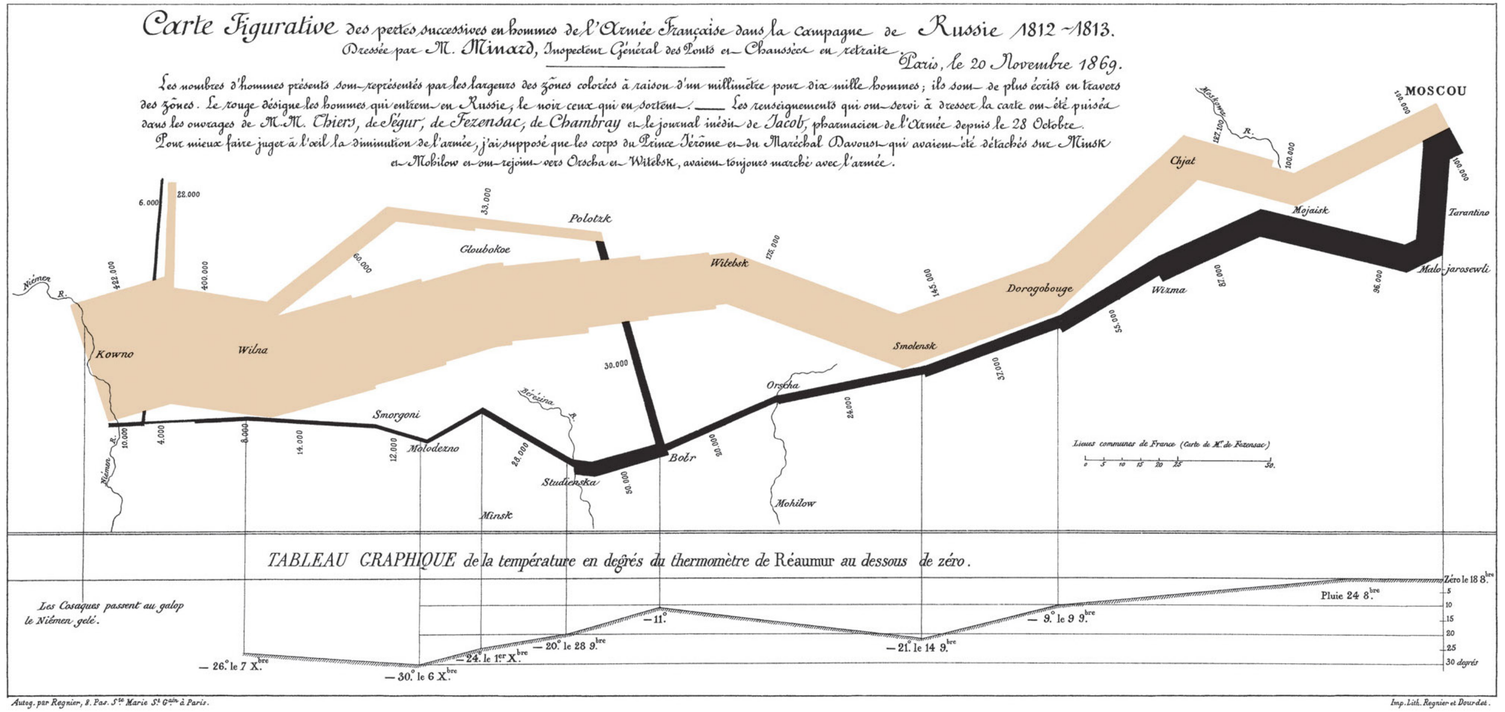


Figure 3.(1861) Charles Minard's 1861 diagram of Napoleon's disastrous Russian campaign of 1812 [17]

Reading graphic information can also play the same role as reading text. Edward Tufte explained how to utilise visual language to simplify information in *The Visual Display of Quantitative Information*.[15] Graphics are used to help readers understand quickly, such as in maps or diagrams to mark important data. In addition, the historical case of Charles Joseph Minard was used by Tufte, identifying two dimensions to describe the six 'types' of data.[16] The six types of data referred to the number of Napoleon's troops, temperature, latitude and longitude, the distance travelled, location, and date (Figure 3). This map shows how to combine different data. For a wayfinding map, it is possible to represent more types of data on just two dimensions. Graphic language is a simplified method of information; when the text on a map is converted into graphic information, the map becomes easier to understand for users.

[15] Edward R. Tufte, *The Visual Display of Quantitative Information* (Cheshire, Conn. : Graphics Press, [1983], 1983).
[16] Charles Joseph Minard, "Charles Joseph Minard, Mapping Napoleon's March, 1861. Csiss Classics," https://en.wikipedia.org/wiki/Information_design#/media/File:Minard.png (accessed 18 Jun, 2018)
[17] Ibid.

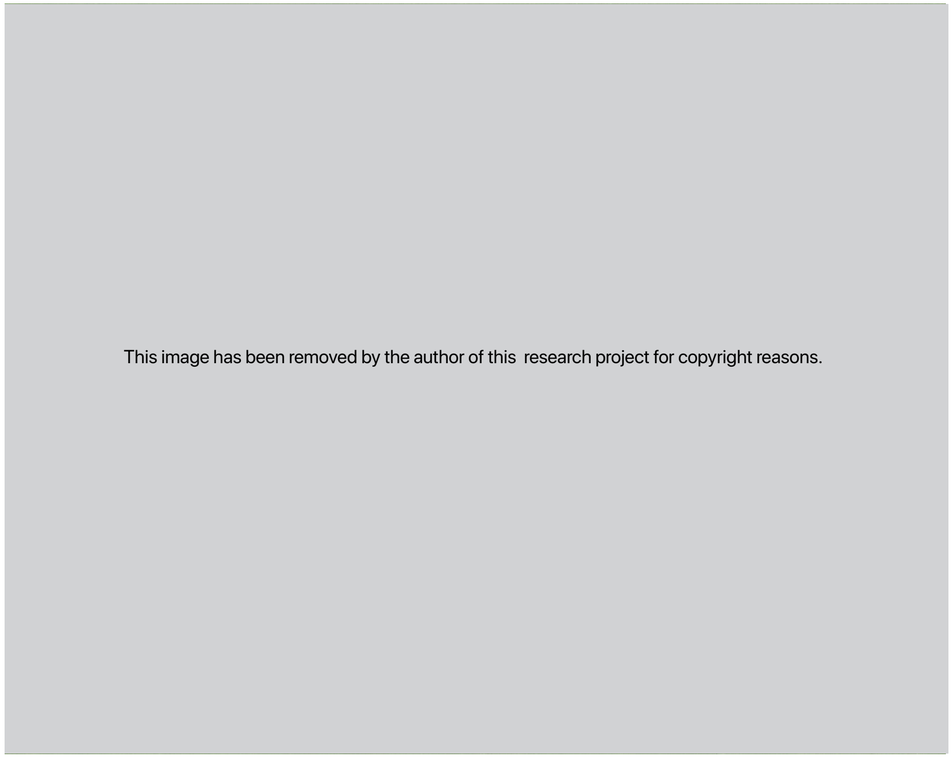


Figure 4.(1908). Map of London Underground lines[18]

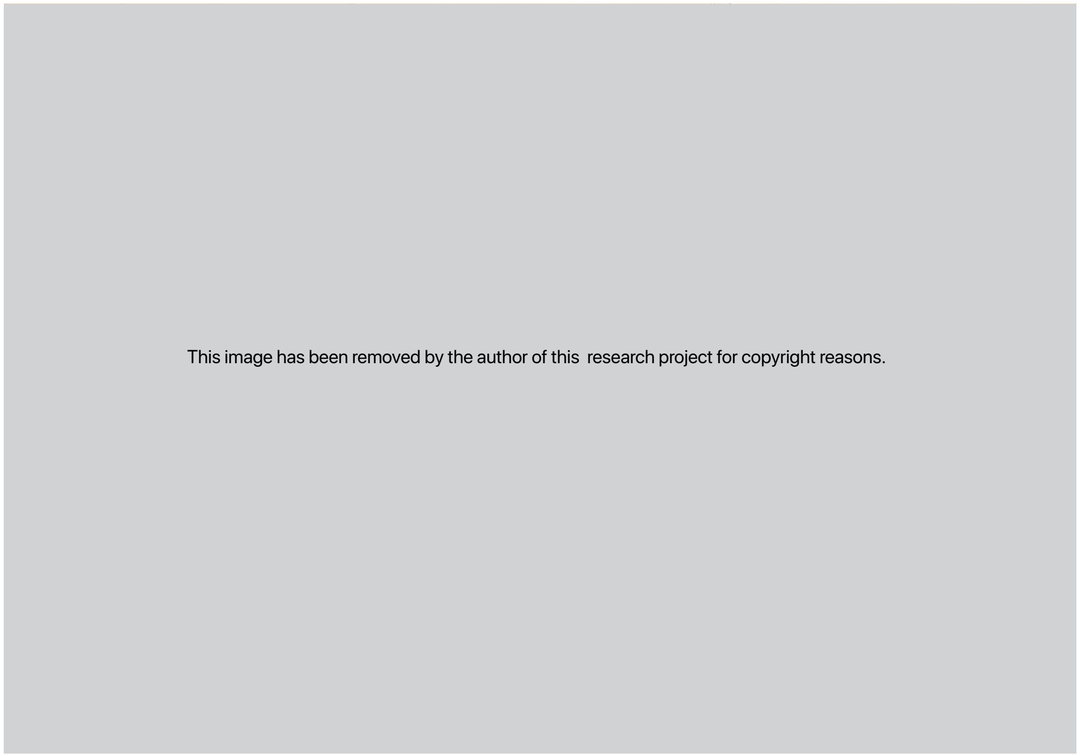


Figure 5.(1933). Beck's London Underground map[19]

[18] London Underground, "London Underground," *Transport for London Website http://tube. tfl. gov.uk/content/about/default.asp* (2003) (accessed 27 Sept, 2017).
[19] Theodore Cardwell Barker and Michael Robbins, *A History of London Transport*: The Nineteenth Century (London: Routledge, 2007).

The London underground map of 1933 was designed by Henry Beck and became the basis of maps for all underground train systems. Comparing Figure 4 and Figure 5, the important difference between this map and the previous version is that Beck removed the distance, time and terrain information and used circles and lines to create spatial relationships to convey information. Thus, when useless information is deleted, only the information required by the user is provided, simplifying understanding. Customised design provides users with a better experience and faster understanding of information. Therefore, it is crucial to filter and optimise the image information for the user. In addition, you need to observe the behaviour of the user if you want to enhance the user experience, in order to provide simple information.

Contextual review

User wayfinding behaviour

Zimring noted that when people enter a strange environment they may feel some stress and anxiety.[20] Arthur and Passini categorised the influence of navigation challenges into four features - functional inefficiency, frustration and pressure, approachability, and security. [21] Safety features are particularly related to emergencies. Users escape from a dangerous area through the wayfinding system guiding them when an emergency happens. When trying to plan an effective evacuation system, Arthur and Passini note that it is vital to understand "the wrong assumption is that users feel panic under the emergency situation". [22] Users tend "to behave in a controlled and rational way as long as they want to survive". [23] Therefore, the key factor is how to eliminate the user's high stress and anxiety through the design of emergency wayfinding systems.

Arthur and Passini also pointed out that three important features could impact on people's reactions to an emergency evacuation. Initially, time is of the essence, especially in emergencies. Through understanding distance and time information, users can reduce stress. Conversely, stress increases when users cannot obtain relevant information, making it difficult to make judgements. Next, the ability of users to process information is affected by stress, which depends on the surrounding environment. [24] Using up physical strength is also of concern. Psychological and cognitive resources have to be assigned to deal with anxiety. Thirdly, stress increases anxiety levels. When people are highly anxious, they are more likely to make bad decisions.[25] The challenge is how to reduce uncertainty in order to reduce individual stress. If a system can

[20] Craig M Zimring, "Stress and the Designed Environment," *Journal of Social Issues* 37, no. 1 (1981): 158.
[21] Arthur and Passini, Wayfinding: People, Signs, and Architecture, 6-10.
[22] Arthur and Passini, Wayfinding: People, Signs, and Architecture, 80-81.
[23] Ibid.
[24] Ibid.
[25] Ibid.

improve information clarity for people without their having to make complex decisions, they can escape by quickly following navigation aids. Therefore, developing an intelligent cognitive map is vital in order to help people.

It is critical to design a valuable wayfinding system for emergency situations in order to simplify and clarify the exit process. The wayfinding system can decrease the likelihood of information overloading, thus decreasing anxiety. Effectiveness, conciseness and clarity of information can enhance the probability of a quick escape.

Concept and development

Overview

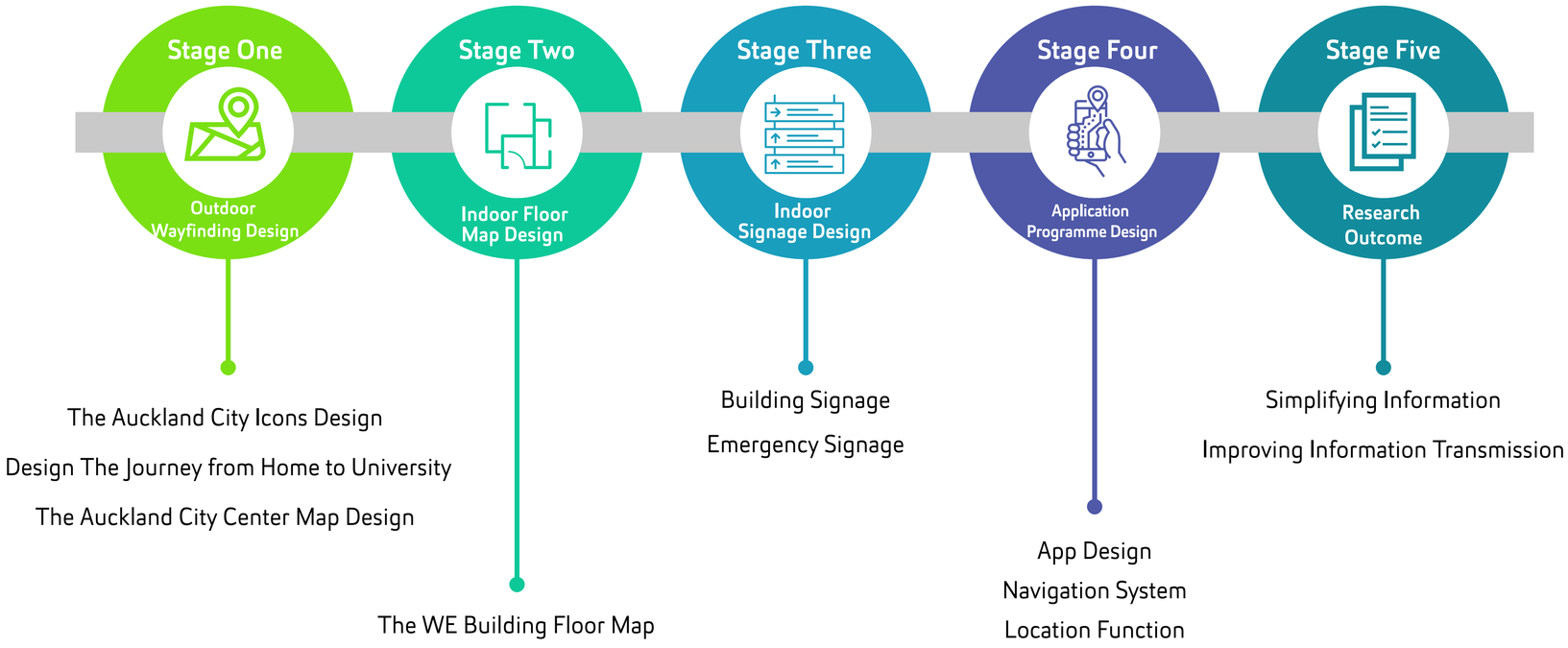


Figure 6. Jonathan Gu (2018). The five phases of concept and development

The basis of this research focuses on the useful transmission of information in the wayfinding system. The whole project can be divided into five phases, as shown in Figure 6 and detailed below.

Concept and development

Stage one: Outdoor wayfinding design

Today, outdoor guidance is more complicated than indoors, so an outdoor navigation system is a helpful example. Valuable project ideas were developed through exploring outdoor wayfinding. The present project focused on outdoor wayfinding design for the first project stage, to formulate an idea for an indoor wayfinding system design. According to the findings of the contextual review, pictogram language is one approach for transferring information via graphics. In an outdoor wayfinding system, such as a park, highway or open air space, signage and cartography are used for navigation. Therefore, for the conceptual stage, this project focused on outdoor cartography design, specifically the researcher's journey from home to university.

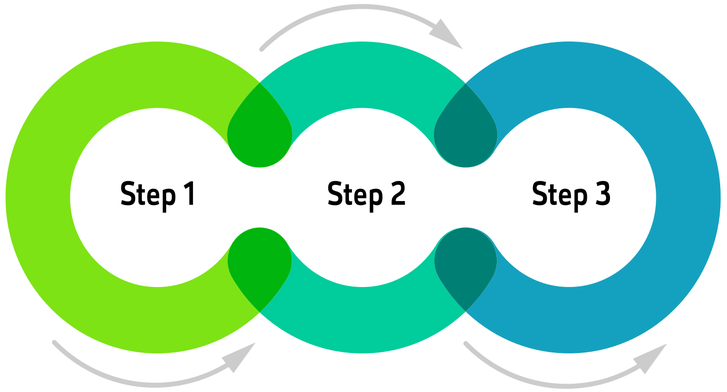


Figure 7. Jonathan Gu (2018). The process of first stage

This design process is illustrated in Figure 7. Firstly, the map is made up of the standard map elements, except for some irrelevant information (Figure 8). Secondly, the map information recombines using the circle, line and less text (Figure 9). Thirdly, Figure 10 provides more information and different routes for this journey on the map. Fourthly, Figure 11 attempts to represent more detailed data in the designated area, such as the city centre. The presentation of information is based on the information required to manage the travel through observation.

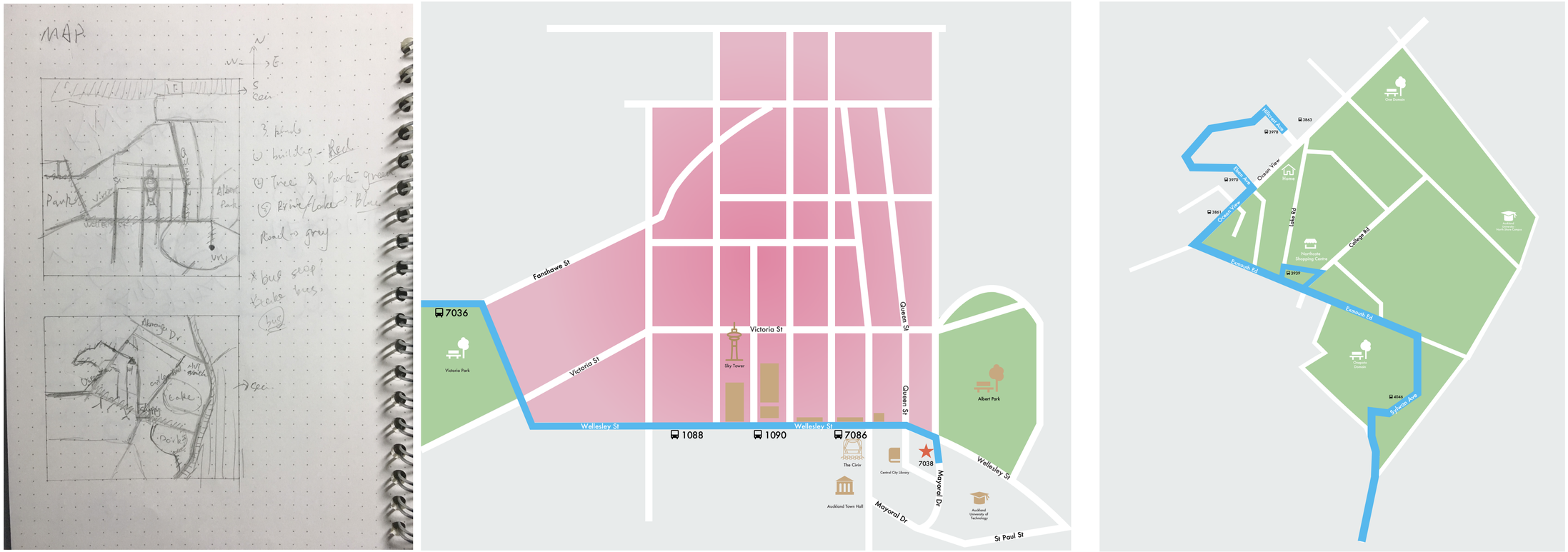


Figure 8. Jonathan Gu (2017). The normal map design for journey between the university and home

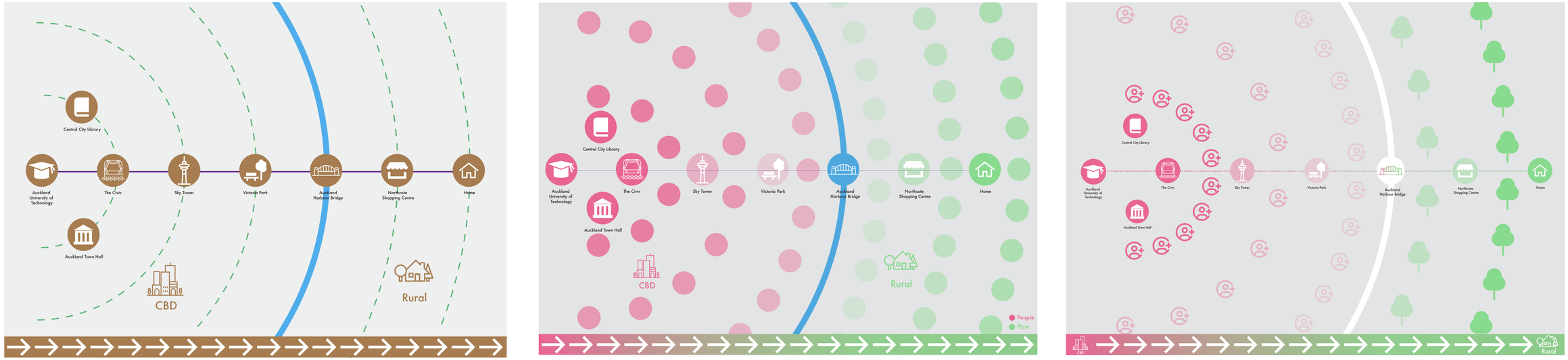


Figure 9. Jonathan Gu (2017). The iconographic for CBD to rural (1)

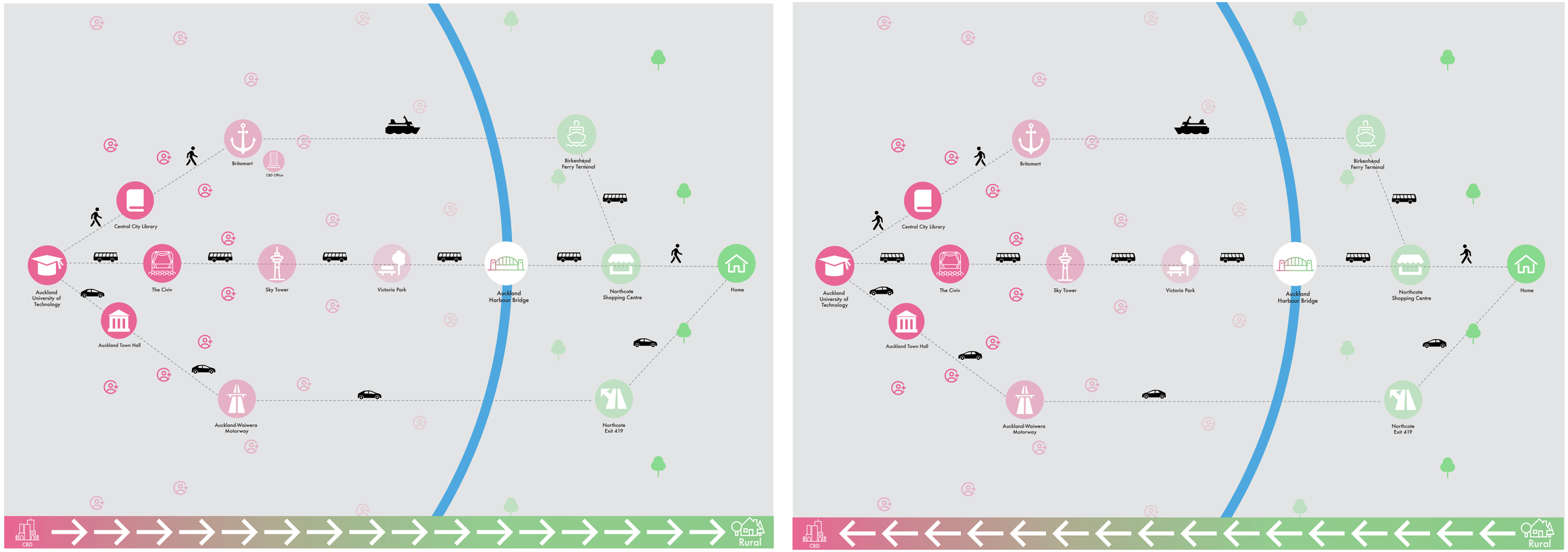


Figure 10. Jonathan Gu (2017). The iconographic for CBD to rural (2)

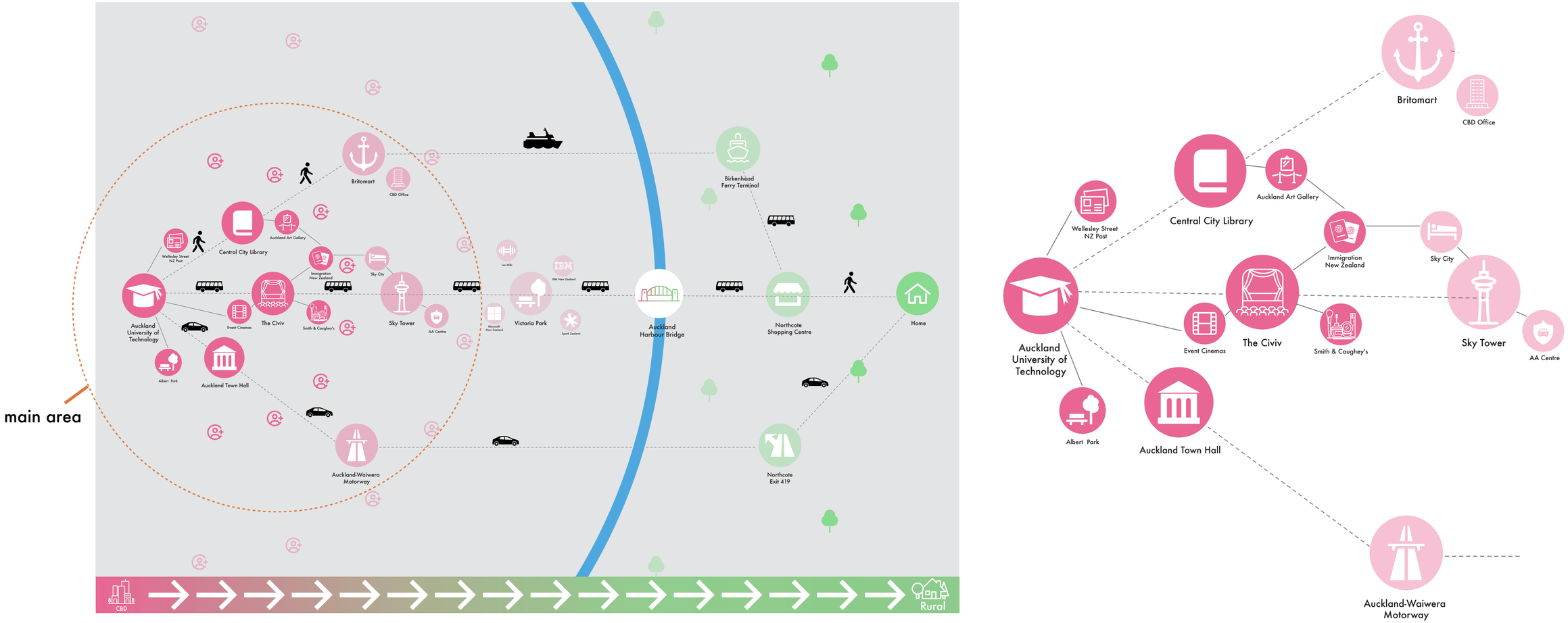


Figure 11. Jonathan Gu (2017). The iconographic for CBD to rural (3)

Figure 12. Jonathan Gu (2017). Icon designs for buildings in Auckland near the University

In this process, circles, lines and dotted lines were used to establish the relationship between different places. Graphics such as lines, dotted lines and circles are used to demonstrate the logical connection between places for the user to understand. Icons were used to replace actual objects such as buildings or particular sites. The isotype map is a useful example where only symbols or graphics are employed to provide map information. In it, pictogram language aims to improve the ease of interpreting icons, as Figure 12 shows. The iconographic for CBD to rural was used to describe the information through graphic language with text. However, it is vital to figure out how to use shapes to describe information without text. Therefore, Figure 13 only uses lines of different colours to illustrate the Auckland city centre map, to test whether the map design can be understood without text information.

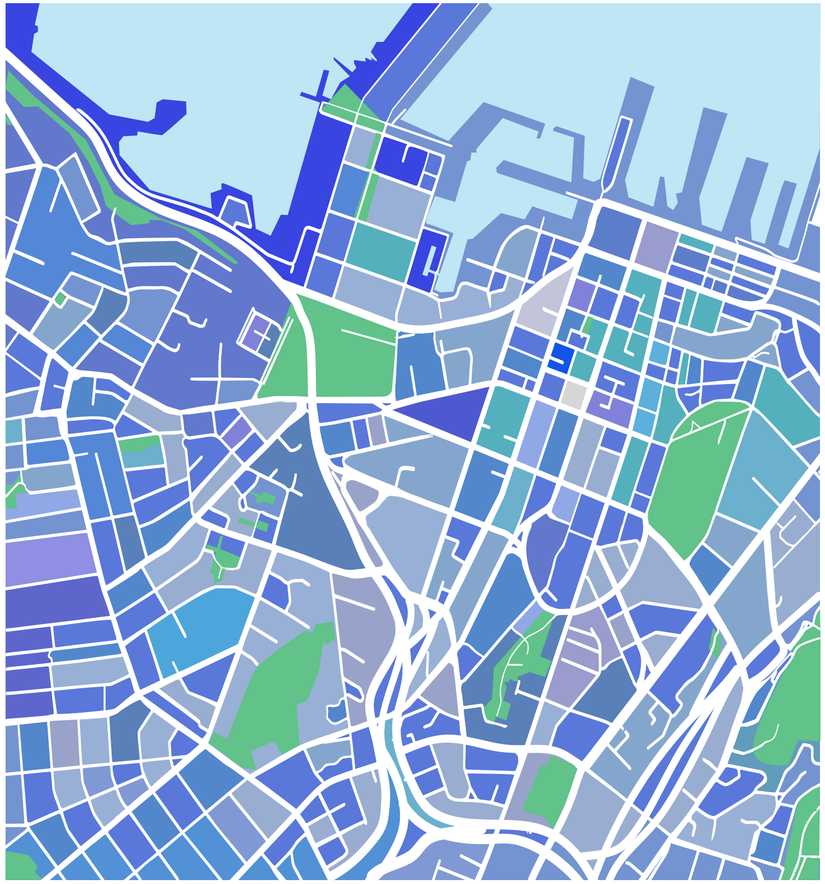


Figure 13. Jonathan Gu (2017). Auckland CBD map

The value of the process described above was to achieve the primary idea of how to simplify map information. The first step was to find the structure or root of information, and then the data could be explored. This approach was used in stage two.

Concept and development

Stage Two: Indoor wayfinding design - floor plan

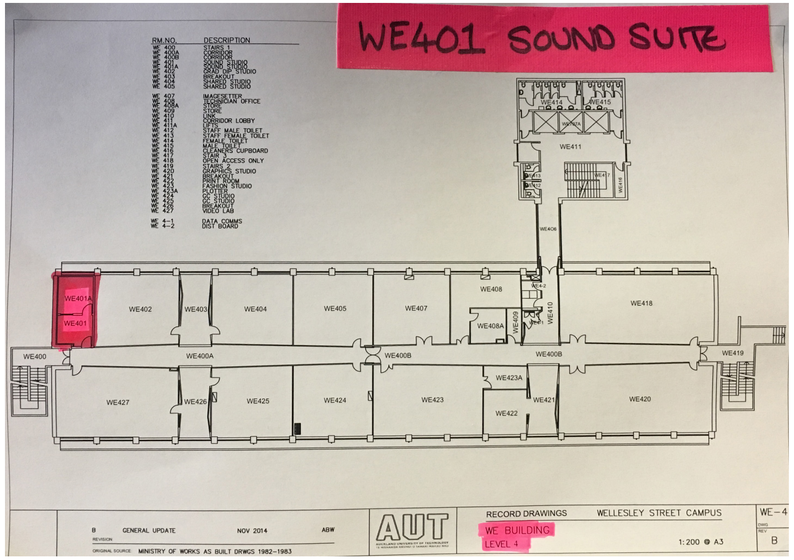


Figure 14. Jonathan Gu (2017). The floor plan for WE building 4th floor

Once the outdoor map design was explored, the design goal was moved to indoor wayfinding design. Since I usually study in WE building, it is easier to observe the familiar environments and I could obtain information for a building I knew. An investigation of the floor plan is a useful way to understand indoor information and how to simplify information for indoor wayfinding. Figures 14, 15 and 16 illustrate the floor plan, floor guidance map and signage board.

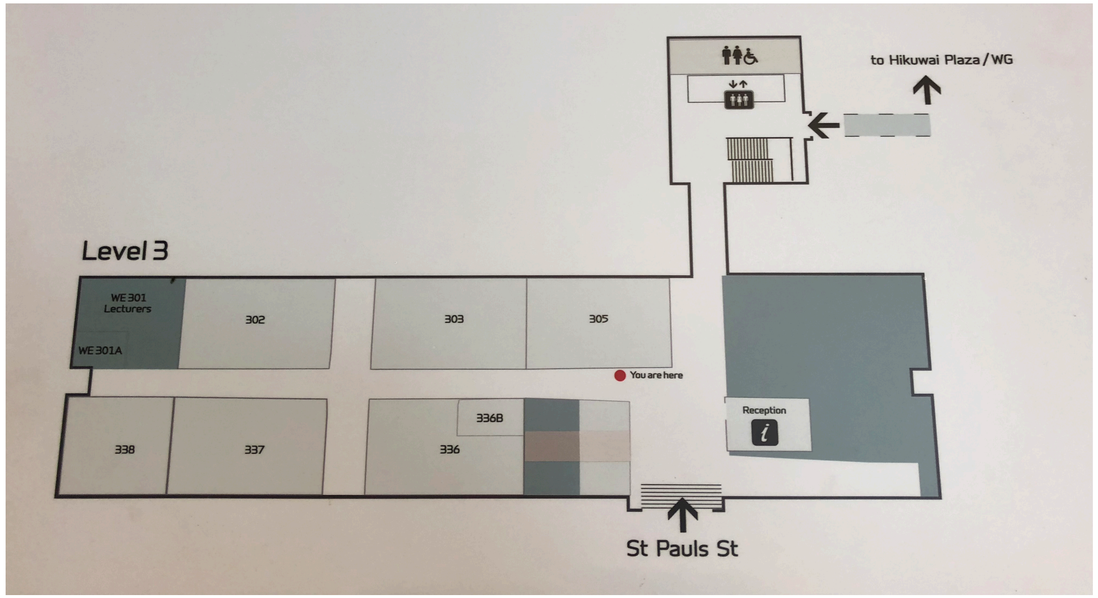
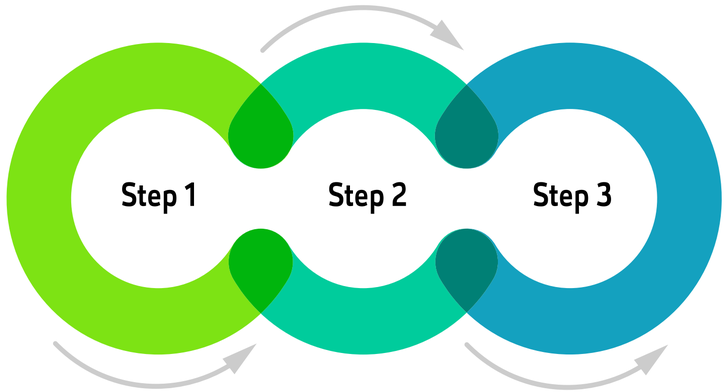


Figure 15. Jonathan Gu (2017). The signage board on the WE building 3rd floor (1)

Figure 16. Jonathan Gu (2017). The signage board on the WE building 3rd floor (2)

Typically, a floor plan depicts the configuration of walls, doors and windows, staircases, floors, and the internal functions of buildings or structures, which are composed of horizontal projection methods and corresponding illustrations. Meanwhile, the floor plan also provides necessary and reliable information for wayfinding. The engineered floor plan is too complicated for laypeople to read. In designing an indoor map, the first step is to understand the typical floor plan and extract and simplify the information from the engineered floor plan. It uses the architectural structure to draw a bird's-view for the users. The question is whether there is already another way to express this information. The regular floor plan provides a quick and familiar approach to understanding the elements in a given space. The second step is to rebuild the relationships amongst them. Circles and lines attempt to do that by illustrating the essential information in the space, such as the corridor, room, entrance and exit. The third step is to create more simplified information. Some redundant information is removed for improved user understanding.



Normal Floor Plan

The unnecessary information is removed from the floor plan so users only have the information they need

Redesigned Floor Plan

Simplified shapes and room names are used to redesign the map

Simplfiying Floor Plan

The data on the floor plan is simplified and refined

Figure 17. Jonathan Gu (2018). The process of second stage

For stage two, Figure 17 shows the design process. Figure 18 shows the usual floor plan for a wayfinding system, and this image provides information only for the public. Then Figure 19 attempts to use simple shapes and room names to design the basic map of floor plan information. Then, the process attempts to simplify and refine data. Figures 20 and 21 are the result of simplifying the floor plan to basic shapes.

Figure 18. Jonathan Gu (2017). The normal floor plan design for WE building 3rd floor

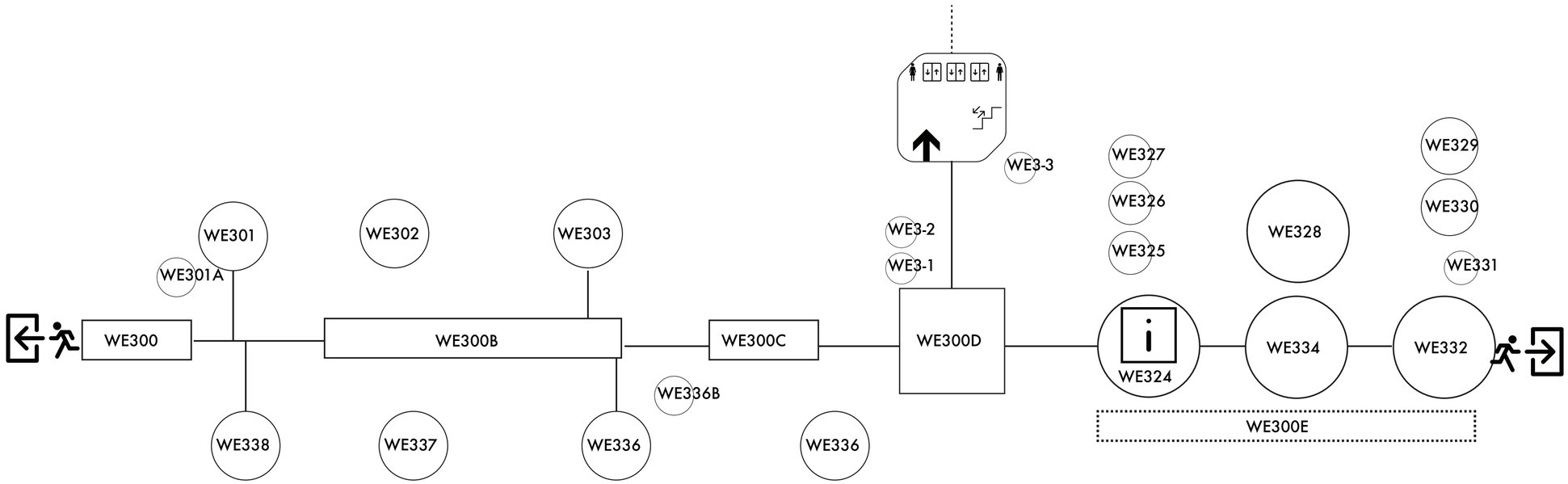


Figure 19. Jonathan Gu (2017). The relationship floor plan design for WE building 3rd floor (1)

level 3

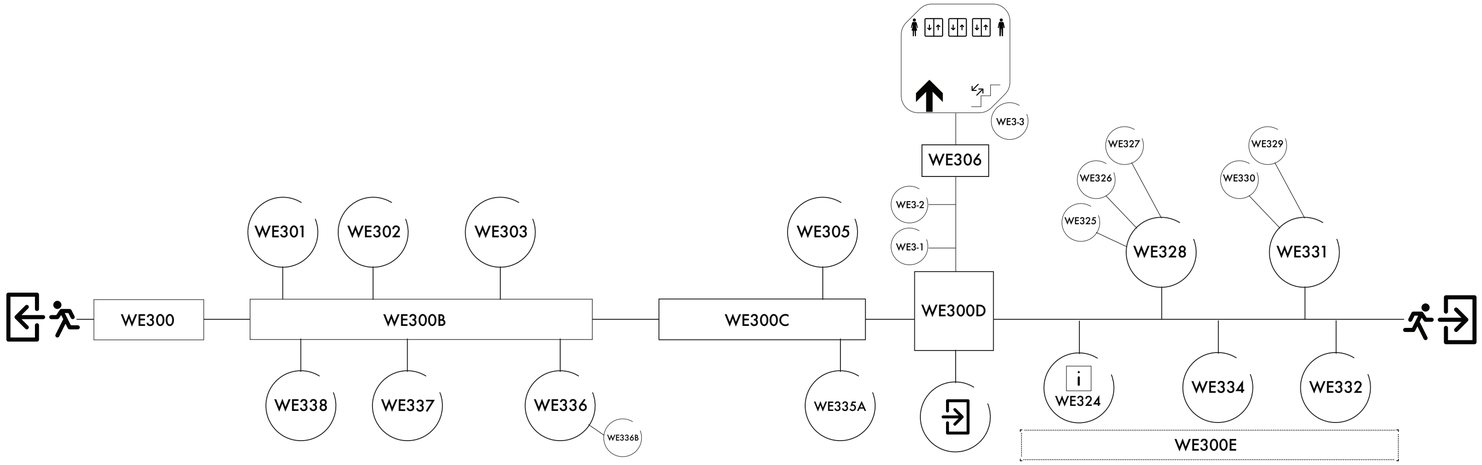


Figure 20. Jonathan Gu (2017). The relationship floor plan design for WE building 3rd floor (2)

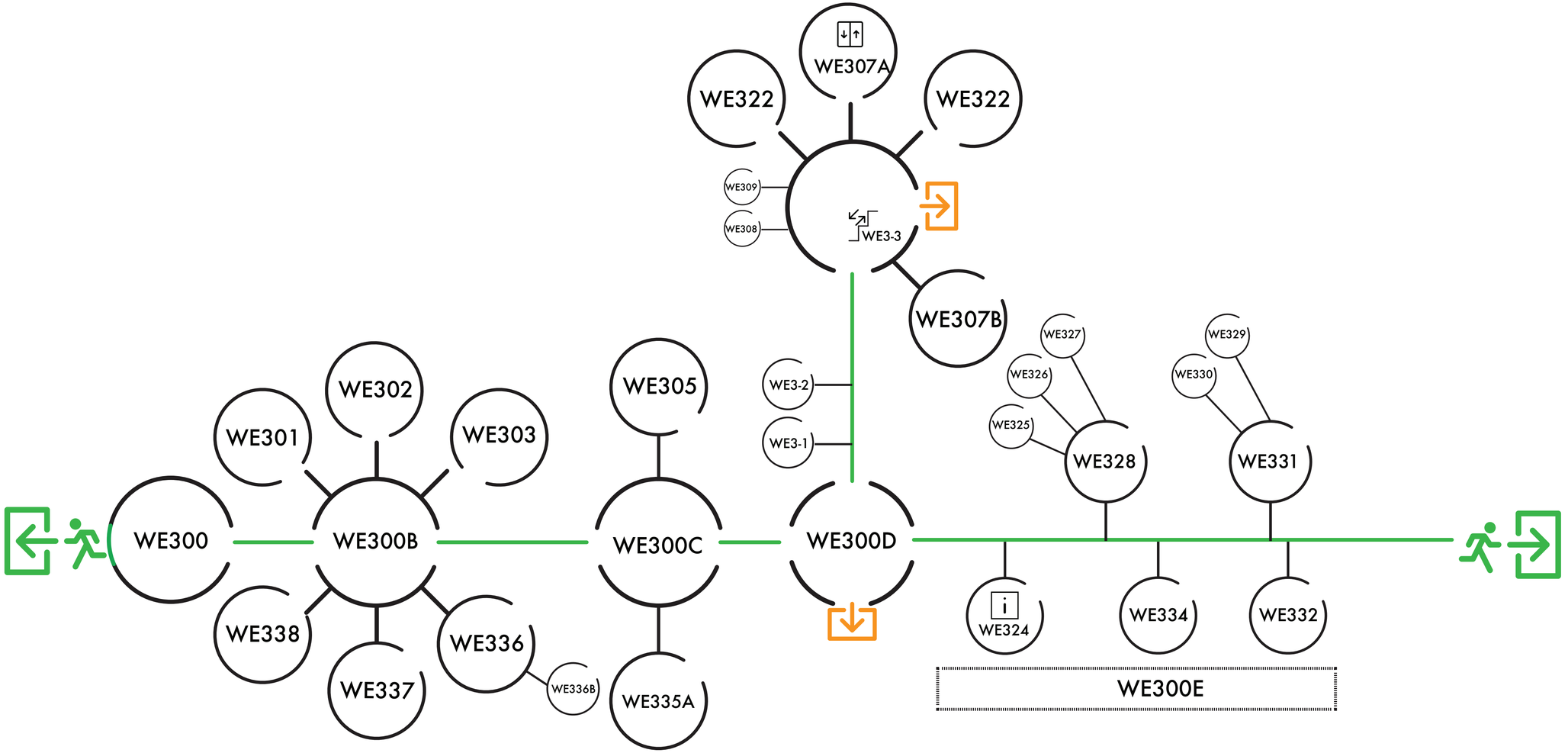


Figure 21. Jonathan Gu (2017). The relationship floor plan design for WE building 3rd floor (3)

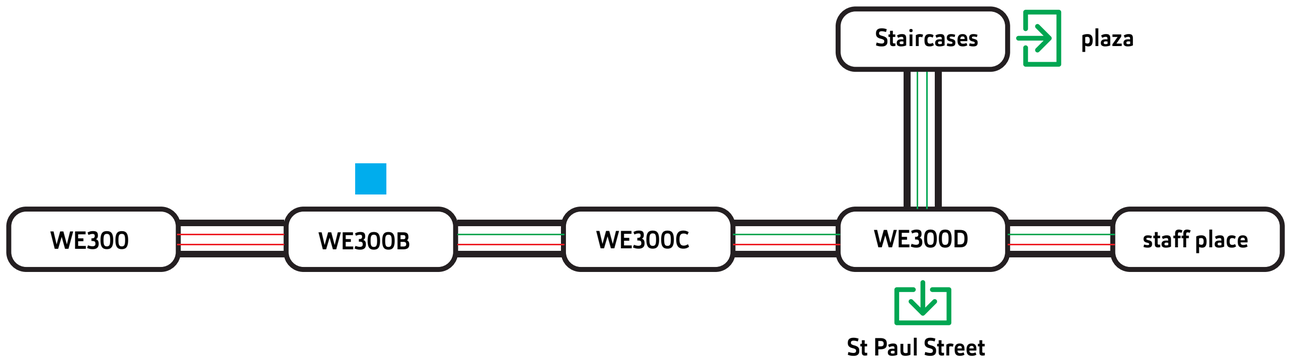
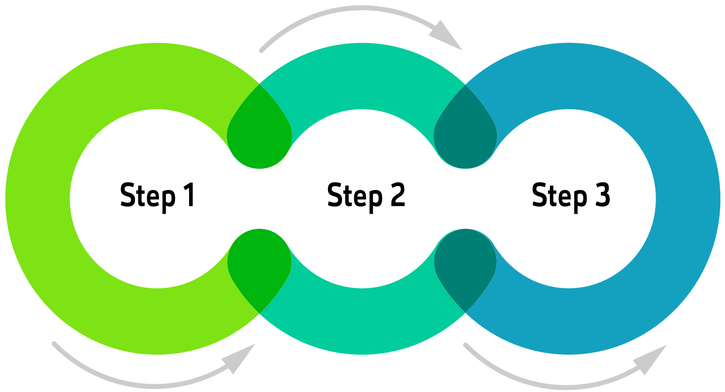


Figure 22. Jonathan Gu (2017). The corridor relation floor plan design for WE Building 3rd floor

When this map was designed, the inclusion of the corridor is vital to connect the rooms. The simple drawn shape is used for the user to read. Due to redundant information on the floor plan, Figure 22 tries to provide corridor information only to illustrate this floor. The blue point indicates the user's position. The thin green line and green symbol indicate the evacuation route. However, the problem with this approach is that the user may not pay attention to the corridor number when they navigate. Therefore, this problem needs to be considered. In others word, the corridor information should be redesigned or portrayed in other ways. For the next stage, the signage is considered.

Concept and development

Stage Three: Indoor wayfinding signage



Indoor Signage Design

Designing indoor signage without the text

Navigation Signage

Designing the direction icons

Emergency wayfinding signage

Thinking about emergency situations and designing the emergency escape signage

Figure 23. Jonathan Gu (2018). The process of third stage

Figure 23 shows the process of stage three. Indoor signage is another way to assist the user to navigate indoors. The signage provides landmarks for indoor spaces. Firstly, the signage was redesigned with icons and pictogram language. After this, based on the design principle of outdoor maps that use descriptive words for simplicity, the indoor guide sign boards were simplified through graphics. The icons can assist the user to understand information. Figure 24 is simplified by pictograms. This process attempts to use graphics to display information without text. However, it may become difficult to understand the meaning without text if text is necessary for explaining information.

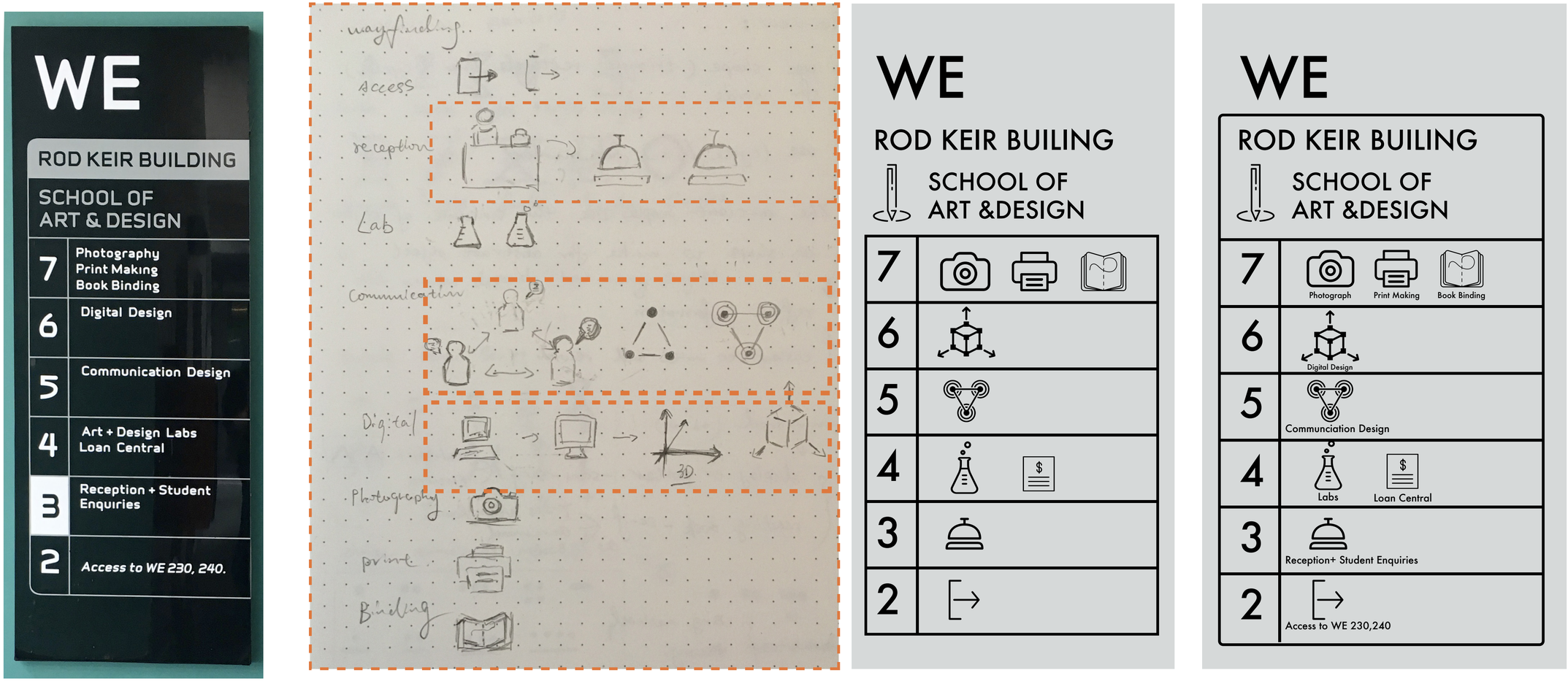


Figure 24. Jonathan Gu (2017). The icons of signage board design process

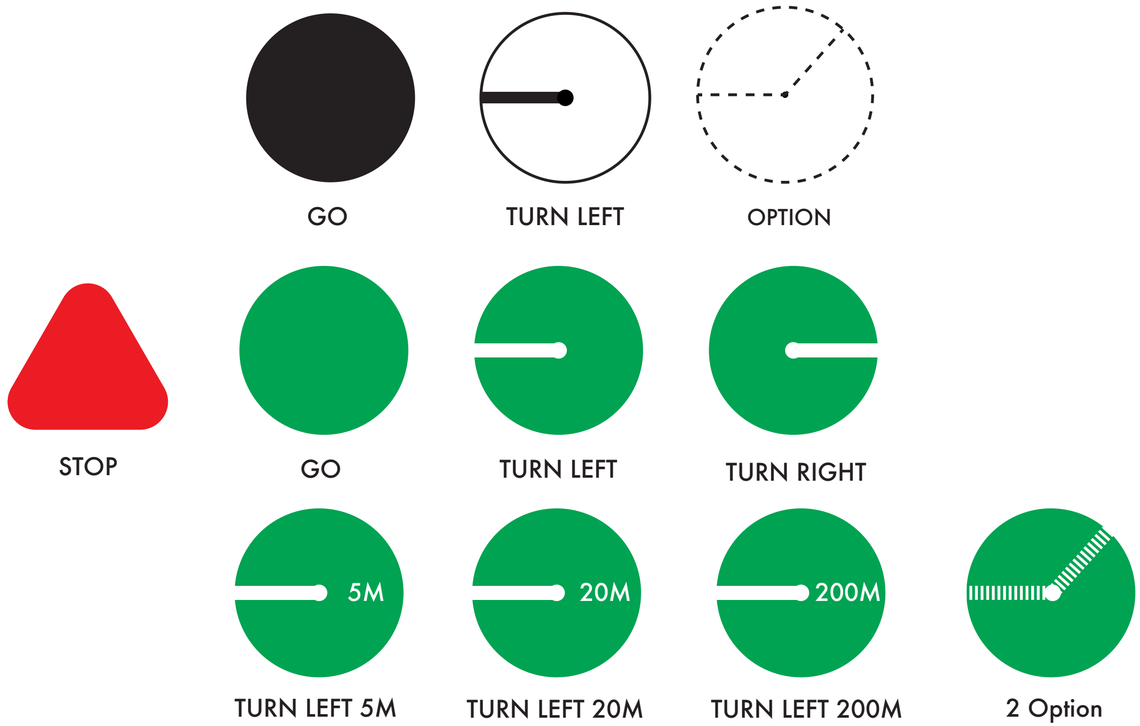


Figure 25. Jonathan Gu (2017). The direction icons design

The signage board design is just a part of signage design in the wayfinding system, with the exit signage and direction signage being another part of this system. Then, the navigation signage is considered with that component. Thus, Figure 25 describes the signage that is used for guiding movement. This process attempts to use circles, lines and dots to give directions. Compared with an arrow, this sample is not clear or precise enough to show the path, and it did not make sense to use it. Arrows proved more accurate for explaining direction.

Figure 26. Jonathan Gu (2018). The creative idea for wayfinding system

Figure 27. Jonathan Gu (2017). Emergency evacuation icons design

Figure 26 illustrates issues around exit signage and emergency situations where I provide an opportunity to rethink wayfinding systems. Normal wayfinding helps people to come into a building, whereas, emergency signage is designed via thinking through the process of evacuation. This type of signage needs to signal the nearest exit. Figure 27 shows the emergency signage design. At the outset of the design, it appeared as radial signage. Then it turns to arrow signage, which can combine with distance signage. The signal strength and colour show the exit information for the user to escape from the premises. This arrow signage is clearer to explain the exit position. In Particular, the black and white icon on the right assists people with red/green colour blindness to navigate. The hollow shape means the user cannot go in this direction, or its level of safety is lower than the other options.

Concept and development

Stage four: Digital wayfinding on the App

Previously, the floor plan and indoor signage designs have been explored. However, this graphic language needed a vehicle to deliver the information to users. Normally, the designer uses a signage board or physical materials to display the information. However, could virtual wayfinding replace those with digital technology? A digital application programme (‘app’) design could perhaps provide such a vehicle. In this stage, the project attempts to use this result for designing an application programme that can function seamlessly for both normal wayfinding and emergency evacuation. Figure 28 is the user flow map to show the process of using the App. The wayfinding application programme functions are composed of the building navigation system and architectural plans’ information. The navigation system contains the located users and provides wayfinding routes for users. The floor plan includes information about the space of the building. This app provides a convenient and fast approach for the user to obtain the information for navigating within the building by the means described above.

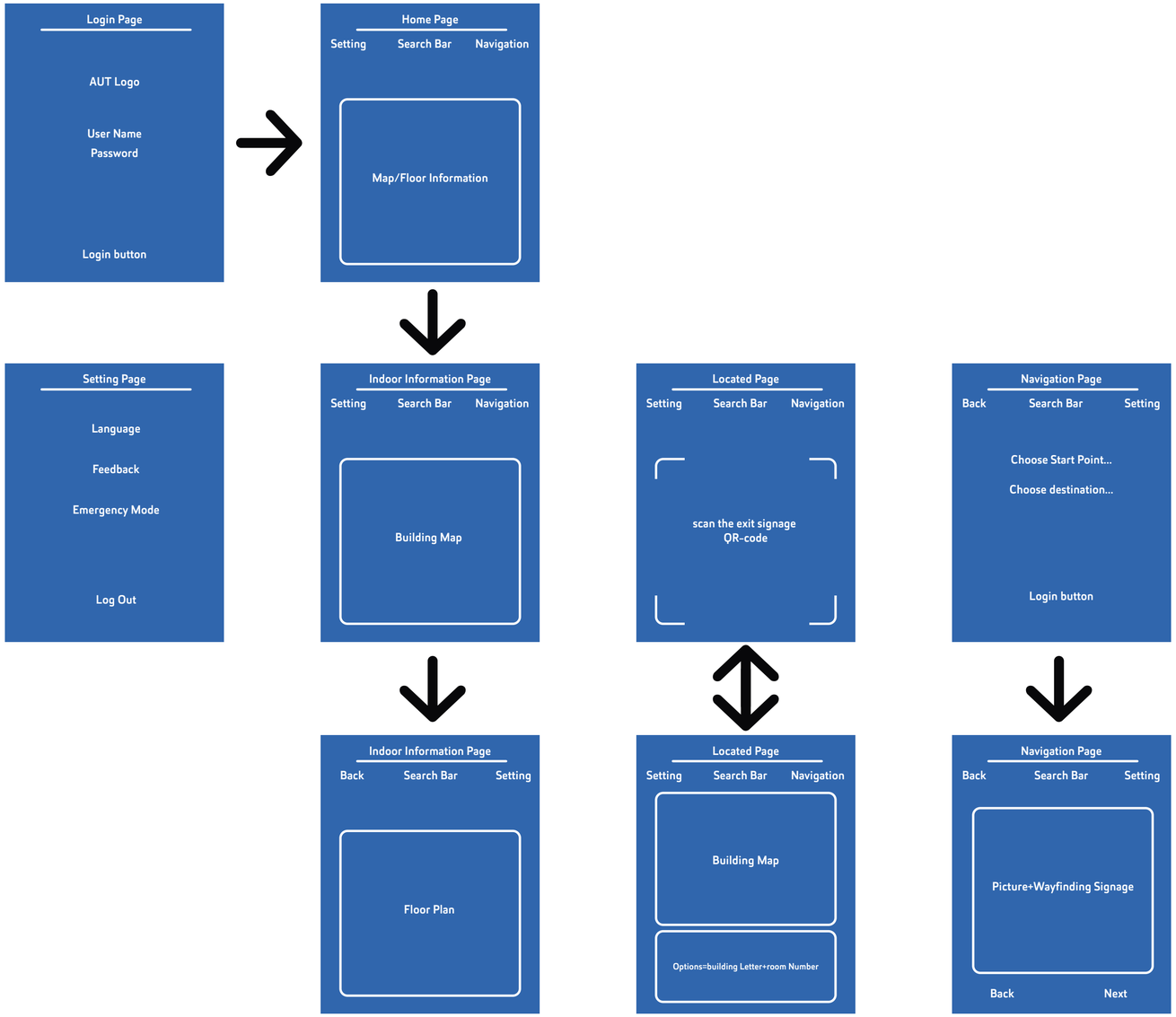


Figure 28. Jonathan Gu (2018). The User Flow Map

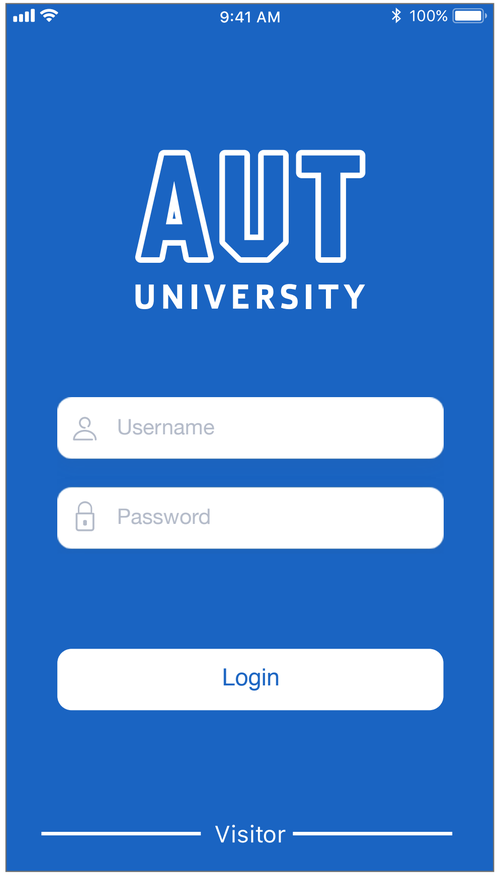


Figure 29. Jonathan Gu (2018). The login in page design for App

In first using this App, the user can log into their account (Figure 29). This account is for distinguishing different users. The visitor's option at the bottom of this page is for a new traveller who has no account or is using the area only once. In this stage, the user's focus is on students, so the demonstration app applies only to university students. In the future, it could apply to university staff users.

Figure 30.(2017). The AUT city campus map made by university department [26]

When the user finishes logging in, the main interface of building information will display on their screen. The button of the top right corner has a layer function where the user can switch on the level of complexity on the university map. It can transfer to the usual exterior building map where the student can view the signage board in the university (Figure 30).

[26] Auckland University of Technology, "Aut-Campus-Map-City-Web-V7," Auckland University of Technology, https://www.aut.ac.nz/__data/assets/pdf_file/0011/118919/AUT-campus-map-city-web-v7.pdf. (accessed 05 Dec, 2017)

Figure 31. Jonathan Gu (2018).
The main page design for app

Figure 32. Jonathan Gu (2018).
The city campus building map design (1)

The interface design basic is provided in Figure 31. It looks like an underground map because it focuses on the building relationships without geography information. The user can focus on the building from where they need to start or on their destination. The first letter W means Wellesley Street, where all building names in the city campus start with W.

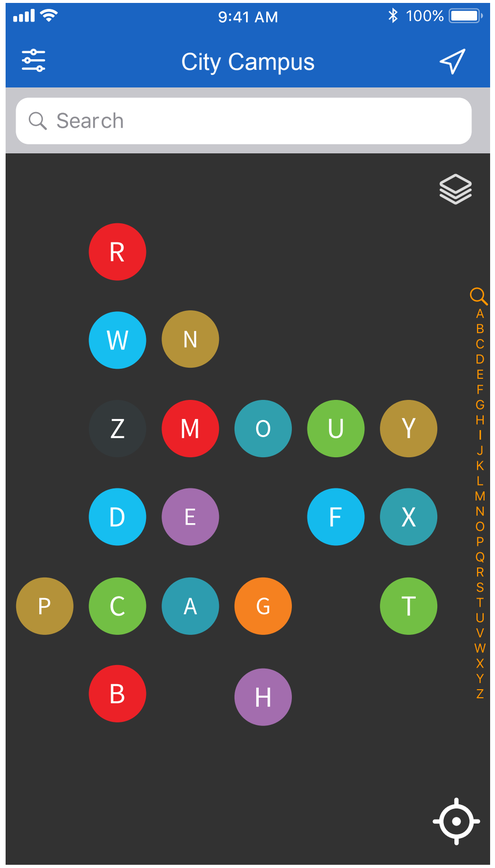


Figure 33. Jonathan Gu (2018).
The city campus building map design (2)

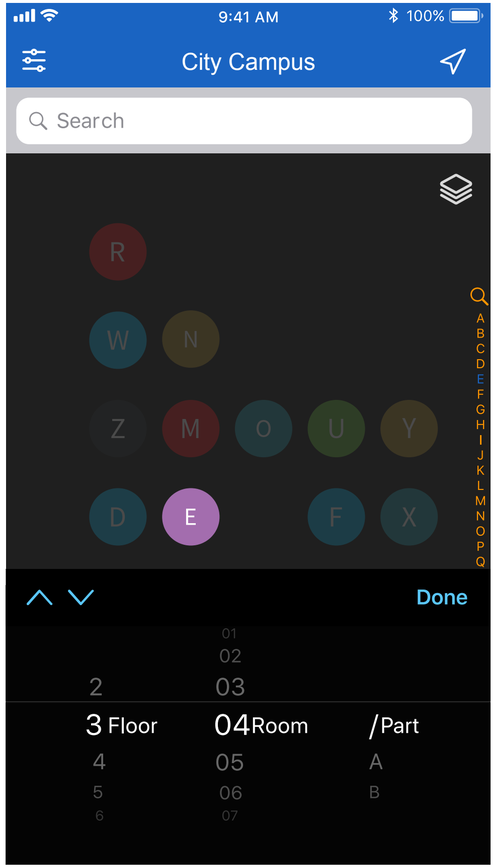


Figure 34. Jonathan Gu (2018).
The city campus building map design (3)

To simplify the information, the letter W can be hidden (Figure 32). The user just needs to double click on the screen, then the letter W will be hidden (Figure 33). The map expresses the relative position relationship between the buildings. With the quick selection of the alphabet bar on the right-hand side, users can quickly select the letters they need. Moreover, when users click the letter, the section will provide the floor options (Figure 34).

This process built the relationship between the outdoor wayfinding and indoor wayfinding because the building position information is for both indoor and outdoor wayfinding information. The user starts their navigation with the building's position. Normally, the user's navigation starts by searching a building name or a specific location such as the library or cafe for indoor wayfinding, so it is important to provide a quick process for them. By reducing the complexity of the navigation process, the time spent receiving information will become shorter. Irrelevant information is removed through deleting the road and distance information.

The floor plan utilised two forms to display the architecture information. Because the screen size is limited, the information display needs to be considered when designing the programme interface. In particular, how to design it within the limited space and how to express more information within the limitations of the screen. One way is the normal form where the user can read the floor plan at the actual main building entrances (Figure 35). Another way is by utilising graphics to simplify the map with rectangles and lines that connect the room and public space (Figure 36). Meanwhile, the icons and room numbers could provide the detailed information about the space for the user to search. When the user reads the map, they can use their fingers to zoom in and out. Different levels of zoom can provide different levels of information.

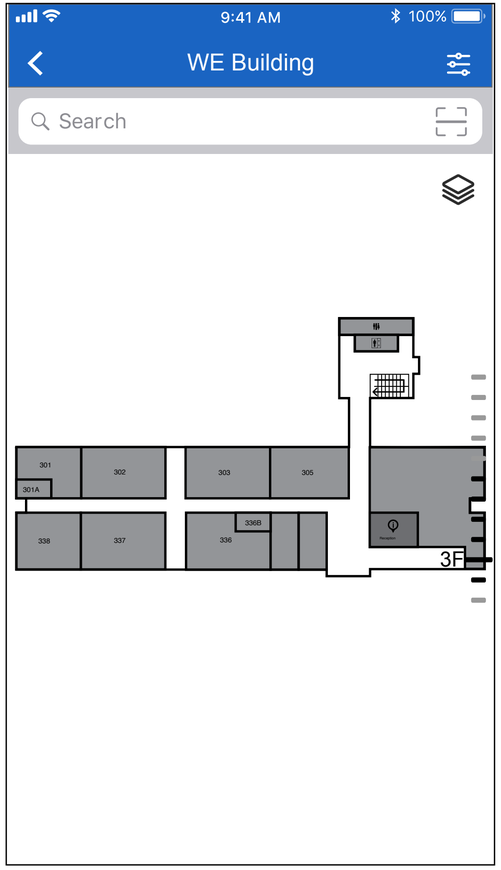


Figure 35. Jonathan Gu (2018). The normal floor plan for app

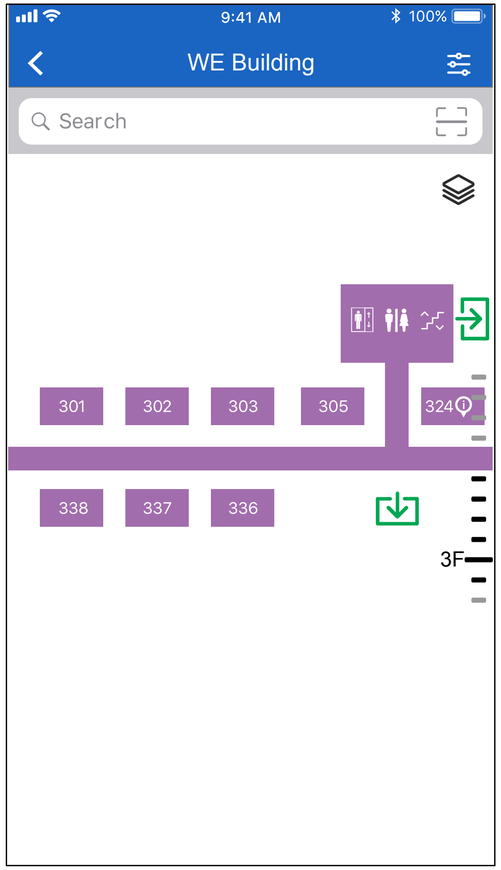


Figure 36. Jonathan Gu (2018). The simplifying floor map for app

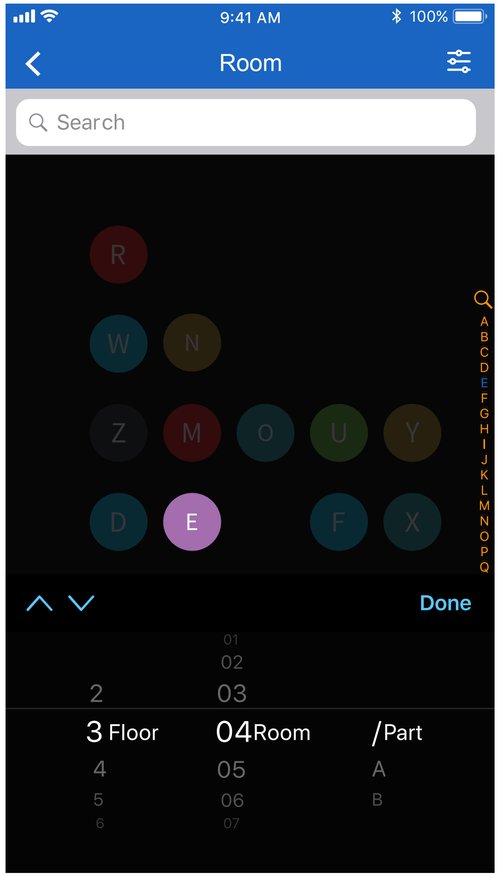


Figure 37. Jonathan Gu (2018). The search room page

There are two approaches to be located in this App. One is the room number with a building letter, such as WE304. Commonly, the room signage system will set the room number for every room in the building, then people could obtain information about room numbers through the signage. Hence, the user can locate themselves through the room number and building letter (Figure 37).

Figure 38. Jonathan Gu (2018).
Design QR code with exit signage

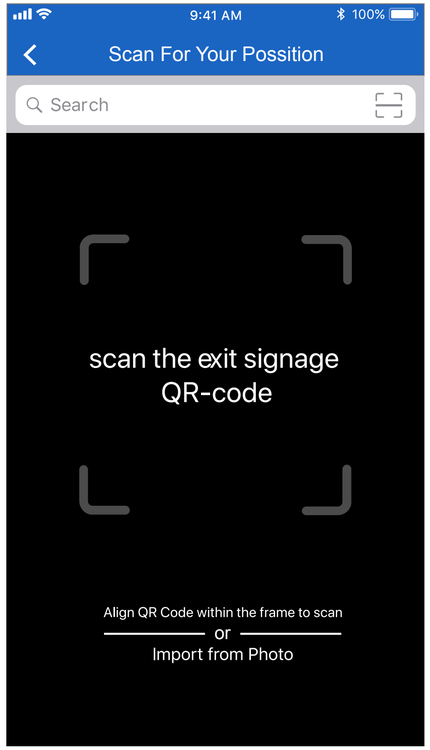


Figure 39. Jonathan Gu (2018).
Use QR-code to locate page

What if sometimes people cannot find signage for the room number? What information can be accessed at any time when they stay indoors? The exit signage is almost easier to find in the space itself. Hence, I decided to combine the emergency and wayfinding elements by adding a QR code to the exit signage (Figure 38) This provides the position information, so the user can use it to locate themselves by scanning the code. Even if the user cannot find help, they can use a phone camera to scan the code (Figure 39). When an emergency situation occurs, the exit signage will still be bright because it runs on a different power system from the normal lines. It is another solution for users to obtain critical location information.

Figure 40. Jonathan Gu (2018).
The process of navigation with photo

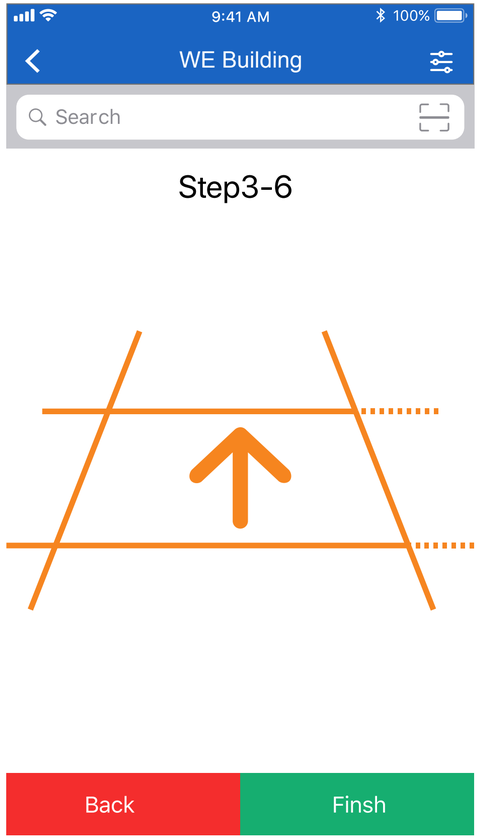


Figure 41. Jonathan Gu (2018).
The process of navigation (only for signage)

For the navigation aspect, the app provides black and white photos with an arrow, because removing colour can reduce the potential distraction of that feature in recognising spatial information. Initially, the photos used arrows for navigation (Figure 40). Secondly, if an area was full of smoke when the emergency situation happened such as on fire, the user would not be able to see anything. The use of solid lines and dash lines attempts to simplify the space structure for users to obtain information about the space (Figure 41).

Figure 42. Jonathan Gu (2018).
The process of navigation (merges the photo and signage)

Figure 43. Jonathan Gu (2018).
The emergency signage with evacuation process

Users can use this simplified navigation in a normal situation and accept this form of information delivery. Therefore, the two forms of expression are merged (Figure 42). The dash lines and solid lines distinguish the wall or corridors. The arrow is a clear sign for a user to know to go straight ahead. The photos assist them when they are lost or cannot make sense of their route. Under an emergency situation, the signage designed in stage two could indicate the exit which the user needs to get to (Figure 43). This use of signage design depends on emergency evacuation icons designed in stage two. This signage illustrates that the user can choose which direction to escape by.

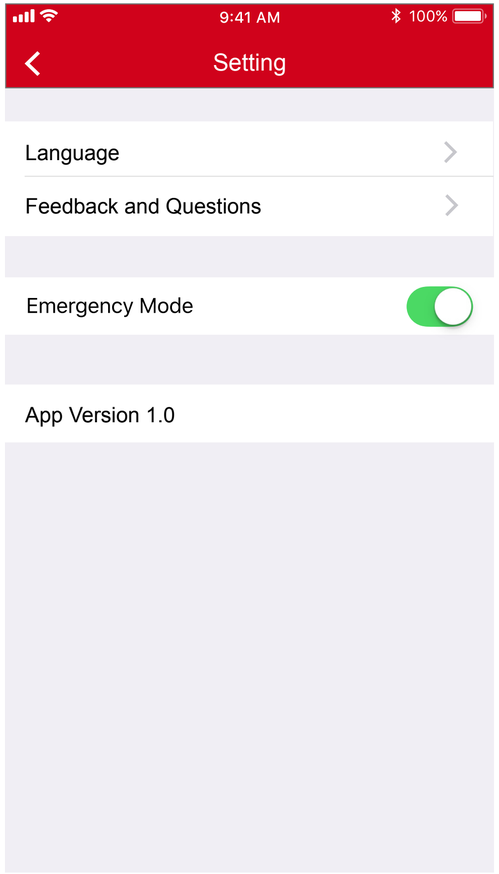


Figure 44. Jonathan Gu (2018). The setting page for app

In the settings function, the app will provide different languages for users to receive feedback to questions through the user's email (Figure 44). In particular, the settings contain the emergency mode for the user. The user can obtain useful information about emergency escapes such as extinguisher or exit location in this mode.

In addition, this app does not require wifi or cellular connection, because sometimes people cannot connect to the internet, especially in an emergency situation. At the same time, the signal could be affected by the building structure. Therefore, prior downloading of all the data on the phone may be the best choice for the user, so they can use it any time without wifi or cellular connection.

Methodology

Overview

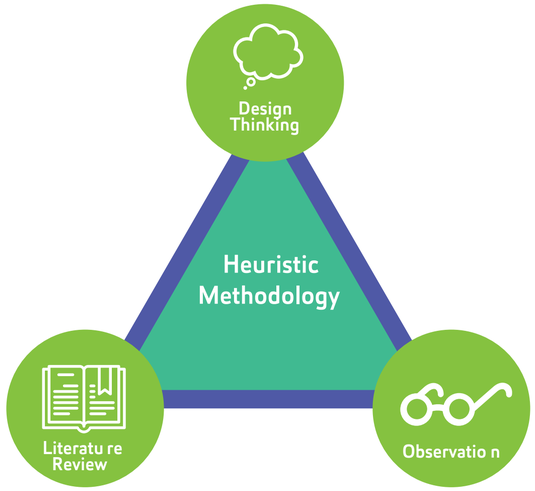


Figure 45. Jonathan Gu (2018). Qualitative Research

Muratovski has described qualitative research as an in-depth research, to be applied when a relevant theory base is missing or inadequate, or when key variables are unknown. It relies on open-ended questions.[27] The research objective is formed by a series of hypothetical questions. There are many possible methods for qualitative research. In this project, three kinds of method were used, as shown in Figure 45. The heuristic, as a core methodology, is applied in this qualitative research. Pearl stated that heuristics are methods or rules derived from experience that assist people through problem-solving, such as the process of trial and error or the process of elimination.[28] The research posed three hypotheses. The three methods used in the project help in exploring the wayfinding system design. The design thinking method assists this thinking in developing and structuring a research process. The observation and literature review method more deeply promote investigation and development of the research.

[27] Gjoko Muratovski, *Research for Designers : A Guide to Methods and Practice* (London: Sage Publications, 2016), 104.

[28] Judea Pearl, *Heuristics: Intelligent Search Strategies for Computer Problem Solving* (United States: Addison-Wesley Longman Publishing Co., Inc., 1984), 3-4.

Methodology

Heuristic methodology

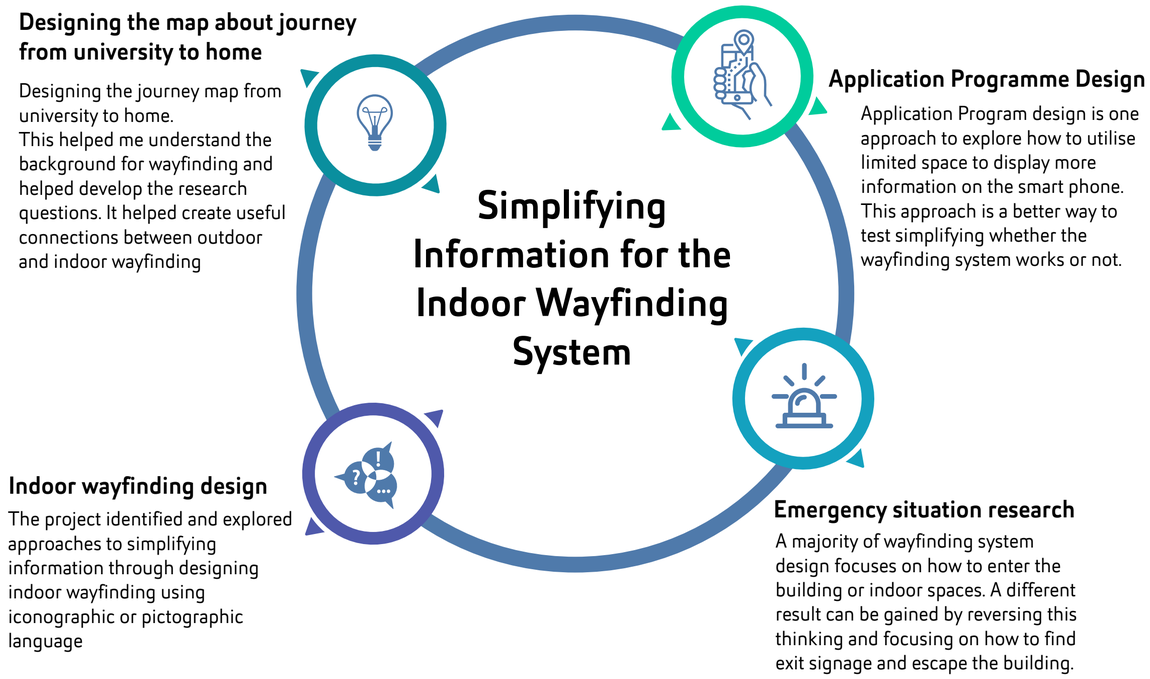


Figure 46. Jonathan Gu (2018). Heuristic Methodology for this project

Kleining and Witt noted that heuristic research using qualitative methods adopts a methodology developed at the University of Hamburg.[29] The heuristic is of iterative design methodology. The design iteration of this project is through the continuous reconstruction and understanding of spatial information from the physical world to the digital world. The research process is circular, and the design idea is extended through exploring different components of the project. Figure 46 represents the thinking and implementation process of the research. Hart proposed the "six Ws" method where the six Ws are questions whose answers are considered primarily in data gathering or problem-solving.[30] This method is used in comparing indoor to outdoor wayfinding, in order to build the components (Figure47).

[29] Gerhard Kleining and Harald Witt, "The Qualitative Heuristic Approach: A Methodology for Discovery in Psychology and the Social Sciences. Rediscovering the Method of Introspection as an Example" (paper presented at the *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*, 2000), 1-2.

[30] Geoff Hart, "The Five W's: An Old Tool for the New Task of Audience Analysis," *Technical Communication* 43, no. 2 (1996): 139-140.

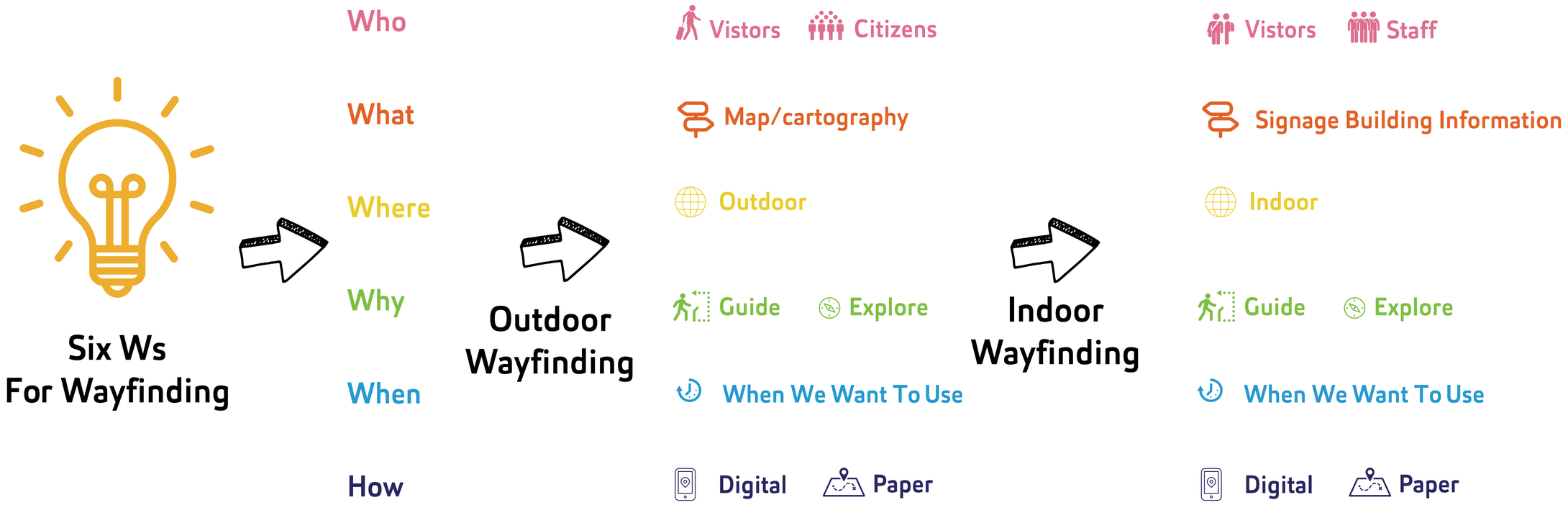


Figure 47. Jonathan Gu (2018). The Six Ws for wayfinding system (outdoor and indoor)

The first step was to design the map for the journey from university to home. This step was beneficial for background understanding about wayfinding and determining the research questions. The design of indoor wayfinding was based on the exploration of outdoor wayfinding because outdoor wayfinding design is more established than indoor.

The second step is for indoor floor plan designing. This project found and explored the approaches to simplify information by developing the design of the floor plan. The experience from the outdoor map design can assist the floor plan design.

The third step focused on emergency situation research. The majority of wayfinding system design focuses on how to enter the building or indoor place. Using reverse thinking in regard to this behaviour, the research focused on how to escape the building and find the exit signage. Therefore, the information design that users receive or consider will be different. The visualisation and graphics of communication information can enhance the effective transmission of information in this hypothetical situation.

Step four is application programme design. Application programme design is one approach to explore how to utilise limited space to display more information on a smartphone. This process is to test simplifying information in digital indoor wayfinding systems. Furthermore, this app could combine both normal and emergency situations.

Methodology

Developing the experimental stages

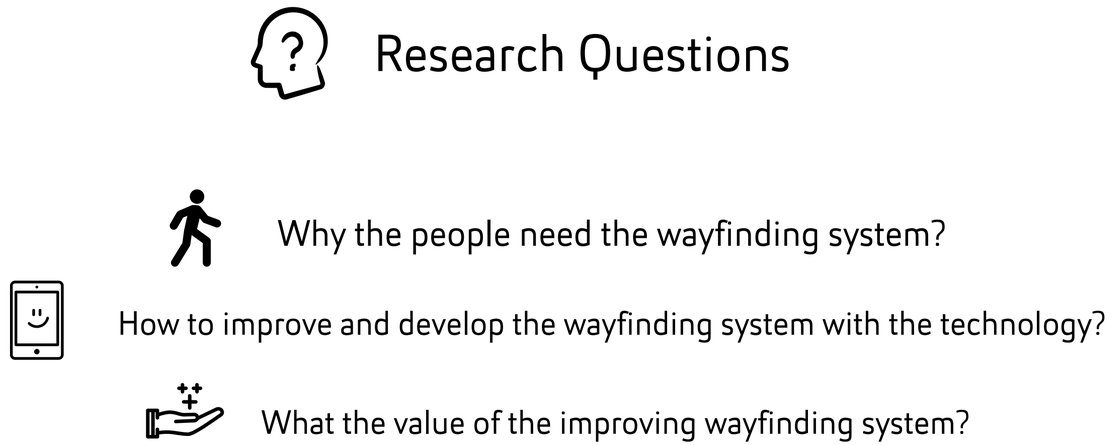


Figure 48. Jonathan Gu (2018). Research questions for this project

According to Buchanan's research, the design thinking method provides a solution-based approach to solving problems.[31] This method was used to organise the research process. The process started with determining the research questions (Figure 48). Then, the timeline of using wayfinding was explored in order to generate questions about what future wayfinding could look like (Figure 49). The vital question was how to combine the wayfinding system and technology in the future (Figure 50).

[31] Richard Buchanan, "Wicked Problems in Design Thinking," *Design issues* 8, no. 2 (1992): 17-18.

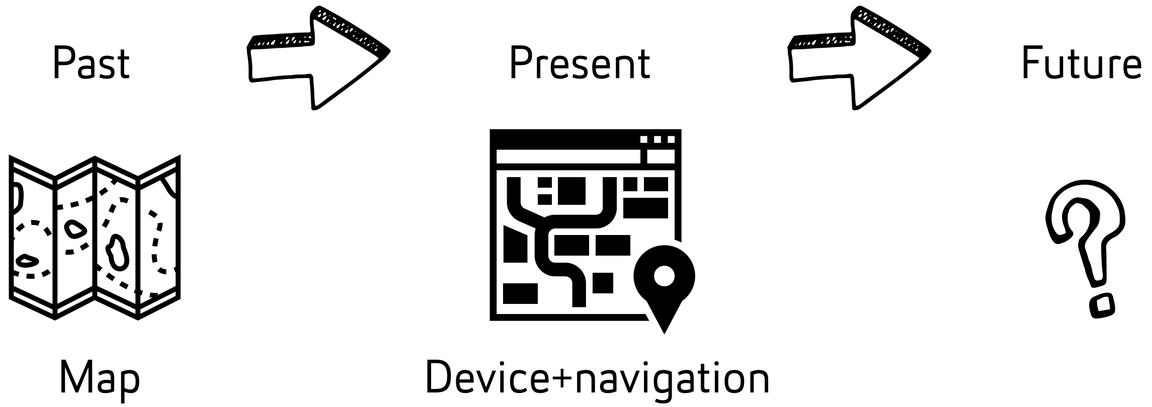


Figure 49. Jonathan Gu (2018). The wayfinding utilising timeline

Figure 50. Jonathan Gu (2018). Idea for future wayfinding

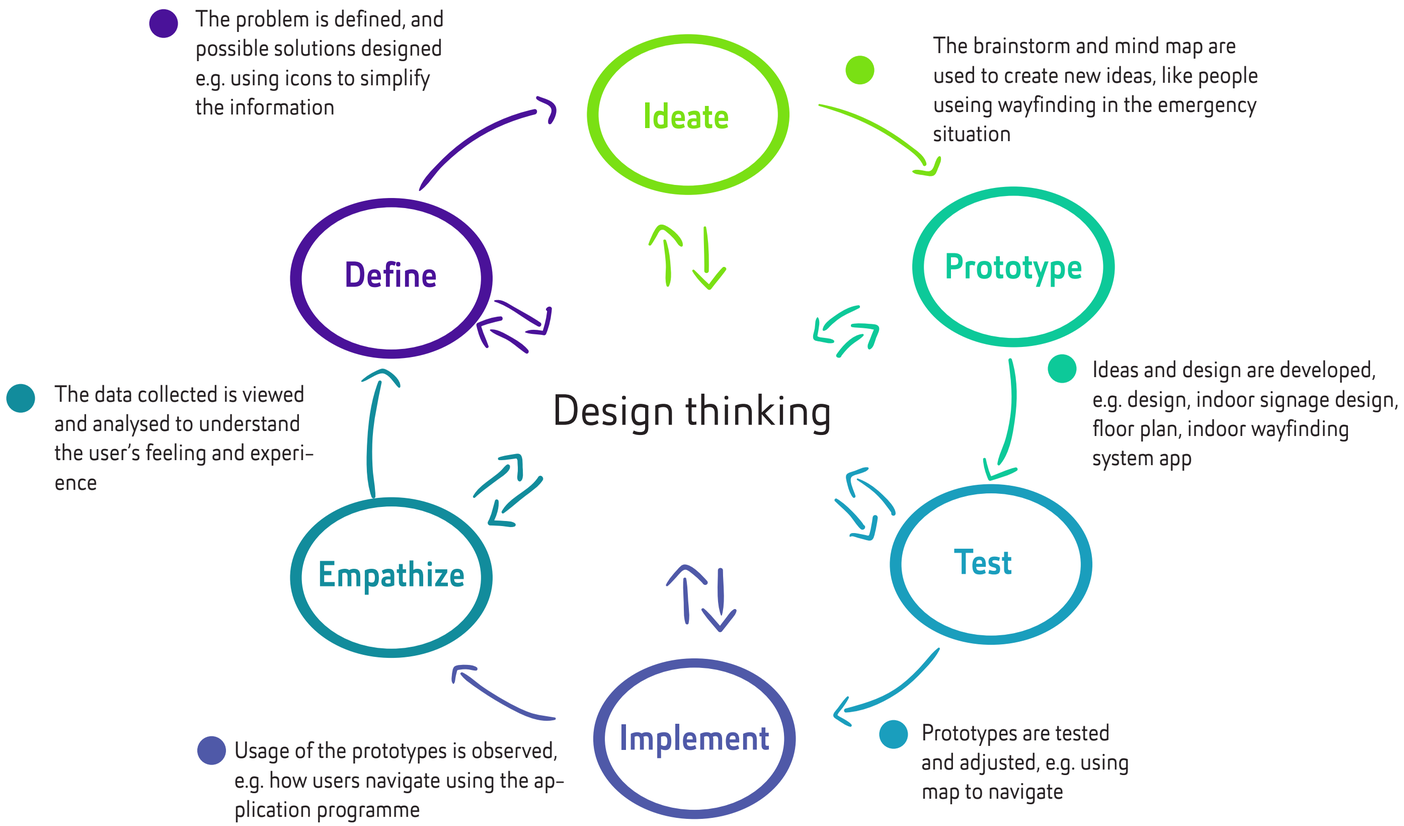


Figure 51. Jonathan Gu (2018). Design thinking Method

The design thinking method was used for research process at different stages (Figure 51). Firstly, this method was applied in order to simplify information in outdoor wayfinding systems by designing the map for the journey from home to university. Secondly, this method was used to find a solution for how to simplify information in floor plan information. Thirdly, it was employed for designing the indoor signage for emergency situations. Fourthly, it was employed for designing the application programme for an indoor wayfinding system. Taking the first stage as an example, the map for university to home applied prototyping, testing, implementing and emphasising as the process for this research. The map design produced a series of results for analysing. The finalisation of map design comprised the results of this project. This design method was valuable for the design process, because it established the basic idea for simplifying wayfinding system information and introducing the process of the project. This method promoted the development of this project on how to simplify the information for wayfinding.

Methodology

Observation method

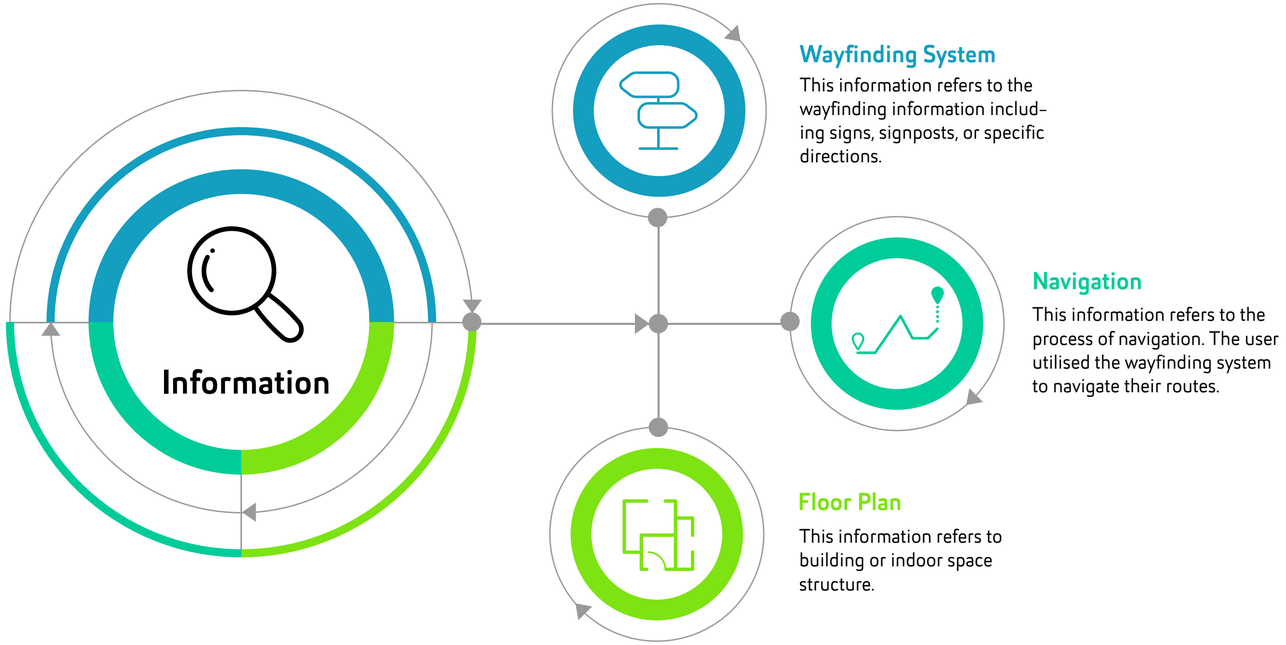


Figure 52. Jonathan Gu (2018). Observation for information

Bakeman and Gottman stated that observational methods comprise observing and describing the behaviour of a subject.[32] The observation method is to investigate the collection of data and information about the subject, such as space information, wayfinding systems and user behaviour in different scenarios. The project has been developed by this method through observing the specific details about the three main elements of wayfinding systems, as mentioned above (Figure 1, p05). The research explored comprehensively the aspects of these three elements. Figures 52, 53 and 54 display the different aspects for observational objects. Taking Figure 52 as an example, the information contains a wayfinding system, navigation and a floor plan. Each of them was obtained by the user in the wayfinding situation. Through observing the wayfinding system such as signs, signposts or directions, and how the user receives this information, the design object became clear. Meanwhile, the project focused on how to improve ways to receive this information.

[32] Roger Bakeman and John M Gottman, Observing Interaction: *An Introduction to Sequential Analysis* (Cambridge University Press, 1997), 3-4.

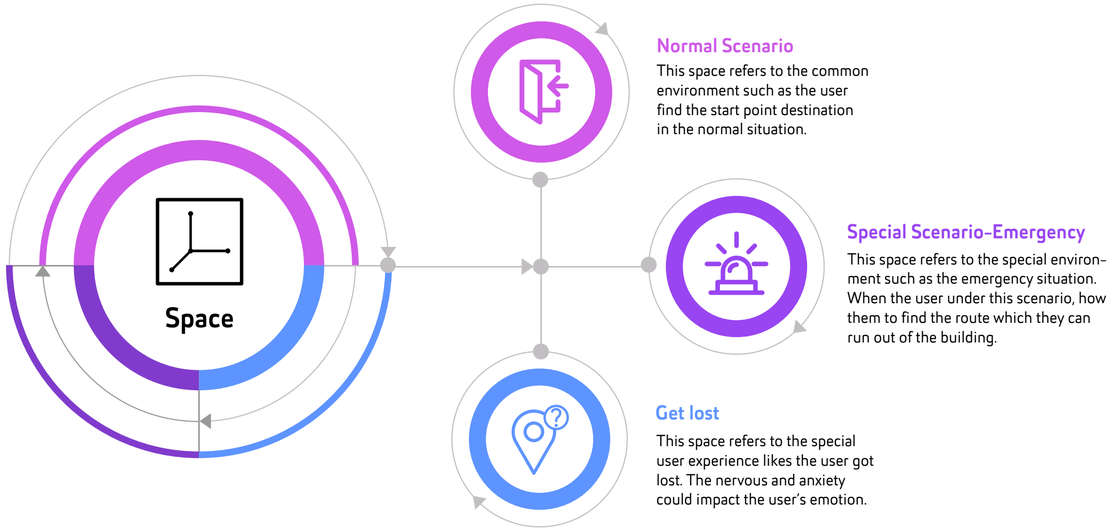


Figure 53. Jonathan Gu (2018). Observation for space

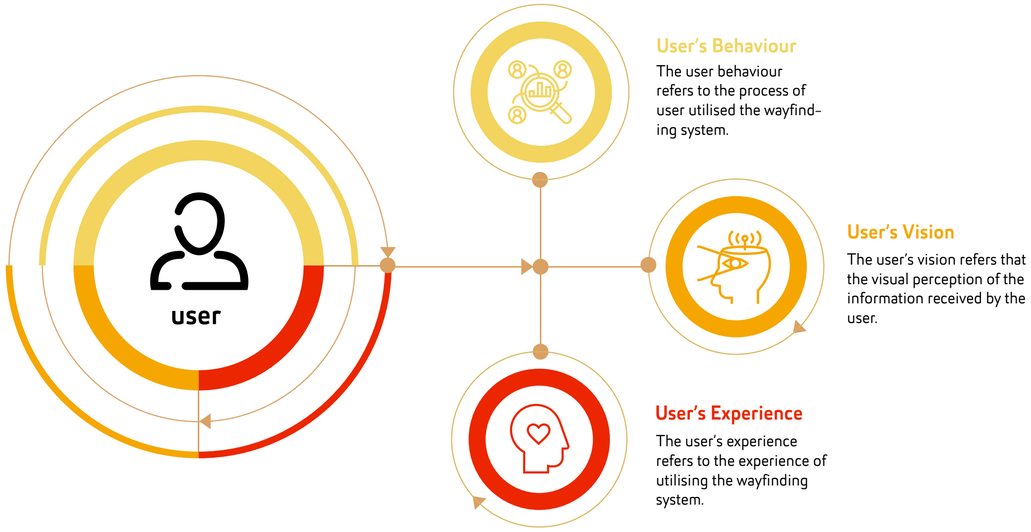


Figure 54. Jonathan Gu (2018). Observation for user

People using wayfinding behaviour became the object of observation. This method, where I assumed the role of user, myself, was intended to find a way to solve the problem of the process of finding an accurate route in a building. Different hypotheses were used to find out the information needed in wayfinding and how to provide information transmission efficiently by taking into account relevant conditions. For example, the environment may have no light, so there is a need to ensure users have a phone, tangible things or live signals to guide them. This method can obtain details about users' behaviour, through analysing this result, and the project can be improved.

Methodology

Literature Review method

Creswell and Creswell noted a that literature review can help build research and find knowledge in the field.[33] The literature review assisted me to evaluate and explore this topic. In this way, the project was improved by reading other academic resources. The resource context contains three elements of wayfinding such as information, space and users. The resources consist of the wayfinding system, simplifying Information in this system and user behaviour under this system. These resources have already been explored in the contextual review and will be explored further in the discussion.

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[33] John W. Creswell and J. David Creswell, *Research Design : Qualitative, Quantitative, and Mixed Methods Approaches* (Los Angeles: SAGE, 2018), 56.

Analysing the results

The relationship between graphics and text

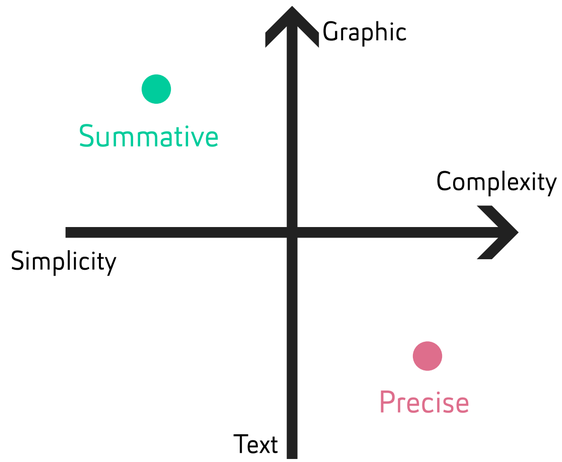

Figure 55. Jonathan Gu (2018). The simplicity and complexity relationship between the graphic and text

In the first design stage, icons and pictogram language were used for describing the textual information. The information is easily received when all the text is removed, but it is difficult to accurately understand information as in Figure 13 (p.27) which is about the Auckland CBD map. Thus, Figure 11 (p. 25), the iconography designed for the Auckland map, balances the relationship between the graphic and text. Figure 55 demonstrates the connection between the graphic information and text information. Therefore, the summative information is the information that needs to be obtained through the wayfinding system. Graphic language can use icons or signage to describe the summative information. The precise information applies only to information that describes a particular need. Moreover, valid text information can explain the abstract graphical information, such as the icons, with a little text. In addition, dots, lines and circles can serve as bridges to these icons.

Analysing the results

Simplifying information relationship with simple shapes

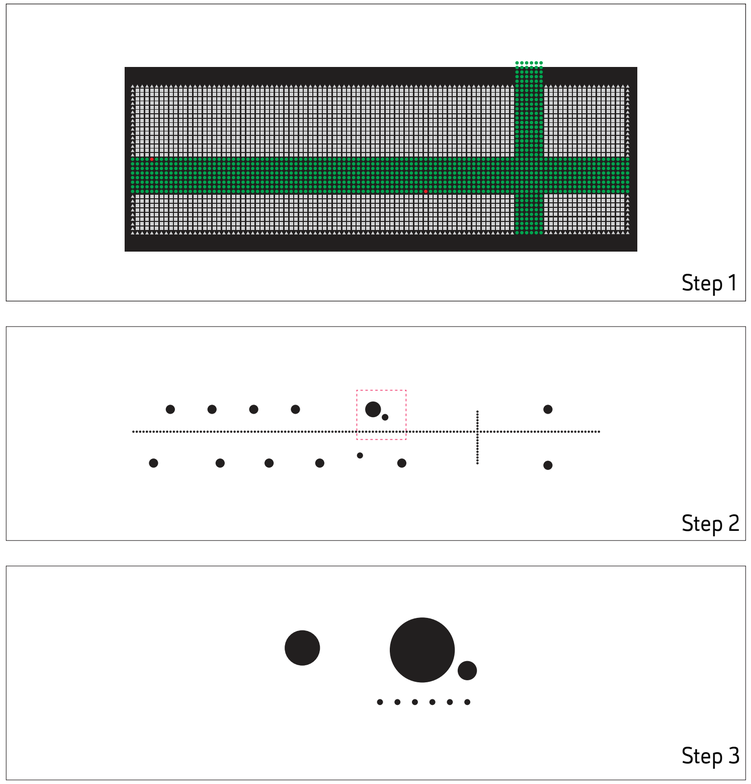

Figure 56. Jonathan Gu (2018). The process of simplifying floor plan information about WE building 3rd floor

Figure 56 shows an abstract approach to simplifying the space information process. In the first step, simple graphics, such as triangle and circle are used to establish the relationship between objects in space, such as rooms, corridors, and the boundaries of the space in the WE building. In this step, the green dots show the corridor information and grey dots represent the room information. In the second step, the corridor information is replaced by the dotted line, while the different rooms are replaced by larger circles in order to simplify the corridor information and room information. In the third step, zooming out from the contents of the red dotted box in step two, the different circles and dot lines show the basic relationship between the individual objects in the space such as rooms and the corridor.

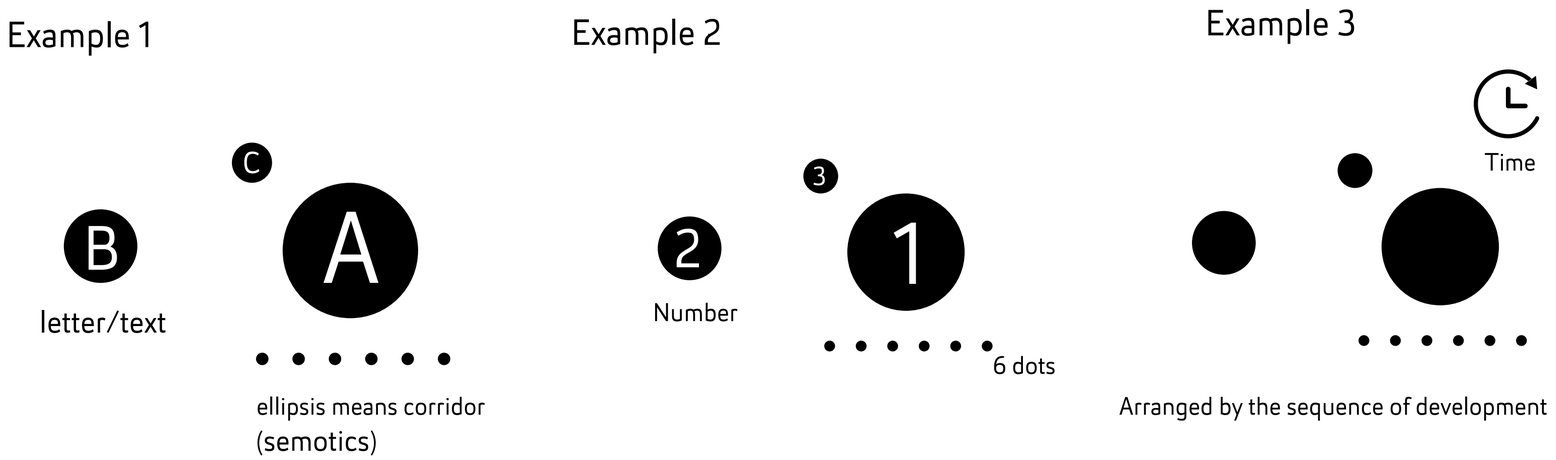

Figure 57. Jonathan Gu (2018). The relationship between the dots

The three examples are constituted with the circle and symbol to illustrate the relevance of these data (Figure 57). The first example uses the alphabet to show the relationships in the space. Numbers are used in the example 2. Their relationships are arranged by the sequence of development of example 3. This process structures the basic relationships between simple shapes and text.

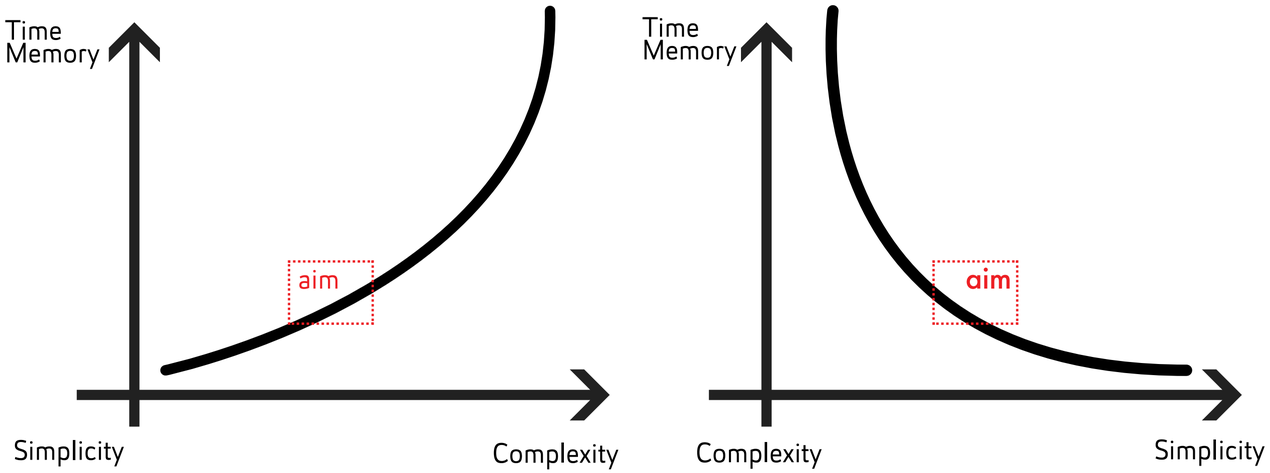

Figure 58. Jonathan Gu (2018).
This number axis charts the relationship between increased simplicity and the time it takes to effectively transmit information

The earlier discussion shows that pictogram language uses icons or signage to assist people to understand abstract information about different spaces but explaining or demonstrating the relationship between two spaces is the main goal for wayfinding systems. Therefore, dots and lines attempt to build the basic relationship among the objects in this space. On the other hand, focus is another method for effective transmission information. It works likes a camera. When the photographer focuses on the tiny detail in a photo, the other images will blur. When redundant information is removed, it is easier to focus on the information that needs to be absorbed. That is, when people focus, they will filter out redundant information. This 'focus' theory could improve the audience's concentration on the useful data. The number axis explains the relationship between them (Figure 58).

Analysing the results

Icons for emergency situations

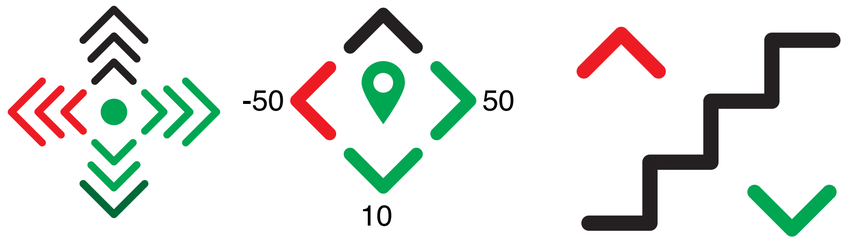

Figure 59. Jonathan Gu (2018). Emergency evacuation icons design

In the third stage, the process was to simplify the navigation signage for the floor wayfinding system. The essence of this stage was to use the icons or signage to illustrate complex information. In this process, a method for how to combine the different bits of information will be explored. There are two factors to take into account in icon design. One is that the abstract icon is difficult to understand without annotation in words. Another is that the icons need to be designed as graphic symbols which people can recognise. Figure 59 shows a way to integrate security information, export information, location information and distance information into the same icon. Due to the user's need for quick information in an emergency situation, this design reflects the amount of information that icons can express.

Analysing the results

Optimizing the information for the application design

The application programme design is not only a continuation of the exploration of simplified information, but also an integration and optimisation of the previously completed design. Firstly, the login interface can pave the way for distinguishing the target audiences. Secondly, the design of the floor plan was applied to the programme. The app tries to integrate traditional plans and simplified planes into software applications so that users can choose the information they need. In addition, exploration and research was formed in the field of indoor positioning. The outdoor navigation uses the GPRS to locate the user, but it cannot be used in the indoor context. Therefore, the QR-code or room number became the main location method for indoor locations. Furthermore, the QR code scanning involves specialised designed data that is scanned into a smart device through a lens to obtain information. This process not only optimises the information but also realises the transformation of information across the platform.

Discussion

Building the information relationship

According to Shannon's information research, abstractly, information can be seen as an uncertain resolution.[34] In this project, the user will encounter the information with limited existing knowledge of an indoor place. The whole design process utilising graphic language describes an information attempt to rebuild the relationship amongst building objects such as rooms, corridors, stairs and exits. The result of a floor plan or app design has demonstrated how to build that relationship. Shannon noted that information is used to eliminate random uncertainties.[35] Individual information is generated by a producer. It can be understood but it may be quickly forgotten. Therefore, even if the information can be described clearly, it may be unclear in a different situation. The information relationship assists data to reduce this uncertainty.

In an emergency situation, the user needs to know the escape information quickly. Thus, it is important to build information relationships for assisting the user to remember unfamiliar and complex information. Circles and lines make up the basic graphic language and are useful elements to establish the relationship. This process is like a neuron building a neural network. The information is located by the position which is built through the line and circle or dot. This relationship uses graphic language to solve the problem when the user cannot remember isolated information. The next section discusses how the project simplified this relationship.

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[34] Claude Elwood Shannon, "A Mathematical Theory of Communication," *ACM SIGMOBILE Mobile Computing and Communications Review* 5, no. 1 (2001): 3.

[35] Ibid: 4.

Discussion

Simplifying information processing

Simplifying the relationship between pieces of information is based on first understanding that relationship. It was achieved through comparing outdoor to indoor wayfinding design to fully understand how to simplify the complex information of an outdoor space, so as to apply the same method to interior space. The underground map provided a solution for simplifying geographical information.

Simplified information requires an understanding of the information itself and the knowledge and mastery of the information structure. Wurman stated that users will be satisfied with the process of reading information if the design is simple and effective for understanding.[36] The purpose of information simplification is to refine the information structure and to understand the information focus, so as to quickly understand the information or extract the information needed through a graphics method. The user's need is to achieve a quick understanding of unfamiliar information under special circumstances. In other words, it is possible to use graphics to simplify complex information and assist users to a more natural understanding of novel environments.

Effective transmission of information separates it into three parts. Firstly, for focus, redundant information needs to be reduced. The second part is to simplify and refine the information, and the third is to synthesize the information and optimize the data for use.

[36] Richard Saul Wurman, *Information Anxiety* (New York: Doubleday, 1989), 84.

Discussion

Reforming information and transmission information platform

Reforming information means reprocessing simplified information. Simplified information can be quickly understood, but it will have lost detail. When users need to obtain accurate and precise information, abstract graphics information can cause misunderstanding due to missing information. A photo or complex graphics can provide more accurate information for users to obtain the precise information. The users may need to customise the information provided. Furthermore, text information is still important for users. The picture of "The Treachery of Images" was made by artist Magritte.[37] His creative work demonstrated that text is necessary for people to understand information. The icons need to use simple words to them because text messages can provide clarity.

In re-forming information, digital wayfinding can use a small screen to display a large amount of wayfinding information by comparison with physical wayfinding. Thus, a digital wayfinding system has some potential advantages over physical wayfinding. However, it cannot completely replace physical wayfinding. The information transmission platform provides the tools to merge digital wayfinding with the physical world to help users.

[37] René Magritte, "The Treachery of Images," *Oil on canvas* 231, no. 2 (1928).

This research allows a user to make a precise positioning through the method of converting information to QR code. This process is converting information into the digital signal. The purpose is that today's use of digital equipment has increased, where digital information and graphics or text transformation can improve the convenience of the medium itself for effective transmission of information. This method also plays an important role in obtaining information. According to Wave's website, the QR-code has two features which are that it is dirt and damage resistant, and it is readable from any direction in 360°.[38] These two features can allow the QR-code to be more widely used in any place. Therefore, the QR-code becomes a platform which connects the information to a digital signal.

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[38] Denso Wave, "Qr Code Features," *QR Code. com* (2010).

Discussion

Limitations

Due to the project time limit, testing was not possible with a wider population. Accordingly, testing the emergency situation was limited to the hypothetical, and not tested. A real emergency situation will be more complicated. Therefore, it needs to be tested in the future. In addition, this project lacked actual user testing. In the future, it is necessary to do ‘on the ground’ testing to ensure the app can work in a real situation. In addition, the structure of WE building is simpler than WA and WT Buildings, and the relatively closed structure of WE building made it easy to simplify the floor plan. There are only two or three alternative routes at each intersection. In contrast, with WA and WT building the number of crossing and corners is increased. Therefore, the application would need to be expanded to accommodate more complex situations.

Conclusion

This project explored how to simplify indoor wayfinding through combining it with emergency evacuation signage and designing an integrated wayfinding programme. Qualitative research involving an heuristic methodology, observational method and literature review assisted this project to find an approach to improve effective information transmission. The information design employed iconography and infographics to design indoor wayfinding components.

The simplification of information is key in developing and improving wayfinding technology. In this project, the design of the application plays an important role in demonstrating simplification of information. However, the app design still has some limitations; for example, users may not know how to use the app in emergency situations. Such issues must be solved through user testing.

The first hypothesis concerned utilising graphics to simplify complex information in order to assist users in understanding unfamiliar environments. Though we aimed to achieve this via research and design of the outdoor and indoor wayfinding system and accompanying app, the project will require user group testing to further gauge the extent of information simplification. The second hypothesis focused on using a digital wayfinding system to enhance physical wayfinding methods, recognising that users rely to some degree on physical wayfinding in all circumstances, and that simplified information in the digital app could potentially facilitate a more efficient

integrated solution. The third hypothesis proposed the merger of digital wayfinding with the physical world, and we employed QR codes as means of translating physical and location information into digital media; however, we found that QR code-scanning technology will need to improve in order for QR codes to function effectively in this capacity. Our implementation of QR codes will also need to be tested in the real environment, because user behaviour needs to be considered in all relevant situations. Our application was designed for the WE building only, so its user base for testing is limited. Nonetheless, QR codes show potential as a medium for conveying essential wayfinding information to digital devices.

This report focuses on emergency situations in which the user is stressed and vulnerable. Because emergency situations are more complex and unpredictable than normal situations, the information readily accessible to users in such events must be carefully considered and comprehensively planned. Extensive testing and investigation are necessary to ensure the effectiveness of the wayfinding system outlined in this report, and to observe user behaviour and state of mind during use of the wayfinding app, with a particular focus on observing utilisation of QR codes. Determining how best to guide users to efficiently engage with an escape system in emergency situations is the next step of the research. Most importantly, minimizing the length of time required to obtain valid information through digital navigation must be a key criterion in judging the design of the app.

In summary, the digital app has the potentials to resolve a set of problems that are not addressed by traditional wayfinding systems. This project has developed a distinctive and functional set of graphics to achieve that goal. The app is still in the development stage, but this phase of the research aimed, as a starting point, to show that the concept is viable.

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