DESIGNING SEABUBBLE DOCKS

A handbook for guidance on the design process for a SeaBubble dock

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Master Thesis
Integrated Product Design, TU Delft

A project made possible by Cities of Things lab & Advier

This master thesis is part of a graduation project of the Integrated Product Design (IPD) Master's programme at the faculty of Industrial Design Engineering at the Delft University of Technology in the Netherlands.

Delft, July 2021

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SUMMARY

The project that is performed is for the master thesis of the master study 'Integrated Product Design' at the faculty of Industrial Design Engineering at the TU Delft. The final product is a handbook that functions as a tool to create a dock for SeaBubbles, and it is developed for the company Advier.

The process started with exploring the scope. The scope can be split up in three directions: the business direction in which the company Advier and its stakeholders is analysed. It becomes clear that Advier will give the handbook to a design agency that will create the actual dock design. The second direction is the analysis of the location. The network is situated in the area of Dordrecht, also known as Drechtsteden. The effect of the weather and tide on this area is analysed and the conclusion is drawn that the design of the dock must deal with changing water levels. The third direction focuses on the SeaBubble, in which the SeaBubble for seven passengers and twelve passengers are presented. The reservation system is mapped out and shows that the SeaBubble will define its route on the demand, in between it is possible that the SeaBubble will change its route. This has a large impact on the passenger journey.
In the passenger journey, two types of passengers are presented: a prepared and an unprepared passenger. The prepared passenger has bought a ticket at home, while the unprepared passenger must buy a ticket at the dock. From this point in the process, the focus will be on the experience of the passenger. By creating a building that fulfils the needs of the passenger when the passenger is being guided, is waiting, and is boarding, the experience of the passenger will be good.

The next part that is being analysed is the elements that is needed for guiding, waiting and boarding. For guiding, first the crowd flow is analysed. Based on this crowd flow, a general layout of the building is created for the location of ticket vending machines, waiting areas and potential one-way systems. Secondly, the needed information is analysed and tested in an online 3D environment. The location and the initial way of communication for several information elements is determined.

For waiting, literature is analysed, and people are interviewed and observed. The passengers will find distraction on a smartphone or while enjoying the view, having a seat is preferred.

For creating a comfortable boarding experience, two supports are needed in an area with even floor and no gaps. By getting inspired from the results, different configurations of docks were created.

By determining the principles behind the configurations, the design choices are mapped out. These design choices are structured with a morphological map and explained in the handbook, which is the final product of this master thesis. After finalising the handbook, interviews were held with the client and an architect to evaluate the final product.

CONTENT

INTRODUCTION

This is the master thesis for the master 'Integrated Product Design' at the faculty of Industrial Design Engineering at the TU Delft. This master thesis describes the design process of a handbook. The handbook is a tool to create a dock for SeaBubbles and it is developed for the company Advier. The dock will be a building, located by the water, to function as a docking location for SeaBubbles. SeaBubbles are river taxis that can drive autonomously. The docking location is a building where passengers can wait for their SeaBubble to arrive. The handbook functions as a guiding document to design these docks. The wish of Advier is to create a network of SeaBubbles, and therefore a network of docks, it will be in the area of Drechtsteden. Advier itself will not design the specific docks at location, this job will be outsourced to a design agency with experience. By creating a handbook, the different possibilities for the design choices become clear and by following my design choices for a case study, the process itself becomes clear too.

The handbook is focused on the experience of the passengers. By creating a building that matches the optimal passenger experience, the service of using a SeaBubble will be perceived as pleasant.

The master thesis will show the process behind the development of the handbook. In this process the focus is on finding how to fulfil the needs of the passenger. The needs of the passenger can be divided into three directions: 'guiding', 'waiting' and 'boarding'. By analysing the needs of the passenger and researching how to fulfil these needs, the information for the handbook is collected. To read the full project brief and topic description, see appendix 8.1.

The structure of this master thesis is split up in six chapters and is guiding you through the entire project. The first chapter discusses the context of the project, like the SeaBubble, the potential locations and the effect of the nature on these locations. This chapter ends with a short introduction of the final product, to help understand the next chapters. In chapter 2 the process is explained, and the passenger journey map is presented. This passenger journey map is used as an underlay in each step that is performed. Chapter 3 shows the results from performed research. The research can be categorized by 'building', 'guiding', 'waiting' and 'boarding'. The outcome of the research results in multiple findings. These findings are used in chapter 4 to create three inspirational buildings. This chapter ends with extracting the design principles out of the inspirations. These design principles are structured in chapter 5 and form the handbook. Chapter 6 evaluates the final product, by interviewing the company, Advier, and an architect.

1. PROJECT GOAL

1.1 SeaBubbles

The design of the dock starts with understanding the SeaBubble, that must dock there. A SeaBubble is a river taxi that is fuelled by hydrogen, which can be a sustainable fuel source. The hydrogen can be produced with water and electricity, and it will not be depleted, unlike fossil fuels. (Klimaatakkoord, n.d.) The SeaBubble has a foil underneath, that will make it possible to lift out of the water when driving, this starts at a speed of 12 km/h. This foil is combined with a fly by wire system which makes it possible to cut through the waves. This way the SeaBubble will not rock, which makes the ride comfortable. By lifting out of the water the SeaBubble will be less affected by water friction, and therefore consume less fuel. In the future the SeaBubble will drive autonomously. By creating a dock that is self-regulating, no people are needed to create the service of using a SeaBubble. (SeaBubbles, n.d.).

Figure 1: SeaBubble for seven passengers with open doors (SeaBubbles, n.d., a)

The design of a dock is a complex topic, especially too complex for one graduation project. Therefore the way of lifting the SeaBubbles out of the water is defined out of scope. For this project is chosen to work with a forklift that will mechanically lift the SeaBubble when docking. This forklift is a concept, presented by Advier, and might change in future improvements. The benefit of this system is that the SeaBubble will be lifted in a stable way and the SeaBubble will not rock during moments of boarding.

Two types of SeaBubbles will become available. The first type is developed for seven passengers and the second type for twelve passengers.. The definitive specifications of the SeaBubble were not available during this project, because the concept of the SeaBubble was not yet defined by the manufacturers. Based on the images and figures provided on the website of the SeaBubble, the dimensions can be derived. In the next paragraphs there will be a closer look at the two types of the SeaBubbles

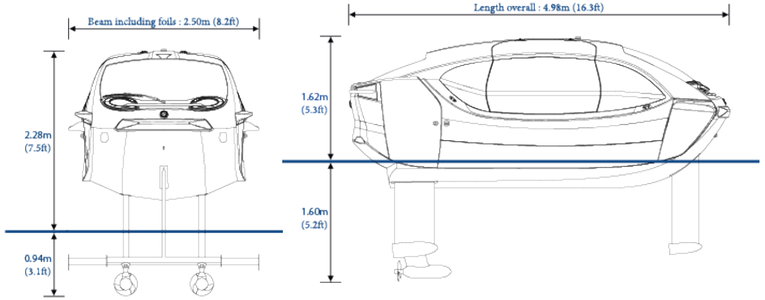


Figure 2: Dimensions of the seaBubble for seven passengers (SeaBubbles, n.d., b)

SeaBubble for seven passengers

In an interview with an employee of Advier, Maurice de Maché, the technical specifications of the SeaBubble and the system were discussed. All SeaBubbles will have around the same height and width, the length will differ per type. The SeaBubble for seven persons will have almost the same length and design as the current type that is suitable for five passengers. To define the dimensions of the type for seven passengers, the images for the type of five passengers will be used, see figure 2.

The boarding process of this SeaBubble will be based on the opening of the doors of this SeaBubble. The door of this SeaBubble will swing open in vertical direction. On the outside of the SeaBubble, there is a small gangway where you can place your feet. This makes stepping inside the SeaBubble easier (see figure 1)

The way of determining the dimensions was by using the images as an underlay and recalculating the sizes of the lines with the actual sizes. For the full overview of determined dimensions, see appendix 8.2.

SeaBubble for twelve passengers

A first impression of the SeaBubble for twelve passengers is given in figure 3. Important to see is that the door is wider and opens in a different way. It looks like the door has less height than the one for seven passengers. The step of the gangway looks deeper and makes it easier to step inside the SeaBubble.

Later in this project, these dimensions will be used for the boarding environment, to determine the location and sizes of the boarding elements.

In this project the focus will be on the SeaBubble type for seven passengers, but the SeaBubble for twelve passengers will not be taken out of the scope. The SeaBubble for seven passengers is more fitting in the context of autonomous driving. There are less passengers inside the vehicle, so the route will be shorter, and the passengers will be earlier at the desired location. If the SeaBubble is not allowed yet to drive autonomously, it is better to choose for a bigger one. This way, less captains are required who can control the SeaBubbles.

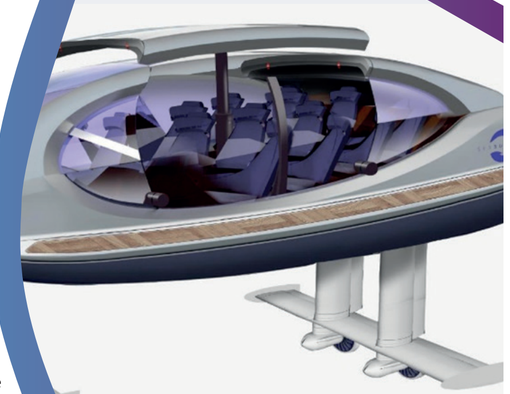


Figure 3: SeaBubble for twelve passengers (SeaBubbles, n.d., c)

1.1.1 Docking options with SeaBubbles

Before designing a dock for a SeaBubble, it is good to know that there are different configurations available to dock a SeaBubble. In these configurations, it is optional to separate the flow of deboarding passengers and boarding passengers. This is a commonly used system in amusements parks. Before starting this project, Advier has analysed four different ways of driving towards the dock and docking the SeaBubble.

The first option is driving into a box, where passengers can deboard and board. Then the SeaBubble must drive backwards to continue the route. Driving backwards is not an option that Advier wishes to use. (figure 5)

Docking option 2 (figure 6) works the same as boarding a rollercoaster: on one side, the passengers will board before the ride in the rollercoaster. On the other side the passengers will deboard at the end of the ride. The difference with option 1 is that the SeaBubble can drive in one direction and does not need to move backwards. In this case, a bridge needs to be built over the docking location of the SeaBubble. If Advier wants to keep the option open for other types of boats to board at the dock, a bridge over the docking locations is not useful, because of the limiting bridge height that is hard to match the mast height of several sailing yachts.

The third option is a carrousel (figure 7): in this concept the middle disk will rotate, so that the SeaBubbles will not drive, but still move due to the disk rotation. A rotating disk can be complex to design when trying to meet the requirement of a sheltered building where passengers can wait. An example of this system is a ski lift or the Fata Morgana, an attraction in the Dutch amusement park Efteling. (Eftepedia, 2021)

The easiest solution is docking option 4 (figure 8). In this system the SeaBubble can drive past the shore. For this project is chosen to use the easiest solution, because this will be the cheapest solution and has therefore the biggest chance of being used in real life.

Figure 4: Boarding system of a roller coaster (Wikipedia, 2021)

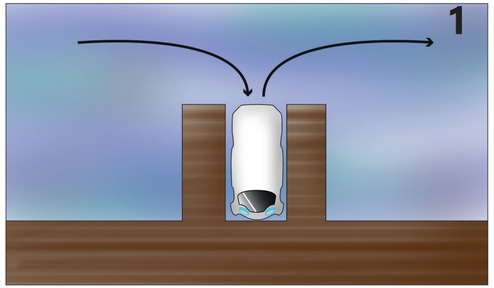


Figure 5: docking option 1

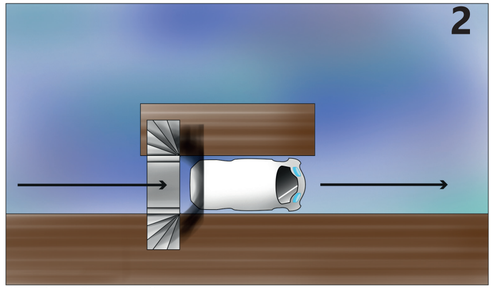


Figure 6: docking option 2

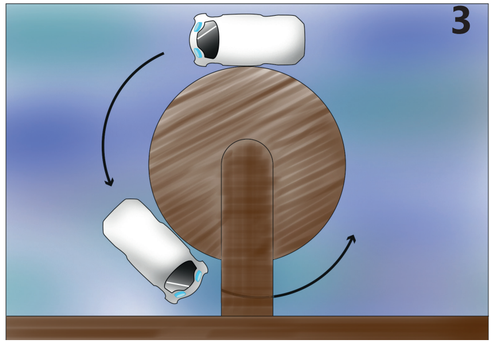


Figure 7: docking option 3

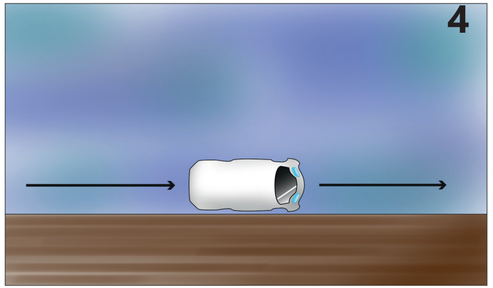


Figure 8: docking option 4

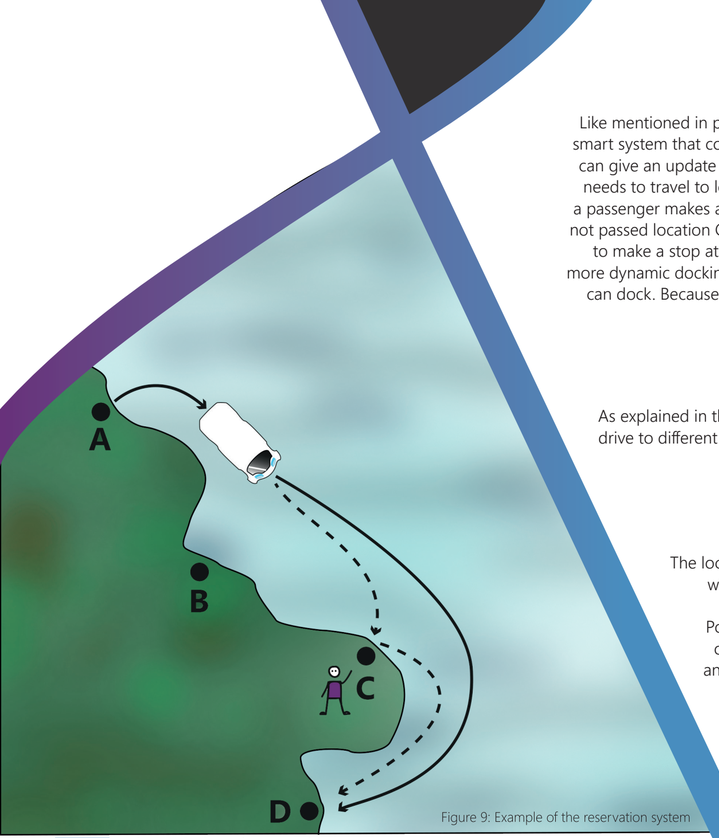


Figure 9: Example of the reservation system

1.2 Reservation system

Like mentioned in paragraph 1.1, the SeaBubble is an autonomous river taxi. There will be a smart system that controls the network of SeaBubbles: it communicates the initial route and can give an update of added docks on the route. A SeaBubble will start at location A and it needs to travel to location D. When the SeaBubble leaves location A to drive to location D, a passenger makes a reservation for a trip from location C to location D. The SeaBubble has not passed location C yet and it is on the route to location D. The SeaBubble gets an update to make a stop at location C (figure 9). This system of reacting on requests, will result in a more dynamic docking situation. At a dock there are multiple dock gates where a SeaBubble can dock. Because of the route that can change every time, it is not definite that the same SeaBubble can dock at the same dock gate all the time.

1.3 Network locations

As explained in the previous paragraph, a network will be created where SeaBubbles will drive to different locations. In this paragraph, the different locations and the effect of the nature on these locations will be analysed.

1.3.1 Drechtsteden

The location for the SeaBubble network is the area of Drechtsteden (figure 10), which are cities that have 'drecht' in the name, Like Dordrecht, Sliedrecht, Zwijndrecht and Papendrecht. These cities are located in Zuid-Holland. Potential locations for a dock can be in city centres, more suburban areas or even industrial areas. When building a dock, the locations need to be analysed on soil types, impact of the weather and the regulations that are applied at these locations.

1.3.2 Types of shores

Different types of shores are based on different types of soil. Some soil types are more solid than others, which results in steeper slopes of shores. In a conversation with an expert, Hil Kuiper, who is a project coordinator at HB Adviesbureau, more insights on shore types are shared. A natural slope will result in a shallow water, which makes it hard for the SeaBubble to reach the shore. The SeaBubble itself has a depth of 1.60 meters when it does not move. A shore that needs a depth of more than 1 meter, directly needs a soil-retaining structures. A soil-retaining structure is built up with a dam wall or a quay wall. This wall can be made from different materials, like wood, bricks or metal. Choosing sheet metal will be the cheaper solution because of the durability and the easiness to produce it.

Figure 10: Drechtsteden (OrangeSmile, n.d.)

For this project, the minimum height for a dam wall is 2 meters: it consists of a depth of 1.60 meters under water level and it needs to be lifted 0.40 meters to have the boarding step at the same level of the quay. This can be seen in figure 10. In other countries other types of shores might be more fitting, this needs to be analysed when creating a dock outside the Netherlands. In this project, the shape of the quay that is presented in figure 10 will be used as a base. In appendix 8.3, the regulations of the municipality of Dordrecht are presented, just like the 'Keur' of the water authority.

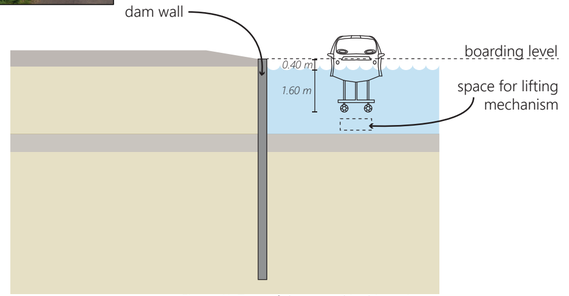


Figure 11: Type of shore used in this project

1.3.3 Weather & Tide impact

Another factor that needs to be considered when designing a dock, is the impact of the weather. In the area of Dordrecht, there is a moderate maritime climate. This means that the temperature range does not change very often. (Climate-data.org, n.d.) There are rainy days and sunny days, and the average wind direction is southwest. (Wisuki, 2012).

Important to know about the Drechtsteden is that the water is connected to the sea and therefore will be affected by the tides. On a normal day, the difference in water level will be around 1 meter. The absolute water level will change in a year from -0.04 to +1.07 metres, the minus and plus stand for the water level compared to the sea level. In appendix 8.4, a more thorough explanation is given for the weather impact.

1.4 Final deliverable

The final deliverable for this project is a handbook that shows the process for designing a dock. The focus for the dock design is on creating the optimum passenger experience. By showing the process, the different possibilities are explained per topic. In the next paragraphs the function of the handbook will be explained, and it will be explained for who this handbook is written.

1.4.1 Function of the handbook

The handbook is developed to show the design process that I have performed during this master thesis and this handbook will be given to a design agency as tool to create a dock. In the next chapter (2.1 Process), the structure of the design process is presented. By sharing the structure of the design process, the design agency will get insights in the reasoning for the design choices that are made. Because of the variety of options at a decision point in the process, I have chosen to focus on showing the biggest differences, the extremes, between the options. When working with the extremes as options, the agency can look for benefits and disadvantages for each option. By understanding the extreme options, it is easier to understand the effect of a less extreme option. For example: when choosing a shape, the extremes can be a rectangular shape or a circular shape. A solution that is in between these extremes is a rectangular with rounded corners. The extremes have a function to inspire the design agency for the potential possibilities and the example process, which is a case study, has a function to explain the design process.

1.4.2 Target group

The company Advier is the client for this project and their goal is to create several docks for a SeaBubble network. By using the handbook, a tool is given to perform the design process the same way for each dock. Advier is a company that organises the logistics to bring people to the desired locations. Advier will not design the dock itself, they will look for a design agency who can create a dock for them. In the next paragraph an overview is given of the stakeholders involved in this project.

Stakeholders

The stakeholders that are involved in this project, and therefore the creation of a dock, are presented in a stakeholder's map (figure 12). This map is placed in a matrix that has a range from little to great, on both x-axis and y-axis. The x-axis shows the level of interest, and the y-axis shows the level of influence power. (MindTools, n.d.)

There are nine stakeholders involved in the map, with Advier having the greatest interest and greatest influence power. Advier is the company that is the creator of this project. The elements for creating a network of SeaBubbles is firstly multiple docks where SeaBubbles can dock and secondly multiple SeaBubbles that are supplied by the company with the same name 'SeaBubbles' (SeaBubble suppliers). The design agency is the stakeholder that will have the responsibility to come up with a concept for the docks and fulfil all needs and wishes of Advier. They have a little less influence than Advier, however, the interest is great. The design of this company will be realised by the work supervisors.

While creating the network of SeaBubbles, the regulations of the municipality and the water authority need to be fulfilled. However, the level of interest of these two stakeholders will be lower than the rest. This is because they only have to check if the regulations are respected.
The skippers are not fulfilling a permanent role in this stakeholder map. The SeaBubble can be self-regulating and can drive autonomously. However, due to the regulations of autonomous driving, a skipper is still needed for driving the SeaBubble.

The users are the passengers that will use the SeaBubble to travel.

The last stakeholder is me; I am executing this master thesis and will deliver some advice to Advier. My interest is great, because I have chosen this project. This master thesis creates the base of design choices for the docks. That is the reason why the influence power is great too.
Based on this overview it becomes clear that the handbook needs to fulfil the wishes and needs of the company Advier and must be understood by the design agency. The focus of the handbook needs to be on telling the story to a design agency.

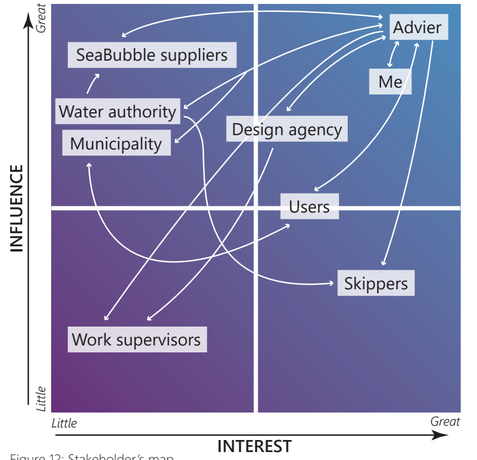


Figure 12: Stakeholder's map

2. PROCESS

A traditional approach is chosen as process for this project, it is the basic design cycle mentioned in the Delft Design Guide (van Boeijen, 2013, p. 19).

The topic of this project is creating a dock for SeaBubbles, and I have chosen for a user-centred focus in this project. This user-centred focus matches with the wishes of company Advier and my vision as a designer. With a topic that consists of new products, it is useful to get a thorough understanding of the topic. That is why the first phase focuses mainly on analysing and researching the topic. By exploring this scope, more insights are found for elements when creating a dock. When using a less traditional approach, in the beginning the focus will be less on exploring the topic and that was less beneficial for exploring a new topic like SeaBubbles. In the next paragraph the process will be explained.

2.1 Explanation of the process

The traditional process has a linear flow consisting of several phases. These phases are based on five steps: analyse, synthesise, simulate, evaluation and decision. (van Boeijen et al., 2013, p. 19) In a phase, it is not essential to follow all steps. In different phases different steps need to be emphasized and explored more into depth. Following the steps helps to complete a phase in a structured way. The order of the phases in this project is first researching the topic, secondly there is an ideation phase, and it ends with finding a concept. Each phase starts with diverging, which is exploring the possibilities within that phase, and it ends with converging, which means narrowing down the findings or options. Each phase will be a bit more specific than the previous phase. In figure 13 the process of this project is visualised.

This project started with exploring the scope. Three directions were explored: the business direction in which the role of Advier and other stakeholders is discussed, the technology direction in which the SeaBubble and the system of the SeaBubble network is analysed. The last direction focused on the user and the elements of the passenger journey. This phase ended with a lot of information that will be used in the next phase.

In this next phase, the focus was on getting inspired for different configurations of docks. By defining the different configurations of the dock, a scope is set for defining the guiding elements and the boarding elements in the dock. The configurations were split up in three inspirational configurations. The principles behind these configurations defined the structure of the design process of a dock. Therefore, the principles are the base of the handbook. The last phase was an evaluation of the handbook. By presenting the handbook to the company and an expert, a final advise was given for the handbook and future adjustments.

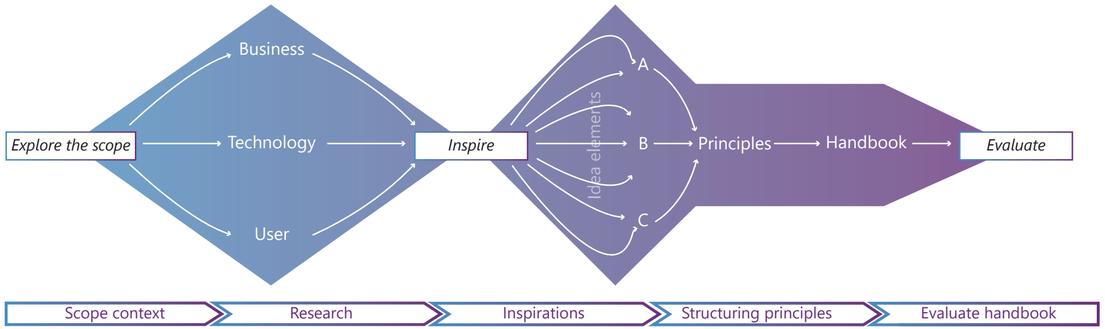


Figure 13: Visualisation of the design process

2.2 Passenger journey and the process

The focus of the handbook will be on the experience of the user. The users are passengers and therefore called 'passengers' from now on. The gender of the passengers is not defined, because the dock should be functional for all passenger types. In this document the term 'he' is used to indicate all passengers, to make it easy to read the paragraphs. There are different types of passengers that will use the SeaBubble for different purposes. It consists of commuters, that will use the SeaBubble to travel to school, work or family. Other passengers might want to use the SeaBubble like an attraction vehicle and use it for entertainment.

2.2.1 Passenger types

In this project will be worked with two types of passengers: the prepared type and the unprepared type. The prepared type is the person who has installed the application of the SeaBubble service on his smartphone and made a reservation for the SeaBubble on beforehand. People who will use the SeaBubble on a frequent base might have benefit for using the application. Sometimes, something happens with the schedule of the passenger and he or she might be in a hurry when arriving at the dock. That is why this type is split up in two options: one prepared passenger (1a) who is in a hurry and one prepared passenger (1b)who is more relaxed.(figure 14).

The second type of passenger is the unprepared type. This person arrives at the dock and decides at location that he or she wants to buy a ticket for the SeaBubble. When buying a ticket at location, it will take more time for the SeaBubble to arrive, because the route of the SeaBubble will be based on the passengers who want to use it. That is why the passenger will have a longer waiting time and has no hurry before the SeaBubble arrives.

2.2.2 Passenger journey map

The passenger journey consists of 5 steps, which are analysed on different elements. This journey only focuses on the way to the SeaBubble, because the other way around has the same steps but is less complex. A passenger journey map (Boeijen, van, et al., 2013, p. 53) is used to map out the experiences of the passengers in this journey. It is important to keep in mind that this passenger journey relates to the reservation system and will influence the route of the SeaBubble.

The five steps are defined by the locations in the process. The first step is preparing the journey, which probably happens via the smartphone, at home or at work. By making a reservation on your phone, internet connection is needed. The reservation will be connected to a SeaBubble immediately and this SeaBubble will adjust its route. The journey of the passenger who is not prepared, starts at the entrance of the building and has not made a reservation.

The second step shows the entrance of the building, which is a pivot point in the journey. Here, the prepared passenger checks how much time is left before the SeaBubble arrives and decides if he must hurry. The unprepared passengers will need a moment to orient and look for a place to buy a ticket.

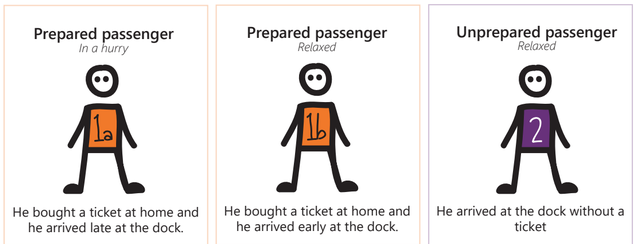


Figure 14: Three passenger types

If the passenger is not in a hurry, there is time to take a seat in the waiting area. While waiting, the passenger will look for his SeaBubble and find some distractions in the meantime. By recognizing his SeaBubble arriving, step four is fulfilled. The last step is the process of boarding the SeaBubble, this happens at the dock gates. (figure 15)

In the passenger journey map, five categories are presented. The first category shows the train of thoughts of the different passengers. This is based on interviews with people who described their journey with a train.
In the second category, with the 'Heart', the customer needs are shown, these are the crucial elements during the activity.

In category three the 'Gift' focuses on what the customer wishes.

The 'Lighting' shows the conflicts during the activity and can be found in category four.

The last category is a graph that shows whether it is a positive or negative experience and is based on my own experience with other public transport vehicles. (appendix 8.10).

Based on this passenger journey, three main themes become clear and will be used to analyse important elements of the customer journey. These themes are 'guiding', 'waiting' and ''boarding'.

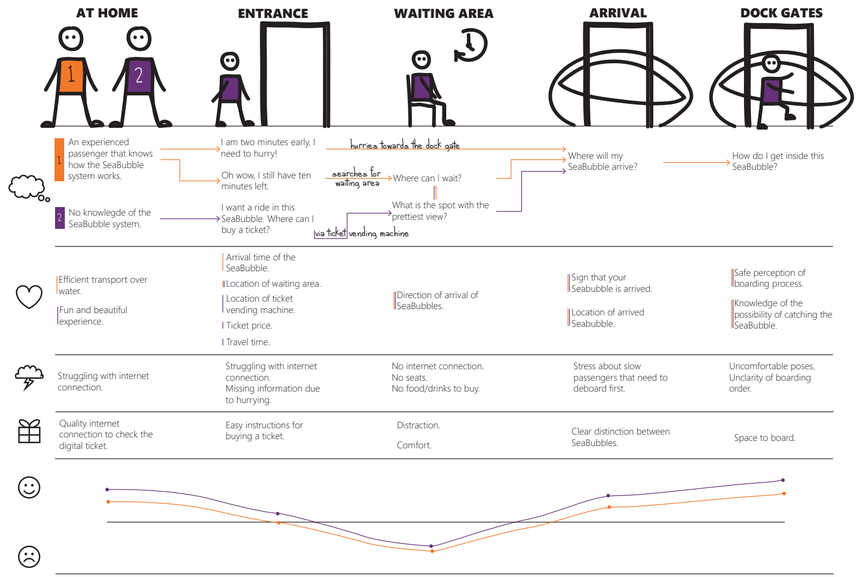


Figure 15: Passenger journey map

3. RESULTS

3.1 Building

In this paragraph, the elements for creating the base of the building will be discussed. These insights were gathered by finding literature and performing tests like interviews and observations. The building is not directly important for this project; however, the guiding, waiting and boarding results are more valuable when analysed in context. That is why this paragraph elaborates on the building.

3.1.1 Shape

The shape of the building is hard to determine on its own, it is connected to the orientation of the building and the size of the building. To make a solid decision, it is valuable to determine the function of the dock. In a crowded area, a dock should be as compact as possible, the size will obviously be as small as possible, having an efficient shape which uses all the space that is available will do half of the work. In this paragraph three extreme options are analysed, see figure 16.

Elongated rectangular shape

The ratio between length and width is about 4:1. When entering the dock, it feels like entering a long airport gate. The benefit of this shape is that by walking straight through the building, you easily find all docks. However, a disadvantage for this shape is that you have no overview of the building when entering it. In this situation the assumption is made that the elongated shape is oriented perpendicular to the quay. If the building is shaped parallel to the quay, there is way less overview of the building when walking straight forward and the benefit for this shape is not there anymore.

Square-like rectangular shape

The ratio of this shape is about 2:3, it is still rectangular, but not as elongated as the previous idea. By making this shape more square-like, there is more overview of the entire hall. In the corners, there is less sunlight, because this is harder to reach. In darker corners, it is harder to see what is in there and that creates a situation with less overview.

Half of a circle

When looking on top of this shape, it looks like a half circle. When entering this building, assuming that it has one entrance in the middle, it is easy to orient yourself, because all walls have the same distance to you. This shape has as benefit that you can easily keep the overview without struggling with darker corners. A disadvantage is that it is hard to place a waiting area in this building that will not get in the way of the crowd that wants to walk to the dock. This problem will be explored thoroughly in the paragraph about 'Guiding'.

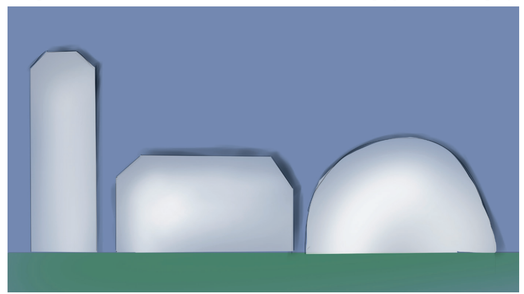


Figure 16: (Left to right) Elongated rectangular shape, square-like rectangular shape & half of a circle

3.1.2 Size

The size for the buildings is based on two variables: the amount of SeaBubbles that can board and the amount of passengers with personal space that fits in the area. Like mentioned in paragraph 1.1.1, the SeaBubbles will dock on one side of the building and lie in front of each other, as can be seen in figure 17. That is why the amount of SeaBubbles is based on the length of the SeaBubble. In paragraph 1.1 the length of the SeaBubble for seven passengers is estimated on 5 meters. A little bit more space is essential so that the SeaBubble can rotate while leaving the dock. In each building, there needs to be space for technical products, like electricity. This extra space is taken out of this project and needs to be considered when designing the actual dock.

The personal space is found in a handbook for architectural buildings. (Neufert & Neufert, 2000, p. 17) This architectural handbook has dimensions for objects that needed to be considered. The personal space is based on strolling passengers (figure 18), and has a diameter of 1250 mm. When calculating the area based on this diameter, the personal space has an estimated area of 1.3 m². (Wiskunde.net, 2021).

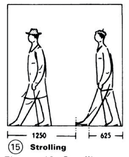


Figure 18: Strolling passenger

Small

The smallest size was implemented in an area of 157 m². The length and width of this square is in this map 12.5 metres. This length is based on the minimum of 4 SeaBubbles docking to a building and having a bit more space to rotate the SeaBubble when leaving the dock. This size is a bit crowded at peaks, moments where 4 SeaBubbles will arrive and per SeaBubble 7 persons will deboard. In the meantime, the new passengers are waiting. It might happen those four times seven passengers are waiting to board, and four times seven passengers are leaving the building, while a few other passengers are waiting for a SeaBubble that is arriving later. About 60 people need to fit in the dock at the same time. For choosing the smallest size possible, it is recommended to choose a shape that is using the available space as efficient as possible. Based on the available area about 120 passengers can fit inside the building.

Medium

The square-like rectangular shape is a bit bigger than the smallest size. This was chosen to be the medium size building. The floor consists of an area of 375 m². Recalculating this to a square shape, the length and width is around 19.5 metres, which results in 6 SeaBubbles that can dock. Having a hall with a bit more space gives the passenger a less crowded feeling, which is perceived as pleasant. (Cantwell, Caulfield & O'Mahony, 2007) If a location for the dock allows you to provide more space for the passengers, it is well spent. Some questions are useful to take in mind when choosing for a bigger dock. First: will the passengers be able to keep the overview with a bigger size of the building? Secondly, will the shape be influenced by changing the size? And following up on this: What is the effect of changing the shape? If there is enough space and money available, it might be a valuable investment.

Figure 17: (Left to right) Small, medium and large

Large

The third size is the largest. The area of this building is 1500 m² and a lot bigger than the previous shapes. The length and width of this square is around 39 meters. This size is probably too big for most locations. However, sometimes a building is situated in a less populated area. This area might not have any facilities. To provide these facilities the pleasure of the passengers will be increased. If this is the case, it is worth to choose for a bigger size of the building. Keep in mind that this size might obstruct the traffic of the water way and that research is needed to determine if it is allowed to build a dock this size.

3.1.3 Orientation

The orientation of the dock will be expressed by using the orientation towards the quay. In this paragraph three orientations will be discussed, the first two have a clear direction: perpendicular and parallel. The third one is more like a bulge connected to the quay. To determine the ideal orientation of the dock, multiple elements need to be considered. Think of interference with the waterway and effects of the wind and the water.

The main rule on the water way is that you must drive on the right side of the waterway (starboard). (Piena, 2018, p.37). This is considered when drawing the interference lines of traffic (figure 19, 20 & 21). Large cargo ships often have lengths of more than 40 meters. These ships are not easy to manoeuvre.

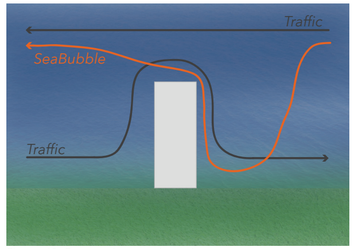


Figure 19: Perpendicular orientation

Perpendicular

A shape that is perpendicular to the quay (figure 19), will interfere the most with traffic on the waterway. How much it will interfere depends on the size of the dock and the width of the waterway. The SeaBubble will drive to the quay and then rotating to dock with the nose of the SeaBubble to the waterway. By docking it takes a bit more time, but it takes less time when sailing away.

Parallel

A dock parallel to the quay is the easiest shape when docking SeaBubbles. The SeaBubble does not have to make difficult rotations. Docking takes the least amount of time. A disadvantage for this shape is that you need a large part of the quay to build your dock. Especially in crowded city centres it might be hard to find a spot that has enough space available on the quay (figure 20).

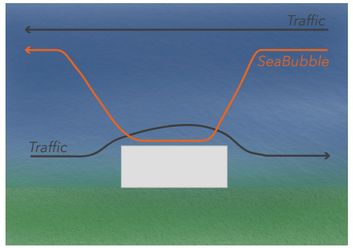


Figure 20: Parallel orientation

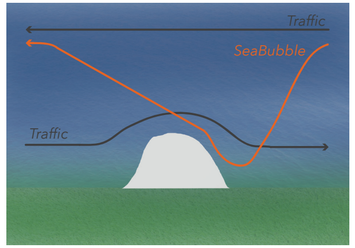


Figure 21: Bulge orientation

Bulge

A solution that can have the best of both worlds might be the bulge (figure 21). This shape is organic with round edges and will therefore interfere less with the waterway. All movements of boats and ships can be made smoothly and round around the dock. By using a rounded shape, it is easier to avoid hitting the quay or the building. The level of interference on the waterway depends on the dimensions of the dock.

3.1.4 Facade

The facade of the dock is the first impression of the dock, and this part of the building can help in the guiding process of the passengers.

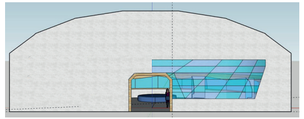


Figure 22: Facade without and with windows

Windows

An important element that can be adapted in the wall of the facade is the option of using windows (figure 22). Windows give the opportunity to look inside the building. This way you can get a glimpse of the SeaBubble, and with an interesting interior, you can draw the attention of people passing by. When being in a hurry, it is easy to look inside and see if your SeaBubble is already there. When choosing for no windows in the facade, people might be curious and wonder how it will look like in the inside. By choosing for a wall with no windows, there is no way for light to enter that side of the building. It might influence the brightness of the interior. On the other hand, glass windows are more expensive than walls.

3.1.5 Water level

Water level

Earlier in this master thesis is mentioned that the effect of the weather will have a significant effect on the exterior of the building. Most importantly is the effect of the tides, as can be read in paragraph 1.3.3, the water level change of 1 meter needs to be considered.

At the start of this project, it is discussed to use a lifting system for lifting SeaBubbles when docking. By choosing for a lifting system, the SeaBubble will be very stable and comfortable to board. The location for this lifting system is important, when connecting the lifting system to an object that cannot move (like a quay or the bottom of the waterway) (figure 23), it must lift the SeaBubble to a variable height to match the water level. However, when the building is on (figure 24) water level and the lifting mechanism is connected to the building, the lifting mechanism can lift to one specific level and does not have to take the water level into account.
In this situation the assumption is made that the SeaBubble will be lifted a little bit higher than the water level, to match the entrance height of the SeaBubble with the floor of the dock gate. This assumption is based on the principle of Archimedes. It takes less effort to lift something in water than to lift something out of the water, due to the upward force on a body. When lifting the SeaBubble the least out of water as possible, the lifting mechanism will need the least force to achieve this (Bots & Bouwmans, 2020).

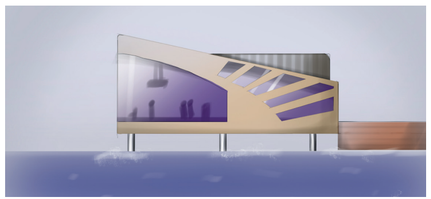


Figure 23: Building above water level

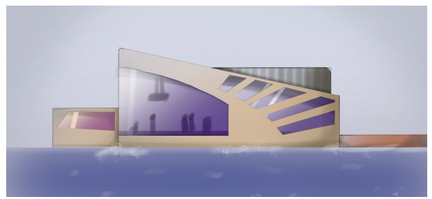


Figure 24: Building on water level

Tunnel with a slope

This paragraph relates to the previous paragraph and is an addition to the choice for a building on water level or above water level. In this paragraph a tunnel is added in the way from the dock to the SeaBubble. The same assumption as in the previous paragraph is made: the SeaBubble needs to be lifted to water level. This means that the tunnel should end on water level. A building that is placed above water level needs a tunnel with a slope to end on water level (figure 25).

A building that is placed on water level can have a straight tunnel (figure 26).The tunnel with a slope needs to end at the same level as the water level, which can be achieved mechanically or floating.

When choosing for a tunnel with a slope, a few things need to be considered. The first thing is the steepness of the tunnel, which might cause discomfort when walking in this tunnel. In the Netherlands there are regulations for the steepness, this can be found in the ASVV (CROW, 2012).
When making the dock wheelchair proof a steep tunnel is a problem. It is valuable to research the connection with the steepness of the tunnel and the perception of discomfort of the passengers.

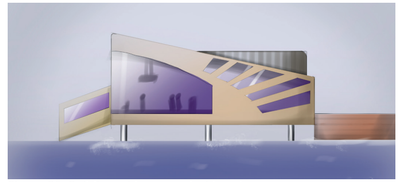


Figure 25: Building with a tunnel with a slope

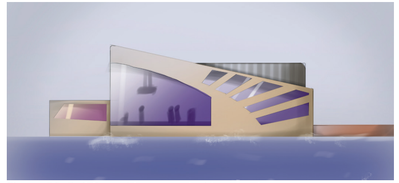


Figure 26: Building with a tunnel without a slope

3.2 Guiding

The passenger journey that is used as an underlay (figure 27) for the research phase shows three main themes: 'guiding', 'waiting' and 'boarding'. In this part of this chapter, the focus is on the guiding theme. The analysis of this theme starts with analysing the behaviour of the crowd. Based on this behaviour, the main route can be determined which affects the global layout of the interior.

3.2.1 Crowd flow simulation

The analysis on the behaviour of the crowd is performed with a crowd flow simulation in the software Anylogic (Anylogic, 2021). A crowd flow simulation shows the different flows of passengers inside a building. In this case a flow that enters the building and is searching for the right dock gate and four other crowd flows that leave the four corresponding dock gates and are looking for the exit. The complete crowd flow simulation can be found in appendix 8.5.

This crowd flow simulation is performed for two types of buildings: 1) with one entrance in the middle of the building, 2) with one entrance and one exit. The building that has a shape of half a circle has one entrance and a fan-shaped flow is assumed to be the crowd flow. The building with a rectangular body has one entrance and one exit and is more suitable for a circular flow.

The route that each crowd has to follow is based on the passenger journey and different scenarios are implemented. Some people needed to wait longer before the SeaBubble arrived than others, and one part of the passengers needed to buy a ticket at the dock before waiting for the SeaBubbles. The percentage of people that wanted to buy a ticket was set on 1%, 5% and 15%. Minze Walvius, the contact from the company Advier said that they assumed that 5% will probably buy a ticket in the future. Two extreme options were selected to be 1% and 15% in these simulations.

Figure 27: Passenger journey as an underlay

The crowd flow simulation started with analysing people who could walk freely through the building. Different setups were tested, like the location of the ticket vending machine and a specification of the waiting area. In the figures the density can be seen by looking at the colour scale from green to red and the source of the accumulations can be determined by the colour of the dots of the passengers. The meaning of the signs can be found in the legend.
For each shape and percentage, the ideal combination is determined, as can be seen in the figure 28. A last test was performed with these findings. A comparison is made (figure 29) with these situations when walking freely or being directed in a one-way structure. Only for the five percent of the rectangular shape and the 15 percent for the half of a circle shape it is ideal to use a one-way direction. The first mentioned option has fewer red spots on the map and is therefore perceived as less dense and better than free walking. The second mentioned situation is the 15 percent and has a long waiting line for the ticket vending machine. By guiding people through this waiting line, they will have less trouble with finding the exit.

The location of the ticket vending machine and the specified waiting area will be used in a user test for the information system in paragraph 3.2.3

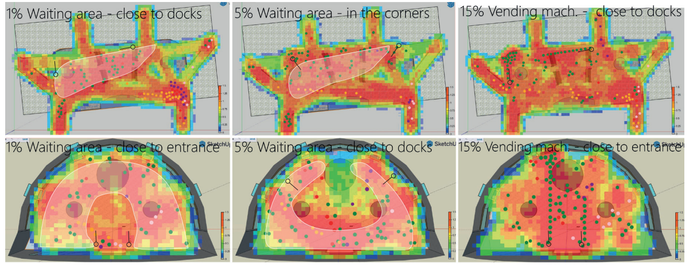


Figure 28: Results crowd flow simulation free walking (Anylogic, 2021a)

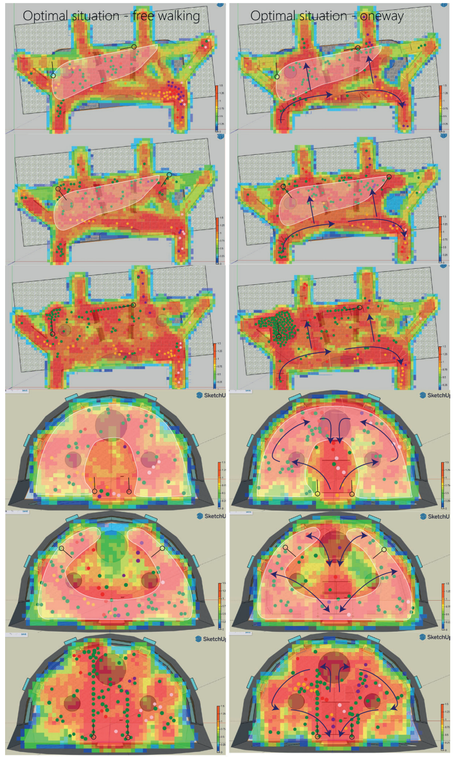


Figure 29: Results crowd flow simulation free walking vs. one-way directions (Anylogic, 2021b)

3.2.2 Needed information

The important element for guiding is determining the information that is needed to find your way through the building. In this project, the passenger journey map is used to find out which information is essential per step in this journey.

In figure 30 the passenger journey map locations are used to structure the needed information. The three passenger types (paragraph 2.2.1) have their own needs, which is showed in each row.

The information presented in this table will be tested in the next paragraph, after combining it with findings from literature. In appendix 8.6, the needed information is mapped out in a clear overview, that functions as a base for the user test on the information system.

	ENTRANCE	TICKET MACHINE	WAITING AREA	DOCK GATES
1a Experienced In a hurry	- Current time - Arrival time - Location of dock gate	→	→	- Sign of arrived SeaBubble - Location of your arriving SeaBubble - Sign of your turn to board.
1b Experienced Early	- Current time - Arrival time - Location of waiting area	→	- Finding a seat - Location of arriving SeaBubble - Recognizing your SeaBubble	- Sign of arrived SeaBubble - Location of your arriving SeaBubble - Sign of your turn to board.
2 New	- Introduction SeaBubble - Location of ticket machine	- Ticket price - Travel time - Current time - Arrival time - Location of waiting area	- Finding a seat - Location of arriving SeaBubble - Recognizing your SeaBubble	- Sign of arrived SeaBubble - Location of your arriving SeaBubble - Sign of your turn to board.

Figure 30: Overview of needed information

Animation 3
Three lines go from bottom to top at once. They appear and disappear all at once.

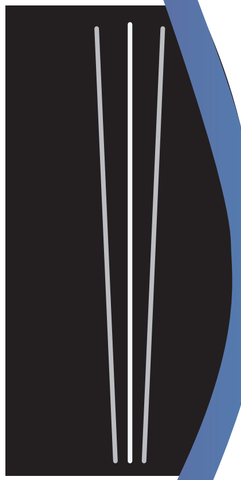


Figure 31: Dynamic lighting (Hiemstra & Tezcan, 2019a)

3.2.3 Information system

It is smart to create a dock where no employees are needed, in combination with an autonomous driving SeaBubble no employees are needed to support the passengers during their journey. To achieve this, the passenger must feel secure when finding his way through the building to the SeaBubble. The passenger needs to be sure that what he is doing is the right thing, because there might be no real-life person to ask questions. This requires clear instructions that are easy to read and understand. First a little bit of insight is gathered in literature for making clear instructions and signals in these situations. In appendix 8.7 a more elaborate version of the literature is presented.

To communicate instructions in a visual way, there are multiple elements that need to be considered. When text is essential for the communication, there is a minimal letter height, which need to be considered. By filling in equation 1, the letter height (H)can be determined.

$$H=0{,}0022 \times D+K1+K2 \qquad (1)$$

D is the distance between the eye and the sign, K1 corrects for the lighting conditions and K2 distinguishes important information from less important information. (Dirken, 2014, p. 371). The values for these variables can be found in this book.

Another option is to use light projections to guide passengers. Hiemstra and Tezcan (2019) have performed a test with light projections that guide passengers in an airport context. The clearest way of animating light is by using a vertical motion in the direction that is needed. In this research, the projections were projected on the floor, which is not practical when large groups are waiting there. The animation that scored best in the test can be seen in figure 31. This is an example that can be considered and needs further testing.

In this project I have focused on the static information to determine the needed information at specific locations, and secondly will be determined if text is sufficient or if shapes are a better solution. In future projects, a dynamic version of the information system can be considered.

3.2.4 User test

To test the needed information like explained in the previous paragraph, a 3D drawing is made in Google Sketchup (figures 32 - 42). By using a mouse, the participants were able to walk through this 3D building. By fulfilling the given tasks, the passengers have used the information system and the importance of the information is shared in an interview. The test is performed by 8 different participants within the range of 25 until 59 years. Below, three important parts of the information system are shared. See appendix 8.8 for the detailed test results.

Entrance

At the entrance, the passengers want to know what time it is and how much time is left before their SeaBubble will leave. Two boards with departure time are tested. One of them shows the current time (figure 34) and the other shows the time that is left before departure (figure 35). There is no distinction in preference for one of these two boards. Some participants want to know the exact time, so that they feel less manipulated by the system while others do not like to calculate how much time is left. By giving the option to have a board that switches between both options, most of the passengers are positive.

	RICHTING	TIJD
≋	Dordrecht Oosteind	17:04
	Zwijndrecht	17:05
	Hendrik-Ido-Ambacht	17:08
	Papendrecht	17:11

Figure 34: Information board with exact times.

	RICHTING	TIJD
≋	Dordrecht Oosteind	2 min.
	Zwijndrecht	5 min.
	Hendrik-Ido-Ambacht	6 min.
	Papendrecht	9 min.

Figure 35: Information board with remaining times.

The waiting area is recognisable by only seeing the benches to sit on. A sign that indicates the waiting area is not necessary. (figure 36)

Figure 32: Map of the docks in the area of Drechtsteden

Figure 33: Information board

Ticket vending machine & Waiting area

The passengers get a ticket (figure 38) after making a reservation via the smartphone or at the dock with a ticket vending machine (figure 37). On this ticket, an icon is shared, in this case it is a raindrop. In the building there is a circle next to each door and the circle is empty when it is not specified as a dock for a SeaBubble yet. When it is defined, the shape of the corresponding SeaBubble appeared in the circle. (figures 39, 40, 41 and 42). The participants had to find the raindrop figure, as can be seen in the ticket here on the right.

Five out of eight participants had no trouble with finding the correct SeaBubble, based on the icon. A few of the participants needed more security that it is the right SeaBubble. By showing the name of the direction, this problem would be solved.

Figure 36: Waiting area

Figure 38: Ticket with the icons

Figure 37: Ticket vending machines

Dock gates

In the 3D building, a traffic light is used to show if the participant was allowed to board or if he or she had to wait. The textual sign (figure 39 & 40) is clear, but the coloured sign (figure 41 & 42) is even more clear. In the future the signs need to be placed above the doors, to keep it visible in crowded moments.

Figure 39: Textual sign - wait before enter

Figure 40: Textual sign - ready to board

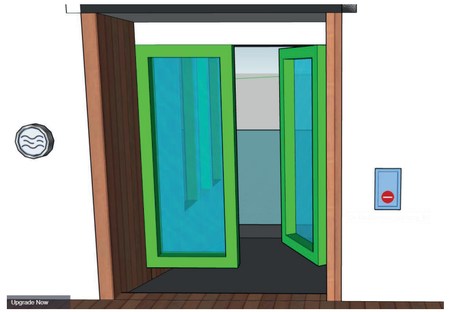


Figure 41: Visual sign - wait before enter

Figure 42: Visual sign - ready to board

3.3 Waiting and Boarding

In this part the layout and elements for the waiting area and boarding area are analysed. By determining the behaviour of the passengers, important elements that need to be implemented in the area can be determined.

3.3.1 Waiting area

When waiting for the SeaBubble to arrive, the passenger will be curious at which dock gate his SeaBubble will dock. It will not directly be clear, and the passenger will try to find distraction in the meantime. In this part of the research, the most common distractions are analysed. The postures during these distractions are analysed, just like the activities itself. In a paper of Cantwell, Caulfield & O'Mahony (2007), the idea of objective and subjective waiting time is presented. When a passenger spends his time in a useful way, the waiting time is perceived as way shorter than being bored. There are only a few activities that significantly influence time perception, these activities are doing small tasks, interactive games and talking. This is interesting to research further when structuring the waiting area.

The next step was performing an interview (appendix 8.9) with seven participants to find out what their waiting behaviour is.

Four elements became clear out of interviews with seven participants. The first element is a sheltered place to wait, this way you are protected from rain, cold weather and wind. Secondly, it is preferred to have a seat when you are waiting for the SeaBubble to arrive. As a third, listening to music helps to get distracted. If sitting is not possible a bit of support when leaning is the second popular posture while waiting. And lastly it is preferred to know what will happen and what you are waiting for, especially how much the delay is of your SeaBubble. Ideally, this delay must be shown in minutes. One activity for distraction is not mentioned in the interview but might have some potential in the building: the beautiful location of the dock, near the water, can result in the wish of passengers to look out of the window.

The third step in this research was observing people in different public areas and determining which posture was used when having an activity (figure 43).

The most popular postures while waiting are found at multiple locations, like a metro station, a train station and a short moment in the main hall of Schiphol Airport. It becomes clear that people try to find a way to sit, if there is an object to sit on, they will try to achieve it. On the airport people sometimes use their luggage as seat. While sitting, leaning or standing, 80% of the observed people were using a smartphone, some in combination with listening to music.

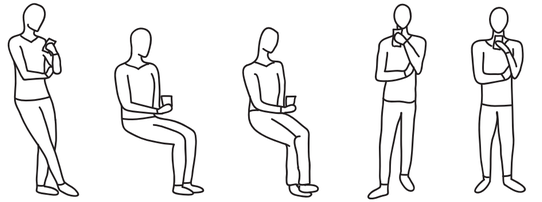


Figure 43: Postures

Objects in waiting area

A solution for a comfortable waiting time is based on previous findings. It is not a solid concept standing on its own, but its functionalities can be useful when deciding which objects are fitting in the waiting area. The two functionalities are a comfortable seat and a comfortable spot to lean against (figure 44).

Figure 44: Inspiration for seats

3.3.2 Boarding area

The boarding area can be split up in the area itself and the objects for that area. By interviewing people about experiences with mounting and boarding commonly known vehicles. The commonly known vehicles were collected in a mind map and structured in a table, which can be found in appendix 8.11. Unknown ways of boarding were analysed by watching YouTube videos (Dauphin horsemanship, 2013) (Nurila, 2018).

The two main findings from the interviews (appendix 8.10) are:

- Improving an unknown situation can be achieved by keeping the legs close to the ground. It will give security that you find support when losing your balance.
- Having a lot of space to board, gives security.

The moments of discomfort have in common that some parts of boarding are unknown and therefore perceived as risky. The discomfort can be divided into multiple directions: instability due to unknown movements, instability due to balancing, discomfort due to missing elements in the context.

Concluding for the elements in the area is that the floor needs to be even and stable. Because of the connection with the SeaBubble, the passengers need to get trust in the SeaBubble lifting mechanism that that will be stable too. That, however, can only be achieved when having boarded once.

After analysing the current and known vehicles in normal transport, the focus has shifted to vehicles that are created to entertain us. These vehicles are used in amusement parks and created to be as comfortable as possible, to keep the passengers up speed. The location for support is the key in this process, because holding a trustworthy and comfortable support, will give you a safe feeling.

By analysing the boarding process of more than 40 different roller coasters, a pattern was found. The vehicles had one or two holds for your hands, to make a big step. When it is easier to make the step, the hold for your hands is less obvious. Most of the steps have an aluminium plate. An example can be seen in figure 45.

The full overview of these pictures can be found in appendix 8.11. Now that an observation is made, it is valuable to implement these findings in a test environment and see if it is still accurate for SeaBubbles.

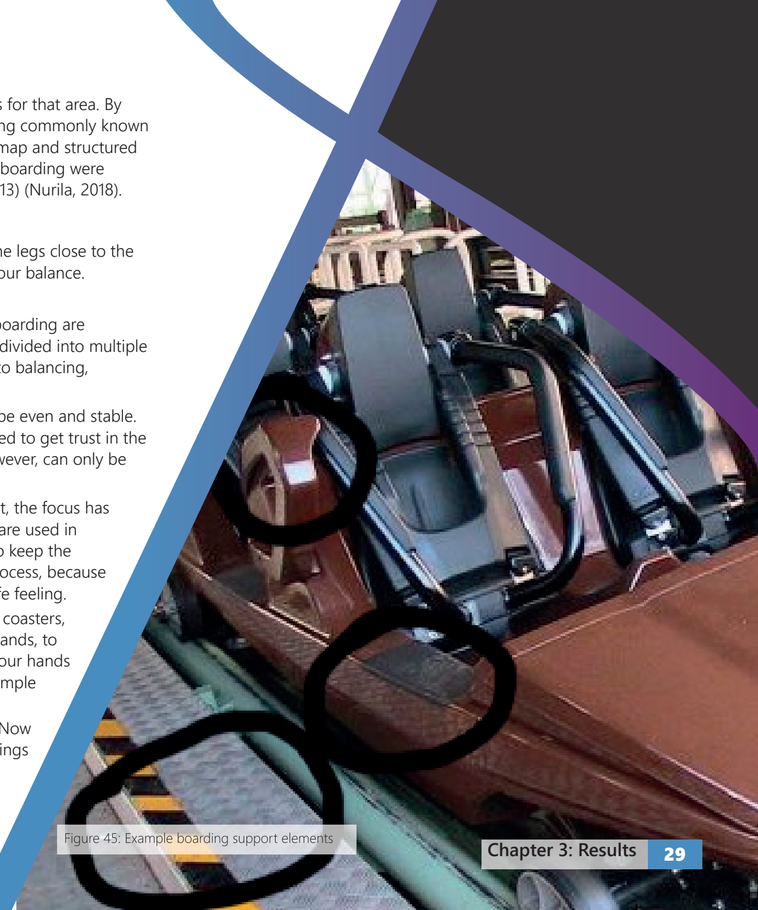


Figure 45: Example boarding support elements

3.3.3 Boarding support

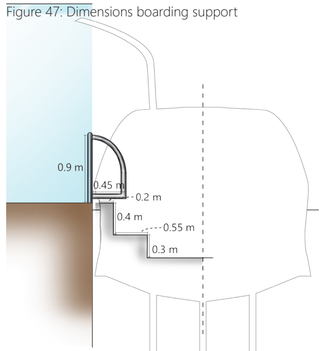
In the boarding process, the passengers have the most secure feeling when there is someone to help them board. However, the SeaBubble will be an autonomous water taxi and it will be ideal for the costs if the dock is self-regulating. This means that it is important to place support that is trusted by the passengers. In this paragraph a first step is made in analysing the function of the support. Based on this user test, the design agency can come up with a way of boarding that will fulfil the analysed needs when boarding.

User test

The boarding support is tested (see appendix 8.12 for the details) with a mock-up scenario (figure 46) where the boarding environment is recreated with wood. Based on the estimated dimensions of the SeaBubble (paragraph 1.1), the setup is created on a scale of 1:1. This lead to a door width of 1.4 metres of the SeaBubble. In figure 47 the rest of the dimensions are showed. On the dock gate itself, the boarding supports were placed. This is chosen because this is still in the scope of this project. Coming up with boarding support inside the SeaBubble is out of the scope and therefore the supports are placed on the dock gate itself. The stairs that were created show the separation of the SeaBubble (below until the grey duct tape) and the dock gate (on top after the grey duct tape).

Figure 46: Descending the stairs in a user test

Figure 47: Dimensions boarding support



The user test is performed with 8 participants who had to ascend and descend the stairs. Photos (figure 46) are made of the position of the hands on the support and afterwards an interview is held on the moments of discomfort.

The outcome is that the supports are a bit too high to grab, but still in reach. It is not necessary to lean forward to grab it. When grabbing the support, the majority grabbed first the front of the support and when making the second step, they replaced their hand to the top of the support. Some of the participants shared that this helped to push themselves up. A redesign for the supports is needed, a rounded shape that guides the passenger when taking the stairs will help. By letting the support start almost to the ground of the boarding environment, the passengers can get more support when boarding.

One problem that is out of the scope was that the steps of the stairs are way too big to be comfortable. This will be explored in paragraph 6.2.

4. INSPIRATIONS

4.1 Inspirations

A lot of findings are presented in the results section. Some of them are requirements for the building, other findings are suggestions for the building. These findings are used to get inspired. A collection of inspirational idea elements is created and used as a base for the three inspirations. In appendix 8.13 these elements can be found. The collection of inspirational idea elements is based on the passenger journey map, because the building needs to fulfil the requirements of passengers that are prepared and passengers that are not prepared yet. The difference in level of understanding between these passenger types needs to be considered. When creating the inspirational docks, I tried to come up with different setups to see what works for shape and elements. A memetic collage (appendix 8.14) is used to get an appearance of the building that is preferred by Advier.

4.1.1 Inspiration A

Inspiration A is an elongated building and is created as a very large option, this makes it possible to place facilities inside the building. It is easy to find your way in this shape (figure 48), because you only must walk straight forward when entering the building. The elongated shape provides two sides where SeaBubbles can dock. Because of the size of the building, it is possible to let SeaBubbles dock on one side and other types of boats on the other side. This is valuable for applying for subsidies at the municipality.

The roof of the building is made of coloured glass. The light will fall through the roof, on the floor. This way the coloured areas will show the route to different docks, and can be a pretty detail (figure 50). This detail is depending on the weather type: on a day with bad weather there is not enough light falling on the floor to guide passengers. In the end of the building is a waiting area, here is a pretty view (figure 49) over the water ways when waiting for a long time.

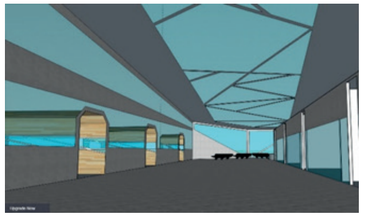


Figure 48: Overview when entering the building

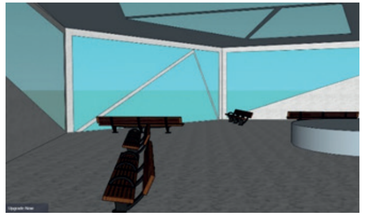


Figure 49: Pretty view at the end of the building

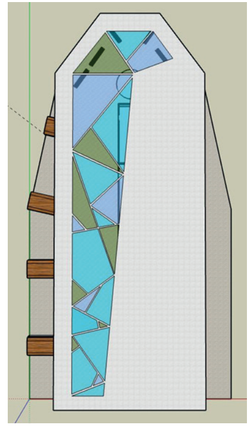


Figure 50: Glass detail in the ceiling

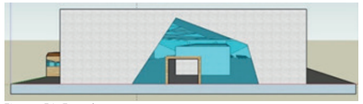


Figure 51: Facade

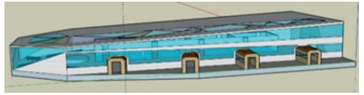


Figure 52: 3D view of inspiration A

4.1.2 Inspiration B

Inspiration B has the shape of half a circle (figure 54) and it has a sphere-like roof (figure 57). There is one entrance door with a lot of glass in the facade (figure 55). This way, the passengers can look inside the building and gets inspired to enter the building. Inside the building there are three large cylinders that can function as a sofa (figure 53) and as an information system. On the edge of the cylinder is space to sit, in the centre a screen can be placed that shows information. The size of the building and the location of the entrance make it easy to get an overview of the building when entering it. The way of boarding is with a door that opens like a box and matches the shape of the SeaBubble (figure 56). This matching shape minimizes the impact of bad weather when boarding the SeaBubble.

4.1.3 Inspiration C

Inspiration C is a rectangular shaped building, but more square-like and less elongated than inspiration A. The orientation of this building is parallel with the quay. The roof of this building is based on the wind direction (figure 59). By defining the main wind direction before building the dock, you can tweak the length of the entrance tunnels a bit. With one longer entrance tunnel than the other one, the building will not be parallel with the quay, but have a bit of an angle (figure 60). With this roof type, it is easier for the wind to blow over the building.

An adaption is made to two tunnels hat lead towards the SeaBubble. These are split in two. By splitting the tunnel, the deboarding and the boarding passengers can be split, and accumulation is prevented. (figure 62).

The facade of the building has no windows, which makes it mysterious (figure 58). The passengers will become curious and wants to peek inside the building. On the inside a large screen with travel information, like a map, can be placed on the large wall.

This building is a bit bigger than inspiration B. By having a rectangular shape and the entrance in a corner, it might be harder to get an overview of the entire building than with inspiration B.

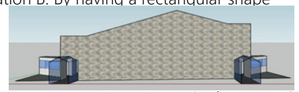


Figure 58: Facade of inspiration C

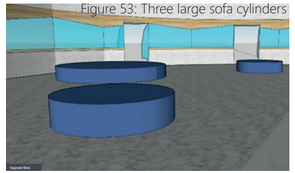


Figure 53: Three large sofa cylinders

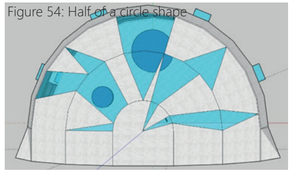


Figure 54: Half of a circle shape

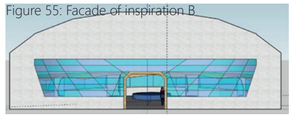


Figure 55: Facade of inspiration B

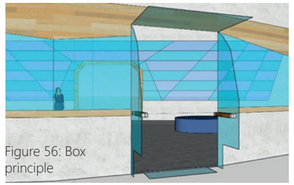


Figure 56: Box principle

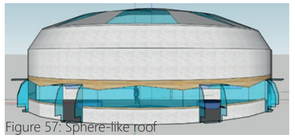


Figure 57: Sphere-like roof

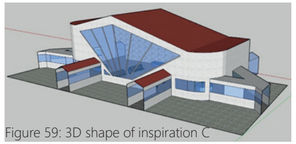


Figure 59: 3D shape of inspiration C

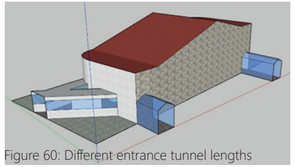


Figure 60: Different entrance tunnel lengths

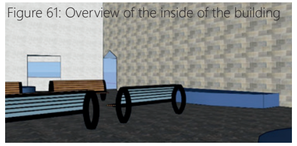


Figure 61: Overview of the inside of the building

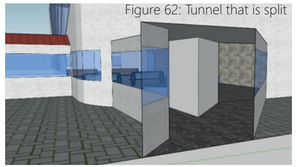


Figure 62: Tunnel that is split

4.2 Principles

The inspirations are created with the results of multiple researches. Different principles are used for fulfilling the specifications that form together the inspirations. By extracting the specifications from the inspirations, the different principles for each specification are found.

In the table (figure 63), the specifications are presented in the left column. The other columns are the solutions or principles for the corresponding specification.

The specifications and principles form the base for the handbook. In the handbook, this will be structured based on the passenger journey map. When structured, the morphological map (paragraph 5.2) is created. This morphological map is the base of the handbook.

Specifications	Inspiration A	Inspiration B	Inspiration C
Access for boarding	Single tunnels	Door	Tunnels with a fork
Entrance door	One central door	One central door	Two tunnels
Entrance wall	No special features	Glass	Bricks
Orientation of docking SeaBubbles	Perpendicular to the quay	Half of acircle	Parallel to the quay
Option for facilities	Facilities inside the building	Facilities outside the building	Facilities outside the building
Shape	Rectangular, perpendicular to the quay	Half circle with sphere features	Rectangular, 'parallel' to the quay
Waiting area	End of the dock	Main hall	Main hall
Size	Large	Smallest as possible	Bit more spacious than inspiration B
Ambience	Light & open	Light & open	Partly light & open
Location information system	No special features	Center of the pouf	Large wall
Weather impact	Tunnels	Matching doors	Tunnels

Figure 63: Table with principles

5. HANDBOOK

The handbook is the final product for this master thesis. In this chapter, the overall structure of the handbook will be explained first. The overall structure of the handbook is based on a morphological map, which will be discussed in the second paragraph. This chapter ends by showing an example of the handbook.

5.1 Structure of the handbook

Based on the principles that are analysed in paragraph 4.2, a document is created to help making the design choices. This is the handbook, and it is the final product for this master thesis. The principles that are explained relate to a design choice that needs to be made. The design choice is based on the specifications of the previous table (figure 63). Some design choices are important to make together, in a group, therefore they are placed in a block. Within the blocks, the design choices can change of order, the blocks itself need to follow up on each other. This way the choices will not need to be revised again. In the figures 64 to 69 the blocks can be seen.

BLOCK 1: CREATING THE BUILDING

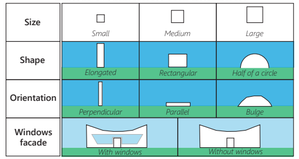


Figure 64: Block 1 of the morphological map

5.2 Morphological map

The blocks are based on a morphological map. This is a tool that shows solutions per subject. The left column shows the subject and the options in that row show the solution for that subject. This morphological map is used as structure of the handbook. Each subject will be explained and the advantages and disadvantages per solution will be presented. This way Advier has a tool to make structured design choices based on the preferences of the passengers in their passenger journey.

The morphological map has a table structure in which the topics that show the design choices are placed in the left column. Each topic is placed in a row and the blocks on the right in that row the solutions are placed. For example, the first row of the first block has as topic 'Size'. The design choices for the size are 'small', 'medium' and 'large'. (Boeijen, van, et al., 2013, p. 121)

The morphological map is the structure of the book. This map is split up in six blocks and it is essential to follow the order of these blocks. The blocks come back later in the handbook, after showing the morphological map. In these blocks, per topic the reasoning for different design choices is explained.

Inside the blocks it is not essential to follow the order of the topics, it is possible to come back on choices that are made earlier in the process.

BLOCK 2: DESIGNING WITH CHANGING WATER LEVELS

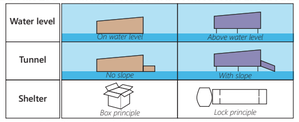


Figure 65: Block 2 of the morphological map

BLOCK 3: FOLLOWING THE CROWD

Figure 66: Block 3 of the morphological map

BLOCK 4: SHOWING THE WAY

Location of information	Facade	Entrance	Ticket vending machines	Waiting areas	Dock gates
Guiding elements	Shapes & Text	Text	Text	Shapes	Shapes & Text

Figure 67: Block 4 of the morphological map

BLOCK 5: BOARDING THE PASSENGERS

Boarding environment	Even floor & no gaps
Boarding support	2 spots to grab with your hands for support

Figure 68: Block 5 of the morphological map

BLOCK 6: FINETUNING THE DOCK

Ambience	Wide & open & light		
Objects in waiting area	To lean against & to sit on		
Distractions			

Figure 69: Block 6 of the morphological map

5.3 Example page

The handbook consists of block 0 to block 6, in which the story behind the handbook is explained in the first chapter. In block 0, the morphological map is explained. Then in the next blocks, 1 to 6, the design choices per topic are explained. In figure 70 an example page of a design choice of a topic is presented.

On the left, the title and a short explanation of the topic is given. On the right, the different solutions are presented with a description and the benefits (+) and disadvantages (-) for that option. An icon (orange bookmark with book icon and page number) is placed on the page that refers to this master thesis, this is to find an explanation or performed research for that solution.

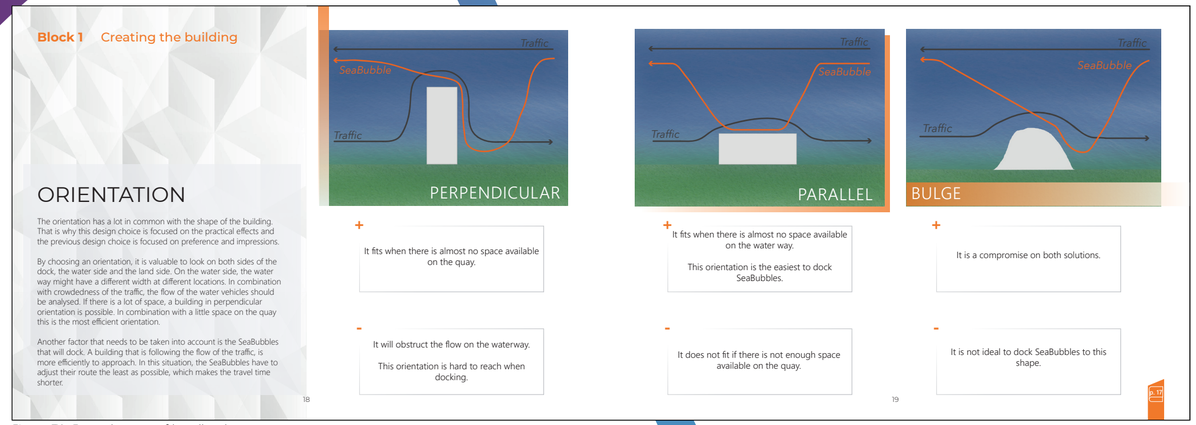


Figure 70: Example page of handbook

6. EVALUATION & CLIENT ADVISE

6.1 Evaluation interviews

At this point in the process, the handbook is still a concept, and therefore improvement is still possible. A way to determine the points of improvement for this handbook is to discuss it with experts. By performing an evaluation interview with experts, the handbook can be analysed on three criteria. First, by looking at the layout of the document, the design agency must find it easy to understand the structure of the handbook. Secondly, if there is information missing, it needs to be pointed out. The last point is the ability to understand the story that is presented in the handbook.

6.1.1 Interview with Advier

The meeting was with Minze Walvius from Advier. The structure of the handbook was clear, it made sense to follow block 1 to block 6. When looking at the information given in each block, it was not clear which were the important blocks, and which were the less important blocks. This resulted in the misunderstanding that each block has the same importance in this project, which is not the case with for example block 6 (detailing). It is valuable to make clear which block is essential for the design of a dock and which block serves as an addition to the dock design. This misunderstanding matches point 3 that needed to be analysed. In block 0, the important parts were emphasized and on the section page that showed a new part is mentioned if it is an 'extra' and therefore only inspirational for the design process.

At the moment of presenting the handbook to Advier, there was still time to add the improvements of Advier to the handbook. This was implemented before the meeting with the architect. The handbook was complete, with block 1 to block 6. However, block 0 was not yet structured as block 0, it was structured as a large introduction section. Another addition that was made after this meeting, was the concluding pages after block 1, 2 and 3. This was to share a decision process for a specific location.
The points of improvements that were given by Advier were considered and adjustments were made before meeting the architect.

Figure 71: Minze Walvius (Advier, n.d.)

Figure 72: Michael Daane Bolier (M& DB, n.d.)

6.1.2 Interview with an architect

The interview with the architect was with Michael Daane Boiler. He is a successful architect for the company MD&B architects and with his colleague he has won a prize at the design of a visitors' centre in Kinderdijk. Kinderdijk is in the same area as Drechtsteden and close to the water. He has expertise in designing buildings close to water and therefore knows a lot about elements to consider when designing a dock.

The meeting with the expert started with a presentation about the handbook in which the structure and the elements were presented. After the presentation, Michael said that the structure of the handbook was complete and clear. A lot of elements were considered, and it made sense that with the focus on the passenger journey details outside this journey were not emphasized. This way, the handbook scored good on criterium 1 and 2. Criterium 3 was about the easiness of understanding the story. In this point, the architect told that he and his colleagues preferred documents that had more visuals, like 2D drawings of situations. When getting the information, they already start sketching and place that object in the potential space. By providing more visuals they can read less, which is preferred, an example is the handbook of Neufert & Neufert (2000). This book shows for each possible situation an example of a building or object that shows dimensions. For a future edition of the handbook, it might be valuable to analyse the possibilities for these visuals.

6.2 Advise for the client

This master thesis had a complex topic, which resulted in bringing together a lot of research and findings. Some parts in this project were less emphasized, because it did not fit into the passenger journey. These parts can still be interesting to look further into when continuing with the design of the dock.

Regulations traffic waterways

In paragraph 3.1.3 is explained that the orientation of the building can have a bad influence on its surroundings. The traffic situation on the water is mentioned. In this project, the basic rules for traffic on the water is used. When designing on a specific location, it might happen that a bit more complex traffic situation is in effect. The specific situation needs to be mapped out before designing the dock.

Perception of slope steepness

In this project is worked a lot with tunnels. Due to changing water levels, it is hard to avoid a slope in a tunnel. The slope of the tunnel is estimated in this project and not analysed into detail. An interesting topic to look further into is the perception of the steepness of a tunnel. A very steep tunnel might look frightening, which affects the passenger experience. A very steep tunnel can be dangerous too: when descending the slope with a wheelchair the acceleration might become too big to slow down. The other way around, when ascending the slope, it might be too heavy to roll the wheelchair up. When combining the ASVV (CROW, 2012) with the perception of the steepness, a comfortable slope can be designed.

One-way instructions

For the crowd flow simulation is chosen to analyse the different options in a free walking mode. The ideal combination, with the least accumulations, for this mode is used as a base to compare it with the one-way simulations. It might be valuable to perform a complete one-way walking mode analysis in Anylogic and see if other scenarios are more fruitful. A suggestion for the company is to use this software when having defined the shape of the building and a bit more insight in the amount of tickets that is sold.

Dynamic lighting

In this project is chosen to define the basics of the guiding elements. An interesting direction to research later is the effect of dynamic guiding elements. The dynamic effects might give an extra dimension to the visual signs and help drawing attention.

Defining shape boarding support

The next suggestion is for the boarding support. In this test (see paragraph 3.3.3), a basic shape is used, to determine the location for the support. There is not yet a research performed on the ideal shape of the supports. This can be an interesting direction. One problem that is found during the test is out of scope, but all participants perceived it as disturbing and even tripped over it. The stairs inside the SeaBubble have different heights, and the steps are too big. By adding an extra step in between the current steps, it will become more comfortable during boarding.

Cost price

Lastly, in this project the cost price for different parts or buildings is not calculated. The focus of this project is on explaining the design choices to improve the experience of the passenger. There is no specific building designed in this project, and therefore no cost price is calculated. The cost price is an important part of the final design of a dock. That makes it important to perform a cost price analysis, when a proposal for an actual dock is created.

7. SOURCES

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8. APPENDICES

DESIGN FOR our future

TU Delft

IDE Master Graduation

Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT

Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME

Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy".
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !

family name: Kuiper 4789
initials: M.J. given name: Meike
student number: 4459202
street & no.:
zipcode & city:
country:
phone:
email:

Your master programme (only select the options that apply to you):
IDE master(s): (★) IPD ( ) Dfl ( ) SPD
2nd non-IDE master:
individual programme: - - (give date of approval)
honours programme: ( ) Honours Programme Master
specialisation / annotation: ( ) Medisign ( ) Tech. in Sustainable Design ( ) Entrepeneurship

SUPERVISORY TEAM **

Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair: Ir. I.A. Ruiter dept. / section: HCD/AED
** mentor: Ir. I.R. Smit dept. / section: HCD/HICD
2nd mentor: Walvius, M.
organisation: Advier
city: Delft country: The Netherlands

comments (optional)

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

Second mentor only applies in case the assignment is hosted by an external organisation.

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

Procedural Checks - IDE Master Graduation

TU Delft

APPROVAL PROJECT BRIEF
To be filled in by the chair of the supervisory team.

chair Ir. I.A. Ruiter date 05 - 03 - 2021 signature

CHECK STUDY PROGRESS
To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair. The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: 33 EC
Of which, taking the conditional requirements into account, can be part of the exam programme 30 EC
List of electives obtained before the third semester without approval of the BoE

★ YES all 1st year master courses passed
○ NO missing 1st year master courses are:

name C. van der Bunt date 08 - 03 - 2021 signature C. van der Bunt Digitally signed by C. van der Bunt Date: 2021.03.08 10:15:04 +01'00'

FORMAL APPROVAL GRADUATION PROJECT
To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **. Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: ★ APPROVED ○ NOT APPROVED
Procedure: ★ APPROVED ○ NOT APPROVED

remark: SeaBubble in title

comments

name Monique von Morgen date 16 - 03 - 2021 signature

TU Delft

Personal Project Brief - IDE Master Graduation

Design for a novel docking system for efficient boarding. project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 08 - 02 - 2021 07 - 07 - 2021 end date

INTRODUCTION **
Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

The SeaBubble (figure 1) will be a water taxi of the future. This water taxi has the looks of a car and is hydrogen powered. Powering the SeaBubble with hydrogen is possible within 5 minutes. The SeaBubble has a foil, which makes it possible to lift out of the water and is controlled by the 'Fly by wire system'. By lifting out of the water, there is less water friction that affects the vehicle, which makes it possible to move faster, more agile and saves on fuel. Another benefit is the shape of the foil: the foil will cut through the waves, like a blade. This way the vehicle will be influenced less by the waves which results in a stable and comfortable journey.

The SeaBubble will be a part of the public transport network, and in the future, autonomous driving is possible. For now, a driver will control the SeaBubble and brings up to seven passengers to the desired location. The company that wants to create a SeaBubble network in Drechtsteden is Advier. They will buy the SeaBubbles straight from the manufacturer and therefore the SeaBubble itself will be excluded from design. The graduation process will focus on the design of a dock for the SeaBubbles. Advier has some requirements for the design of the dock. The overall looks of the dock should be futuristic and luxurious, just like nowadays airports and the current SeaBubbles. Important elements for the design of the dock are: enough space for safely fuelling hydrogen, mooring options for enough SeaBubbles and other boat types. The dock should have a comfortable and relaxing ambiance, therefore a lot of facilities, like shops, bathrooms and meeting spaces, are needed. The different routing options and information for travelling should be clear and self-explanatory and has to match with the location of boarding for each SeaBubble.

The dock that will be designed for Advier is a complex design with a lot of elements. Coming up with a thorough and complete design for the entire dock is too ambitious as a graduation project. That's why I will focus on designing one element of the key elements: the self-regulated boarding of passengers. In figure 2, an impression is given of the dock in context.

space available for images / figures on next page

introduction (continued): space for images

image / figure 1: SeaBubble

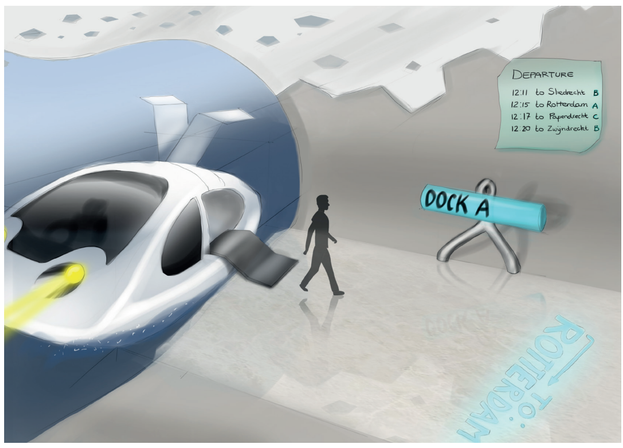


image / figure 2: Futuristic Dock

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

The process of boarding consists of multiple steps. It starts with the SeaBubble that will autonomously dock itself and then it will be lift up by a machine. The next step is deboarding the current passengers and boarding new passengers. The passengers that just arrived at the dock need to find their way on the dock to the next step of their journey. The SeaBubbles should be able to drive autonomously, therefore the process of docking, boarding and finding your way on the dock needs to be self-regulated. Trust is a key element in the design process: passengers need to trust the way of boarding to be as comfortable as possible and they need to trust the autonomous SeaBubble to communicate clear about boarding and wayfinding. The ideal situation for this project will be that the passenger can trust the way of travelling with the SeaBubble, which includes wayfinding on the dock, boarding as comfortable as possible and getting the confidence of the SeaBubble that you are doing the right thing. In the docking design different principles of docking are still possible including the way of approaching and leaving of the dock of the SeaBubble.

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

The design is an ergonomic solution for boarding passengers in a SeaBubble, to make boarding as comfortable as possible for passengers and secondly providing travel information and routing to guide passengers through the automated system of docking. The project will deliver a guidebook for the routing design of the dock.

To solve the stated problem, I will design an ergonomic solution for boarding passengers in a SeaBubble. The SeaBubble itself is already finished, so a solution needs to be implemented into the design of a dock. The ergonomic solution will start focusing on making boarding as comfortable as possible. After finding the most comfortable way of boarding, a clear advice can be given on the location of mooring the SeaBubble and the journey after boarding and deboarding can be designed. The focus will be on boarding and providing travel information and routing. In the process I will research different concepts of boarding, as well as looking into guiding principles for passengers while boarding. I will integrate specific research into the different iterations of the concepts. In the end, I will deliver a guide book that shows the elements of fluently boarding a SeaBubble.

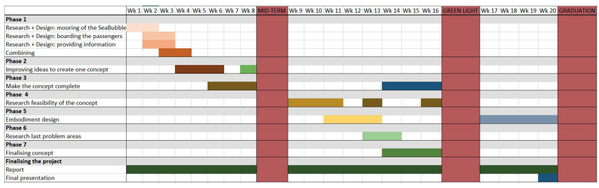
Personal Project Brief - IDE Master Graduation

TU Delft

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 8 - 2 - 2021 7 - 7 - 2021 end date



For the planning, I have used a Gantt chart and planned multiple phases. The project will follow the traditional design process, with starting a research phase followed up by ideation that will result in a concept. This concept will be elaborated, materialised and tested. The phase will be based on an iterative process, because all design choices will give me reasons to perform more specific research. This way the concept will become more concrete in every phase.

Initials & Name M.J. Kuiper 4789 Student number 4459202

Title of Project Design for a novel docking system for efficient boarding.

Personal Project Brief - IDE Master Graduation

TU Delft

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

This project fits very well with my interests. I am interested in a lot of sports that involve water. I like swimming, sailing, kite surfing and ice skating. In my bachelors I have followed the minor 'Sailing yachts'. It was amazing to learn about the mechanics behind sailing.

When I learned about the SeaBubble I was immediately interested in the foil that will lift the SeaBubble. The SeaBubble itself is ready to manufacture, that's why improvements to the SeaBubble are out of scope. In my project I want to focus on the passengers that will use the dock and the SeaBubble. I like to create solutions that make people happy. By focussing on mounting and dismounting, I have the best opportunity to make the passengers happy.

My point of attention during this project is about communication. I have experienced in the past that my coaches had a different idea of my concepts in their minds and when I presented my work it wasn't what they expected. Then I needed to take a step back and redo that step, which costs a lot of time. I want to make clear appointments with my client and coaches about my future steps to prevent losing a lot of time by bad communication.

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.

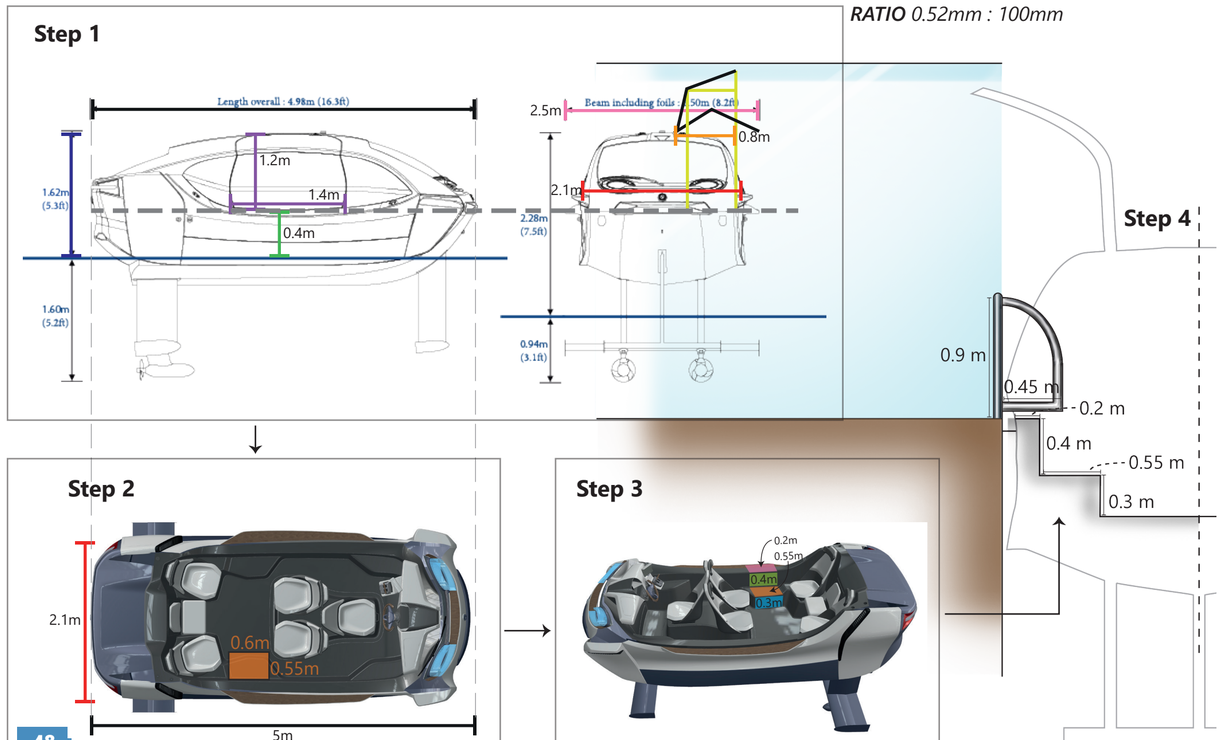
-

Initials & Name M.J. Kuiper 4789 Student number 4459202

Title of Project Design for a novel docking system for efficient boarding.

8.2 - Dimensions of the SeaBubble

An estimation of other dimensions is based on the 2D images with dimensions from the SeaBubble website. These images were used as an underlay and the dimensions were used in other images from the website.



8.3 - Regulations

This is a combination of the two regulations that are applied on the area of Dordrecht and Drechtsteden. There are rules of the municipality Dordrecht that you have to take into account and there are rules of the water authority, in Dutch is it called 'Keur'. The 'Keur' are the general rules and the other rules are the policy of the municipality. These regulations are collected from the public website of the municipality of Dordrecht and the water authority 'Hollandse Delta'. (Baat & Hermus, 2014) (Haag et al., 2014) (Waterschap Hollandse Delta, 2018).

Keur – algemene regels

WK 1

Vrijstelling wordt verleend van het verbod, bedoeld in artikel 3.2, eerste lid, van de keur, voor het plaatsen en behouden van beplanting voor zover deze:

4. in de zonering van een regionale waterkering wordt geplaatst;
5. niet in of nabij een weg en/of oppervlaktewaterlichaam wordt geplaatst;
6. niet in duin- en/of strandgebied wordt geplaatst;
7. in tuinen en parken wordt geplaatst;
8. indien het bomen betreft, op tenminste 3,00 m uit de kruin van de waterkering worden geplaatst.

WT 1

Vrijstelling wordt verleend van het verbod, bedoeld in artikel 3.2, eerste lid, van de keur, voor het aanleggen en behouden van een steiger en/of vlonder, voor zover:

1. deze niet wordt aangelegd in/nabij een weg, waterkering en/of beschermingszone;
2. deze wordt aangelegd op 2,50 m uit de perceelgrens die haaks staat op een oppervlaktewaterlichaam in beheer en onderhoud bij het waterschap, en op 1,50 m uit de perceelgrens die haaks staat op overige oppervlaktewaterlichamen;
3. deze aansluit op eigendom van de initiatiefnemer of rechthebbende;
4. een steiger niet wordt aangelegd: a.

a. binnen een natuurvriendelijke oever;
b. in een oppervlaktewaterlichaam met specifieke natuurdoeleinden;
c. in een hoofdwatergang;

5. deze wordt aangelegd en behouden in of aan een oppervlaktewaterlichaam met een minimale waterbreedte van 3,00 m;
6. het oppervlaktewaterlichaam en de steiger

Breedte oppervlak-te-waterli-chaam	Maximale breedte steiger/vlonder (gemeten vanaf de waterlijn)	Maximale lengte steiger/vlonder (parallel gemeten aan de insteek)
> 3 m	1/10 van de breed-te van het opper-vlaktewaterlichaam met een maximum van 1,50 m	Maximaal de helft van de lengte van het perceel met een maximum van 4,00 m

voldoen aan de volgende maatvoering:

WT 3

Vrijstelling wordt verleend van het verbod, bedoeld in artikel 3.2, eerste lid, van de keur, voor het plaatsen en behouden van beschoeiing in een oppervlaktewaterlichaam en indien van toepassing tevens in een waterkering, voor zover:

1. deze niet wordt aangelegd in/nabij een weg;
2. deze niet wordt geplaatst: a. binnen primaire watergangen, met uitzondering van het binnenwater de Waal; b. binnen een natuurvriendelijke oever;
3. het talud van het oppervlaktewaterlichaam niet steiler is dan 1:2;
4. deze een maximale grondkerende hoogte heeft van 0,30 m.

WT 13

Vrijstelling wordt verleend van de verboden, bedoeld in artikel 3.2, eerste lid en artikel 3.4, van de keur, voor het onttrekken aan en/of brengen van water in een oppervlaktewaterlichaam en/of het plaatsen en behouden van een onttrekking- en/of lozingsvoorziening in een oppervlaktewaterlichaam, voor zover:

1. maximaal 300 m^3/u wordt onttrokken, en/of
2. maximaal 450 m^3/u wordt geloosd;
3. de onttrekking- en/of lozingsvoorziening niet in duin- en/of strandgebied wordt geplaatst.

Beleidsregels

Hoofdstuk 2. Beheer en onderhoud van waterstaatswerken

§ 1. Onderhoudsplichtigen

Artikel 2.1 Onderhoudsplichtigen

1. Onderhoudsplichtig zijn degenen die in de legger ingevolge de Waterschapswet of in artikel 2.14 van deze keur tot het verrichten van gewoon of buitengewoon onderhoud aan waterstaatswerken zijn aangewezen.
2. Onderhoudsplichtigen van waterstaatswerken zijn verplicht tot instandhouding van het waterstaatswerk in overeenstemming met zijn functie.

§ 4 Onderhoud aan oppervlaktewaterlichamen door derden

Artikel 2.5 Gewoon onderhoud aan oppervlaktewaterlichamen.

1. De onderhoudsplichtigen van oppervlaktewaterlichamen zijn verplicht tot het daaruit verwijderen van begroeiingen en afval die schadelijk zijn voor het functioneren van het oppervlaktewaterlichaam.
2. De onder het eerste lid vermelde onderhoudsplichtigen zijn tevens verplicht tot het herstellen van beschadigingen aan oevers en tot het onderhouden van begroeiingen, dienstig aan de waterhuishoudkundige functies van het oppervlaktewaterlichaam.

Artikel 2.6 Buitengewoon onderhoud aan oppervlaktewaterlichamen

De onderhoudsplichtigen van oppervlaktewaterlichamen zijn verplicht tot

instandhouding daarvan overeenkomstig het in de legger ingevolge de Waterwet bepaalde omtrent ligging, vorm, afmeting en constructie.

§ 7. Algemene regels, nadere regels en onderhoudsplicht, indien geen (actuele) onderhoudslegger is vastgesteld.
Artikel 2.13 Algemene regels /nadere regels
Het bestuur kan voor de verplichtingen, bedoeld in de artikelen 2.2 tot en met 2.12 en 2.14, algemene regels stellen, die mede kunnen inhouden een gehele of gedeeltelijke vrijstelling van de in deze artikelen genoemde geboden of nadere regels met betrekking tot deze verplichtingen.
Artikel 2.14 Onderhoud aan waterstaatswerken zonder (actuele) legger
1. Voor waterstaatswerken, waarvoor het vaststellen van een legger ingevolge de Waterschapswet is voorgeschreven, maar waarvoor nog geen legger is vastgesteld, is de onderhoudsplicht als volgt, tenzij het onderhoud op andere wijze is geregeld:
a. Voor waterkeringen of gedeelten van waterkeringen en ondersteunende kunstwerken met een waterkerende functie berust het gewoon onderhoud bij de eigenaren ervan en het buitengewoon onderhoud bij het waterschap;
b. Voor oppervlaktewaterlichamen berust het gewoon en buitengewoon onderhoud bij de aangrenzende eigenaren;
c. Voor overige waterstaatswerken berust het gewoon en buitengewoon onderhoud bij de eigenaren.
2. Voor waterstaatwerken, waarvoor het vaststellen van een legger ingevolge de Waterschapswet is voorgeschreven en die op grond van een projectplan of een watervergunning zijn aangelegd of gewijzigd ten opzichte van de legger, geldt, zolang vaststelling van een legger of van een wijziging van de legger niet heeft plaatsgevonden, dat voor de onderhoudsplichten op grond van dit hoofdstuk de ligging, vorm, afmeting en constructie van het waterstaatwerk worden aangehouden, zoals aangegeven in het projectplan of de watervergunning. Als geen vergunning is verleend, moet het waterstaatswerk worden onderhouden overeenkomstig de oorspronkelijke vorm en afmetingen.

Hoofdstuk 3. Handelingen in watersystemen
§1. Gebruik van waterstaatswerken
Artikel 3.2 Watervergunning waterstaatswerken en beschermingszones
1. Het is verboden zonder watervergunning van het bestuur gebruik te maken van een waterstaatswerk of bijbehorende beschermingszones door, anders dan in overeenstemming met de waterhuishoudkundige functies, daarin, daarop, daarboven, daarover of daaronder handelingen te verrichten, werken te behouden of vaste substanties of voorwerpen te leggen, te laten staan, te vervangen, te verwijderen te vervoeren of te laten liggen.
a. Het is verboden zonder watervergunning van het bestuur een waterstaatswerk, te vervangen, te verwijderen, te wijzigen of aan te leggen.
2. Het is verboden zonder watervergunning van het bestuur in het profiel van vrije ruimte werken te plaatsen, te wijzigen, te vervangen, te verwijderen of te behouden.
3. Het is verboden zonder watervergunning van het bestuur vaartuigen, vlotten of andere voorwerpen in een oppervlaktewaterlichaam te hebben.
4. Het bestuur kan aan een watervergunning het voorschrift verbinden dat de houder van die vergunning een betaling of een andere compensatie verricht met het oog op de bescherming van de belangen waarvoor het vereiste van een vergunning is gesteld.
5. Voor waterstaatwerken, waarvoor het vaststellen van een legger als bedoeld in artikel 5.1 van de wet is voorgeschreven en die op grond van een projectplan of een watervergunning zijn aangelegd of gewijzigd ten opzichte van de legger, worden, zolang vaststelling van een legger of een wijziging van de legger niet heeft plaatsgevonden, voor de verbodsbepalingen op grond van dit artikel de ligging, vorm, afmeting en constructie van het waterstaatwerk aangehouden, zoals aangegeven in het projectplan of de watervergunning.

§2. Brengen, onttrekken of infiltreren van hoeveelheden (grond)water
Artikel 3.5 (Buiten)beschermingszones: watervergunning
1. Het is verboden zonder watervergunning van het bestuur in de beschermingszone en de buitenbeschermingszone:
a. afgravingen en seismische onderzoeken te verrichten;
b. explosiegevaarlijk materiaal of explosiegevaarlijke inrichtingen te hebben;
c. leidingen, tanks of andere werken met een overdruk van 10bar te plaatsen of te hebben;
d. boringen te verrichten voor het exploreren of winnen van gas of vloei- of delfstoffen.
2. Het is verboden binnen een strook van 250 meter, horizontaal gemeten vanaf de kernzonegrens van de primaire waterkering, zonder watervergunning van het bestuur een windturbine te plaatsen, te wijzigen, te vervangen, te verwijderen of te behouden.

Hoofdstuk 4. Wegen
§1. Algemene bepalingen
Artikel 4.1 Begripsomschrijvingen
In dit hoofdstuk wordt verstaan onder:
a. Beplanting: bomen, heesters, houtstruik, veld en tuingewassen, de wortels inbegrepen.
b. Grens van een weg:
1e: grens van hetgeen krachtens de definitie van wegen en volgens artikel 4.2, derde lid, tot de weg wordt gerekend;
2e: voor de toepassing van de artikelen 4.3 t/m 4.7 wordt de grens van de weg geacht te liggen op ten minste 4,50 meter uit de kant van de voor het verkeer bestemde banen en 5.00 meter boven de verkeersbaan.
c. Doel van de weg: een weg is een gebaande en daardoor begaanbare verbinding tussen twee of meer punten om verplaatsingen mogelijk te maken. Het doel van een weg is transport van mensen en/of goederen.
d. Rechthebbende met betrekking tot het recht van beplanting: degene met een zakelijk recht dan wel een persoonlijk recht;
e. Verkeer: alle weggebruikers als bedoeld in artikel 1 van het Reglement Verkeersregels en verkeerstekens 1990;
f. Verkeersbaan; de verhardingsconstructie van zowel de hoofdrijbaan parallelweg,(brom)fiets, voet- of ruiterpad;
g. Voertuigen: fietsen, bromfietsen, gehandicaptenvoertuigen, motorvoertuigen, trams en wagens;
h. Weg/wegen: openbare wegen in de zin van artikel 1 van de Wegenwet en in beheer bij het waterschap, alsmede feitelijk in aanleg zijnde openbare wegen, waarvan het beheer bij het waterschap zal berusten.
Artikel 4.2 Reikwijdte
1. Dit hoofdstuk is van toepassing op de bij het waterschap in beheer zijnde wegen. Het bevat specifieke bepalingen omtrent aanleg, instandhouding en bruikbaarheid van wegen en omtrent de vrije, veilige en vlotte afwikkeling van het verkeer daarover.
2. Voor de toepassing van artikel 4.3 van dit hoofdstuk, worden tracés waar openbare wegen en toebehoren zijn voorzien gelijkgesteld aan openbare wegen zoals vorenbedoeld.
3. Voor de toepassing van dit hoofdstuk behoren tot de weg:
a. de openbare verhardingen, stoepen, glooiingen, bermen en taluds voor afwatering van de weg dienende voorzieningen, binnen de in artikel 4.1 omschreven grens van een weg;
b. de kunstwerken en andere zich in de weg bevindende of daarmee rechtstreeks verbonden werken die deel uitmaken van het weglichaam, zoals wegsloten, duikers, bruggen, sluizen, tunnels, viaducten, beschoeiingen en geluidswerende voorzieningen;
c. het wegmeubilair, zijnde de door of namens de onderhoudsplichtige of beheerder van de weg in, op, boven of naast de onder a. bedoelde verharding aangebrachte voorzieningen met een doel of strekking, overeenkomende met het gestelde in lid 1, van dit artikel;
d. de beplanting (met inbegrip van de wortels) welke door of namens de onderhoudsplichtige of beheerder van de weg is aangebracht.

§3. Overige bepalingen betreffende gebruik van en onderhoud aan wegen
Artikel 4.4 Recht van beplanting
Degene die een recht van beplanting op een weg heeft is verplicht:
a. van zijn voornemen tot het planten, vellen of rooien ten minste dertig dagen tevoren schriftelijk kennis te geven aan het bestuur;
b. zich bij de uitvoering te gedragen naar de gegeven voorschriften en aanwijzingen.
Artikel 4.5 Onderhoudsplicht
1. De verplichting tot onderhoud van een weg, rust op degene die daarmee is belast bij of krachtens wettelijk voorschrift of ingevolge een overeenkomst, ontheffing of vergunning.
2. De verplichting tot onderhoud van beplanting op een weg rust op de rechthebbende op die beplanting, indien die rechthebbende niet is aan te merken als onderhoudsplichtige krachtens het eerste lid.
3. Het bestuur kan ter bescherming van de weg en het veilige gebruik ervan voorschriften geven waaraan onderhoudsplichtige derden zich bij de uitvoering van onderhoudswerkzaamheden dienen te houden.
Artikel 4.6 Omvang onderhoud
1. Het onderhoud van de wegen omvat al hetgeen nodig is om de wegen in een goede staat te houden, in het belang van de vrijheid van het verkeer en van de instandhouding, de bruikbaarheid en de veiligheid van de wegen, een en ander met inachtneming van hetgeen omschreven is in de wegenlegger als bedoeld in de Wegenwet.
2. Tot het houden van de wegen in goede staat behoort onder meer:
a. het in zodanige staat houden van de kunstwerken dat zij voor de goede toestand van de weg geen gevaar opleveren;
b. het in een tegen de achtergrond afstekende kleur bewerkt houden van leuningen van bruggen en andere kunstwerken;
c. het in goede staat houden van de weguitrusting en de wegmarkering.
3. De rechthebbende op beplanting op wegen draagt er zorg voor dat:
a. deze het uitzicht voor het verkeer niet belemmert;
b. geen takken over de verkeersbaan uitsteken op geringere hoogte dan 4 m;
c. geen takken over de bermen en paden uitsteken op geringere hoogte dan 3 m;
d. deze de wegverharding niet beschadigt of verontreinigt dan wel op enigerlei andere wijze gevaar of hinder voor het verkeer oplevert.

8.4 - Weather impact

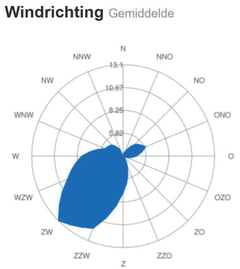
In the area of Dordrecht, there is a moderate maritime climate. There are no large varieties in temperature and drought. The chosen location is close to the Groothoofdspoort in Dordrecht.

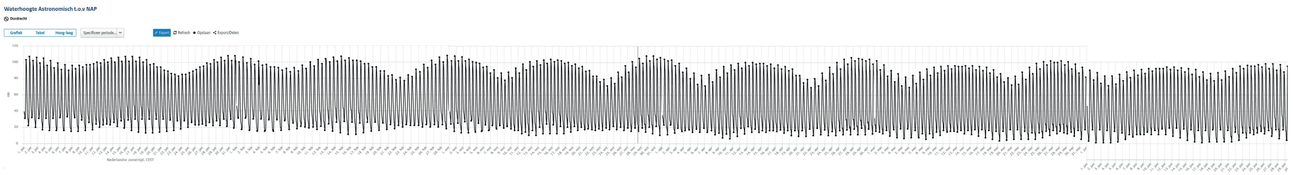
In the next table the average maximum temperature and average minimum temperature are shown per month. The maximum temperature has a range from 3.7°C to 18.4°C and the minimum temperature has a range from 1.1°C to 14.4°C. These are average temperature; it is possible that some days the temperature will come below the lowest average temperature and some days the temperature will come above the highest average temperature. Almost every month has 9 days of rain. (Climate-data.org, n.d.)

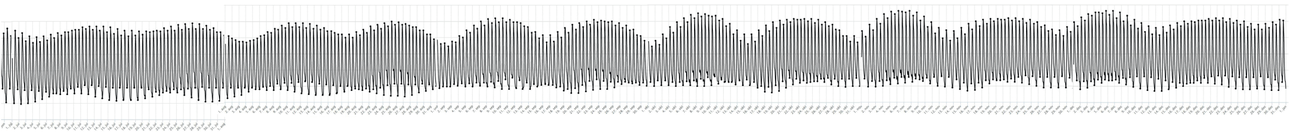
The average wind direction for Dordrecht is Southwest (SW). The stronger the wind gets, the more often it will come from the Southwest. At lower wind strengths the wind direction will be at Northeast (Wisuki, 2012).

	Januari	Februari	Maart	April	Mei	Juni	Juli	Augustus	September	Oktober	November	Decemb
gemiddelde Temperatuur (°C)	3.7	3.9	6.3	9.9	13.5	16.4	18.4	18	15.4	11.7	7.5	4.4
Min. Temperatuur (°C)	1.4	1.1	2.8	5.5	9.3	12.1	14.4	14.1	12	8.8	5.1	2.3
Max. Temperatuur (°C)	6	6.8	10	14.2	17.6	20.4	22.3	21.8	19	14.8	9.9	6.5
Neerslag (mm)	68	58	59	54	66	71	84	81	67	66	69	75
vochtigheid(%)	86%	83%	79%	73%	72%	72%	74%	76%	79%	82%	87%	86%
Regen dagen (d)	9	9	9	9	9	8	11	10	9	9	10	10

The height in water is calculated for every hour per day, this is necessary for large ships to prevent getting stuck. In this project it is valuable to know the water level, because the dock will be connected to the quay. In the figure below, the water level is shown for a year. The lowest point and highest point are marked with a purple line. The lowest point is 0.04m below NAP (Normaal Amsterdams Peil) and the highest point is 1.07m above NAP. (Rijkswaterstaat, n.d.)



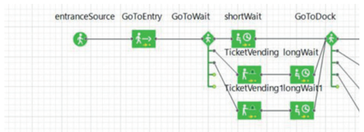




8.5 - Crowd flow simulations

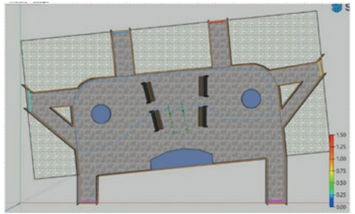
Setup
The crowd flow simulations are performed in the program 'Anylogic'. This is a program where all types of logistic simulations can be performed. In this case the simulation is performed for the flow of passengers. In the simulation there were 5 flows of passenger: the first flow is the entrance line where passengers will enter the building to find the right dock. Therefore this is the most complex flow.

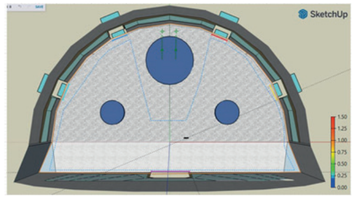
In the figure below the flowchart can be seen. In the entranceSource, the passengers enter the building. The passengers will enter the building in groups of 4 persons and has a green colour. From here they are directed towards the waiting area. Some passengers need to buy a ticket at the ticket vending machine before entering the waiting area. The ratio of buying a ticket is 1%, or 5% or 15%. These numbers were based on a discussion with the company. After having a short waiting of half a minute to one minute or a long waiting of 1 minute to 10 minutes. This will differ per passenger. After waiting the passenger will find its way to the dock.



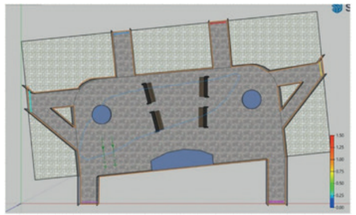
The four other flows are a simple enter line at the dock gates and then the passengers will be instructed to go directly to the exit. The passengers will enter in groups of 4 persons or 7 persons. This is based on the amount of passengers that can board in a SeaBubble and a bit less than the maximum capacity.

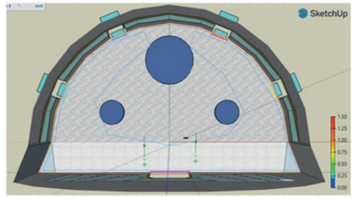
In the figures below the location of the vending machine is presented and the waiting area matching with the vending machine. The simulations will be analysed for the least crowded options, and ideal combination of the location of the waiting area and ticket vending machine will be chosen.



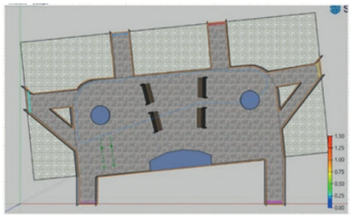


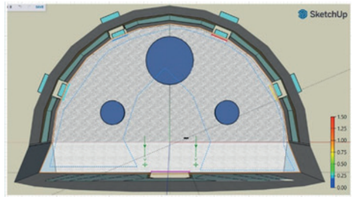
In these two options, the ticket vending machine is located at the centre of the waiting area.



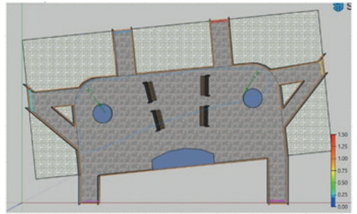


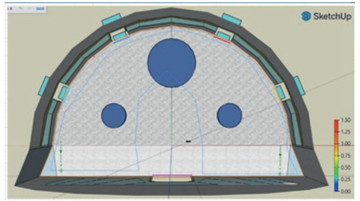
In these two options the ticket vending machine is located close to the dock gates.





In these two options the ticket vending machine is located close to the entrance.





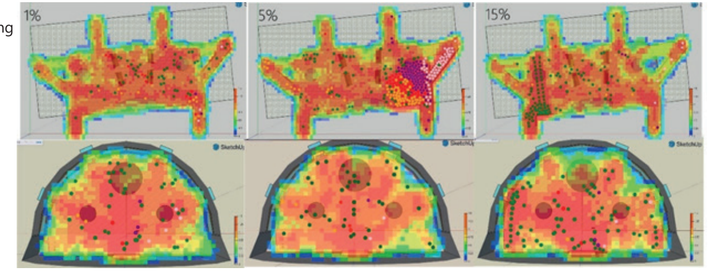
In these two options the ticket vending machine is located in the corners.

Simulations

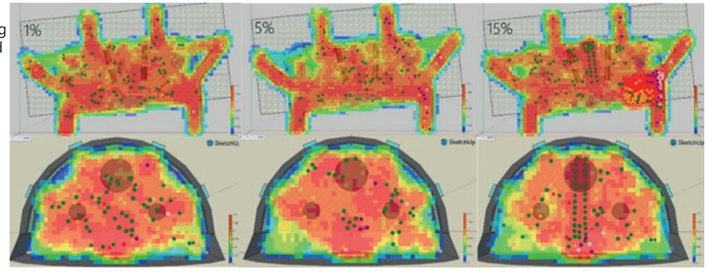
Now the overview for each simulation will be presented. In the paragraph about crowd flow simulations, the conclusions will be drawn based on these figures. First the simulations of the ticket vending machine is shown, then the simulations of the waiting area and lastly the simulations of one-way structure.

Ticket vending machine

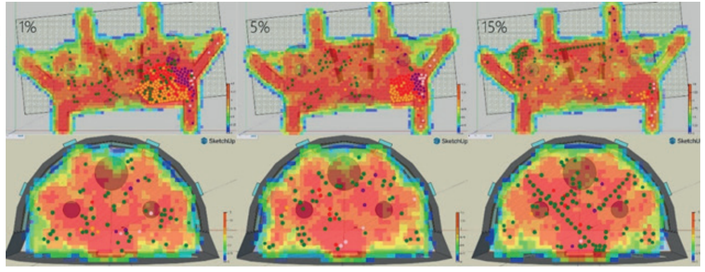
The ticket vending machines are placed close to the entrance.

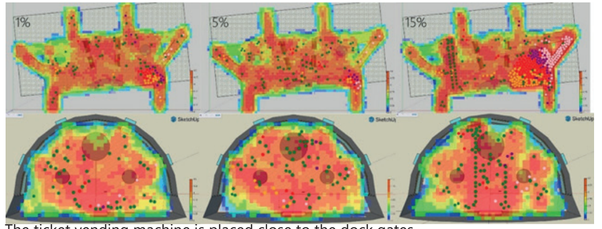


The ticket vending machine is placed in the centre of the waiting area.



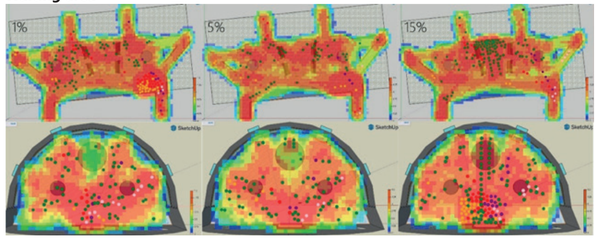
The location of the ticket vending machine is in the corner of the building.



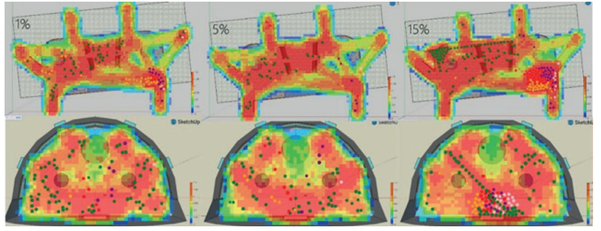


The ticket vending machine is placed close to the dock gates.

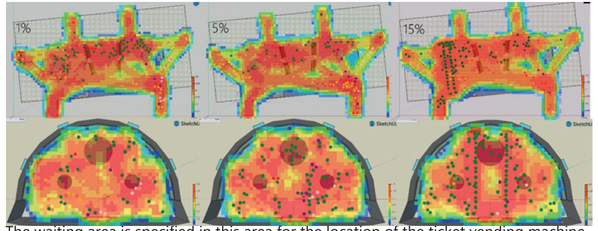
Waiting area



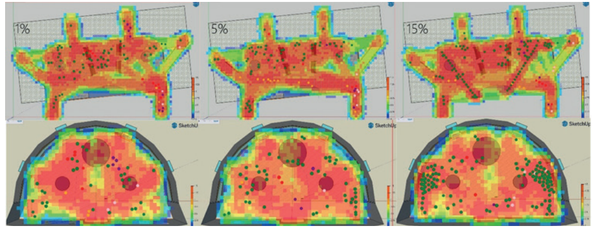
The waiting area is specified in this area for the location of the ticket vending machine in the centre of the dock.



The waiting area is specified in this area for the location of the ticket vending machine close to the dock gates.



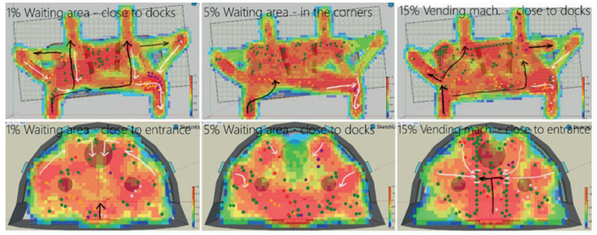
The waiting area is specified in this area for the location of the ticket vending machine close to the entrance of the dock.



The waiting area is specified in this area for the location of the ticket vending machine in the corners of the dock.

One-way

The one-way simulations were based on the ideal combination of waiting area and location of the ticket vending machine. These ideal simulations were changed into simulations with a one-way structure. By comparing the outcome, the benefit of one-way structure can be seen.

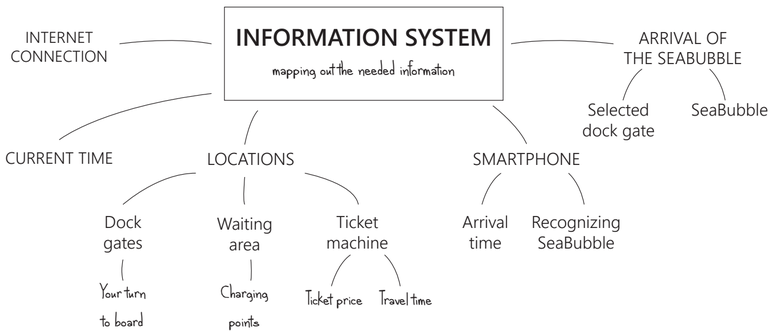


8.6 - Determining needed information

The needed information for the information system is determined by analysing the passenger journey map and splitting the three types of passengers. At each location the information is mapped out per passenger type. This can result in an overlap of information.

The overlap of information is structured in the mind map below. There is information that need to be present on the smartphone or the bought ticket. Internet connection and current time are extra options that can be placed somewhere in the building. This information is not limited to one location. The other locations have specified information. The most important information is the information on the arrival of the SeaBubble, this is essential for continuing the passenger journey and by making this information clear, the passengers will feel secure and therefore more pleasant.

	ENTRANCE	TICKET MACHINE	WAITING AREA	DOCK GATES
1a Experienced In a hurry	- Current time - Arrival time - Location of dock gate	→	→	- Sign of arrived SeaBubble - Location of your arriving SeaBubble - Sign of your turn to board.
1b Experienced Early	- Current time - Arrival time - Location of waiting area	→	- Finding a seat - Location of arriving SeaBubble - Recognizing your SeaBubble	- Sign of arrived SeaBubble - Location of your arriving SeaBubble - Sign of your turn to board.
2 New	- Introduction SeaBubble - Location of ticket machine	- Ticket price - Travel time - Current time - Arrival time - Location of waiting area	- Finding a seat - Location of arriving SeaBubble - Recognizing your SeaBubble	- Sign of arrived SeaBubble - Location of your arriving SeaBubble - Sign of your turn to board.



8.7 - Literature research guiding

Like mentioned before, several things are combined in this topic 'Guiding'. Based on the customer journey three important research questions are determined. One of these three questions fits underneath one of the other questions. The three questions that will be answered are:

- What makes a route a fast route?
- What makes instructions clear for guiding and boarding?
  -What is a clear signal to indicate that it is guiding or boarding?

Starting with the first question might give some insights for the rest of the questions.

A fast route differs per object that is moving. For example, a car that is driving is fast with straight lines and must slow down when making a curve. In this case the focus is on human beings, we are very agile and can keep pace when making curves. This can be seen as instant speed: when we start walking, we are directly at the speed that we want.

There are a lot of algorithms created to simulate an ideal route. Because of the simplicity of the speed and movement of the pedestrian, the shortest route will be the fastest route. (Dijkstra, 1959). In this route you will look at your current position, and the end goal. All parts of the road have a value, which is equal to the distance. Then the algorithm will run through all possible routes and determine which route has the lowest value. That will be the fastest route.

The answer to the next questions: What makes instructions clear for guiding and boarding? and What is a clear signal to indicate that it is time for guiding or boarding?

There are multiple elements for instructions that need to be considered. When text is essential for the communication, there is a minimal letter height, which need to be considered. For dynamic visual signalling, you need to consider what kind of information you want to show and what is best for that. There are guidelines presented in the book 'Productergonomie' for creating a scale and the numbers on the scale. Lighting is involved too in signalling. Some text is hard to read when it is light up in one colour.

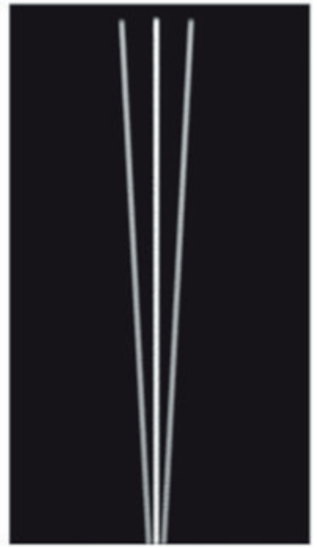
Suzanne Hiemstra (2019) has also performed a test with light projections in an airport context. Four types of signals are used in the research. The clearest way of animating light is by using a vertical motion in the direction that is needed. In this research, the projections were projected on the floor, which is not practical when large groups are waiting there. The animation that scored best in the test can be seen in the figure on this page.

For the support it is important to make use of usecues, these are elements with a clear function: the user knows what to do. A guideline is presented in 'Productergonomie'.

These guidelines are no guarantee for optimal design; therefore, a user test need to be performed. In this test one setup is tested with small tweaks in setup.

Animation three

Three lines go from bottom to top at once. They appear and disappear all at once.



8.8 - User test information system

To test the elements for the information system, a 3D environment is created in Google Sketchup. There were four different buildings: two buildings had one entrance and two buildings had two entrances. The next distinction is based on the type of information provided in the building: type one showed mostly textual signs, type two showed mostly shape-formed signs.

Research goal

This test is performed to analyse if the right information is provided at the right moment in the passenger journey. A side track of this research was looking at the way of communicating, which way of communicating was more clear: shapes or texts.

Setup

Like mentioned, four buildings were created in Google Sketchup. The participants were able to walk through the building by using the cursor. Physical paper tickets were created to give to the participant when the ticket was 'bought' at the virtual ticket vending machine.
Before starting the test, an introduction was given that the participant saw a SeaBubble and got intrigued in using this SeaBubble. That is why the participant would want to walk inside and buy a ticket. This was the moment that the participant had to start the test and walk to the ticket vending machine. After buying the ticket, the participant was told that there was time left before the SeaBubble arrived. This was the moment the participants started to wandering around. After a while, the SeaBubble was arrived and the passengers had to find the right dock by using the information presented on the ticket. When the SeaBubble was found, the participant had to open another building, the version with the other entrance type and information type. When opening this document, the participant was told that he was in a hurry and had to run straight to his SeaBubble.
After performing the test, a few questions were asked to gather more insights.

Results

The answers to the next questions were given in the interviews with 8 participants within a range of 23 to 59 years. Five of the participants were male and 3 were female.

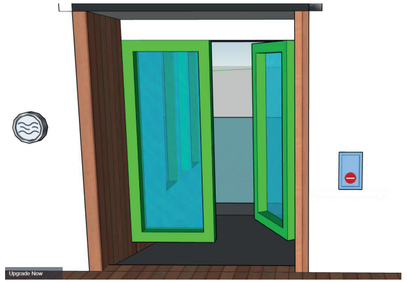
Was it doable to find all information?
Participant 1: The ticket machine was easy to find. The sign for wait/go can be clearer when adding a dynamic
Participant 2: Finding the information was doable. It would be nice if the current time is showed on the ticket vending machine.
Participant 3: The map on the outside of the building was a good addition. All objects were located on a logical place. When looking through the windows, I could already plan my route.
Participant 4: The system with the icons reminded me of the system on the boat to Texel. With memorizing your icon, you were able to find your car inside the boat.
Participant 5: The tasks were doble. However, it would be nice to have a time indication on the ticket vending machine.
Participant 6: Yes, all tasks were doable.
Participant 7: Yes, all tasks were doable.
Participant 8: It was hard to walk in this environment, but all objects were placed at a location that made sense.

Was the information board useful?
Participant 1: The information board was not noticed. After revisiting this board, a preference is given for the countdown version. The actual time can be checked on your smartphone and therefore it is not essential to use this as the base for the information board.
Participant 2: The information board was useful. The version with actual departure times was nice. Or both and then alternating each certain amount of seconds.
Participant 3: The information board is good, an alternating board with times would be even better.
Participant 4: The information board was in one setup not centred in the opening of the entrance. Placing this board in the same direction of the entrance, it would be better visible. An information board that works as a countdown is nice. Having the actual time results in a lot of math riddles to solve. That is not pleasant.
Participant 5: The board was not visible, it was placed too high. When standing in the waiting area, you would want to know how much time it costs before the next SeaBubble will arrive, just in case you get confused with the SeaBubbles arriving.
Participant 6: The information board was clear. Good format. Both versions were nice, alternating these options is a good solution. However, confusion might occur when the SeaBubble has a delay. In train stations this is presented in alternating red text, and that might cause confusion.
Participant 7: Yes all tasks were doable.
Participant 8: It was very easy to recognize where the SeaBubble would arrive. The icon had a good function.

Was it clear when the SeaBubble was ready for boarding?
Participant 1: Yes, it was clear. The version with shapes were still clear when looking on a distance.
Participant 2: No it was not clear. The green signs next to the door did not catch the attention. When placing it above the door or integrating the colour in the door frame. This way it is better visible in a crowded area.
Participant 3: Yes
Participant 4: The sign that shows wait or go is clear. There was no preference for the version with text or shapes. The added green element is good, when only having a red sign it scares me and I would not dare to use that entry. Maybe it is nice to show how much time is left before boarding, just like waiting areas in airports.
Participant 5: It was clear that I was allowed to enter when the text go showed or the visual green sign was presented. Maybe a combination of these signs would be extra useful, however only the arrows are also enough.
Participant 6: Yes it was clear, I immediately knew what to do. Maybe it would be helpful if the signs are placed above the door. When it is crowded it is easier to see the sign above the door than next to the door.
Participant 7: Yes it was clear.
Participant 8: In this scenario it was a bit confusing that the signs were not actual changing, but that was probably a disadvantage of using this setup. It was something I was really looking for, so that is some useful thing to take into account. Making it clear that something is changing with the signs. Something dynamic.

Was the location of the wait/go signs okay?
Participant 1: In this setup you have placed it at different locations, probably to let us choose the preferred one. I would really like it if the signs are always at the same location. If you choose to place it on the right side of the door, then place it everywhere on the right side of the door.
Participant 2: I have already mentioned this in my previous answer.
Participant 3: I felt insecure if I were allowed. The visual signs weren't clearly focused on the passengers. It might be some signs for technicians. Maybe I am old fashioned, but I would appreciate it if there was someone like a conductor who could check the tickets and help you board.
Participant 4: When it is crowded it is pleasant if the signs are placed above the door. This is mainly for the icon that indicates the SeaBubble, the wait/go sign can be placed next to the door, it does not matter.
Participant 5: Yes, it was okay.
Participant 6: The location was good, it was one of the first things that I noticed. However, I still wonder when my ticket will be checked, or can everyone just walk directly to the SeaBubble?
Participant 7: The location might be placed a bit higher, that it is placed on eye height.
Participant 8: I would prefer if these signs are placed above the door, just like the traffic lights that are placed above the road.

Was there missing information?
Participant 1: There was no information missing, but the location of the information board can be better. It would be nice if it was placed in the waiting area. This would help to keep updated on potential delays.
Participant 2: There was no information missing.
Participant 3: There was no information missing.
Participant 4: There was no information missing.
Participant 5: Not necessarily missing information. But I had some struggle with recognizing the icon as an icon, I thought it was a logo, so it did not make sense.
Participant 6: The name of the building was missing. And it would be nice if there was a subtle pattern that shows the waiting line for the ticket vending machine.
Participant 7: I think the information system was complete.
Participant 8: A clock is missing, I would like to know how much time is left. And I would have a lot of fun to see where the SeaBubbles are driving, it would also be useful to know if there is a delay and where the delay is.



8.9 - Interview waiting area

The goal of this interview was to find out the experience of the waiting area in public transport. By interviewing four participants with the age of 18, 22, 26 and 55. The question that was asked was to describe the moment of arriving at the bus stop, train platform or other waiting area of public transport.

Participant 1
He had most often used the train. Most of the time he is five to ten minutes early, to be sure to catch the train. When waiting for the train he always spends time on his smartphone. He does not search for a spot to sit, he just stands and wait for the train to arrive. One disadvantage of the train station of Delft is that a cold wind enters the hall, this is an annoyance of this participant.

Participant 2
She travels mostly by train and she arrives between two to five minutes before departure at the platform. When biking to the train she listen to music and that activity continues when waiting and entering the train. If there is time left, she looks for a place to sit.

Participant 3
He owns a car and does not use public transport often. When using a form of public transport it is by train. He uses it with friends to go to festivals or on vacation. Because he is using it with friends, they entertain each other by having conversations. Sometimes they show some funny videos on their smartphone or text other people. One disadvantage is that he has to bring a lot of luggage with him when using the train. Other passengers have trouble to avoid the pile of luggage and often trip over it.

Participant 4
She travels by train to her work and has to use it during rush hour. She does not like the crowdedness of a train platform and struggles to find a seat. This is something that annoys her and it feels unfair. She is paying for the service of using the train and still there is not enough space to sit, both at the platform as in the train.

8.10 - Interview how to board / mount

The interview about how to board or mount a vehicle is performed after analysing two parts first. Before showing the vehicles that the participant had to imagine to mount or board, an analysis is performed on the instructions of boarding or mounting the vehicles. The next two parts are my own experiences with boarding and the experience of two participants.

Part A: How to instructions

Vehicle	How to board	Image
Scooter / motor cycle	The scooter is parked and leans on a stand that balances the scooter. First thing is to stand next to the scooter. You will place the foot the closest to the vehicle on the highlighted area or on the other side of the scooter. Then you can sit on the scooter while keeping one or both feet on the ground. Then you can fold the stand and drive away.	
Kick scooter	You grab the steer with both hands. Then place one foot on the spot. With the other foot you can kick and make some speed.	
Bike	This depends on the type of bike. The first bike has a tube that connects the steer with the saddle, for this bike, you can stretch your leg closest to the bike and swing it over the back of the bike. Now you can place yourself on the saddle and then place your feet on the pedals and start cycling. With the other type of bike you don't have to swing your leg over the back of your bike. You can just make a step with one leg (closest to the bike) between the saddle and steer. Then you can sit and start cycling.	 
Recumbent bike	First you need to grab the brakes of the bike with both hands. Then you will put one leg over the bike and take a seat in the chair. Then you can put your back against the backrest. Your feet are still touching the ground. Then you will make a little bit of speed. When feeling stable you can lift your feet to the pedals and start cycling.	
Horse	You stand next to the horse, looking forward. Then you grab the hold of the saddle with the hand closest to the horse. With the other hand you can hold the rein while placing the hand on the top of the neck of the horse. Now you place your foot in the stirrup and you push yourself up. Now you put your free leg over the horse and place it in the other stirrup.	
Bus / Metro / Train	These three ways of transport have the way of boarding in common, they all have a stair to board. It consists of two or three stair steps you walk it like a normal stair. When feeling less comfortable you can use the support.	
Airplane	Boarding in an airplane is possible via two ways. The outside option has a stair connected to the airplane (the use of these stairs is like 'bus / metro / train'), the inside option is a tube that is connected to the building of the airport and the door of the airplane. The use of this tube is just by walking through it.	
Truck / Tractor	The truck and the tractor have both small stairs to climb into the truck. These stairs are less comfortable than the stairs used in trains, metros or busses, because the steps are smaller and placed right above each other. It is more like climbing a ladder, which is less comfortable.	
Car / taxi cab	To give a grounded answer to this way of boarding, I have watched 6 persons boarding a car and they did it all the same way: first they open the door. Then they put their foot the closest to the car inside the car. Then they will bend into the car and sit in the seat. Then they place the last foot in the car.	

Water taxi	Boarding into a water taxi is not so comfortable. You can see how it works in the image. The step that has to be made is very big and the boat rocks a bit which is not comfortable.	
Ferry	The ferry has multiple lanes. Two for cars and one sidewalk for pedestrians. You can walk to the office on the ferry and buy a ticket.	
Motor boat	A small motor boat has no gangway, these boats have no support for boarding. To step on board of the boat you have to make a big step on a wobbly boat. There is no clear spot for your feet, so you have to find a stable spot yourself.	
Sailing yacht	Expensive sailing and motor yachts like the one in this picture, have a support for boarding, it is a gangway and makes it possible to walk on board. This way of boarding is more comfortable than the one where to make a big step.	
Rollercoaster	In a boarding situation of a traditional roller coaster, per row two people will wait for boarding. When the rollercoaster arrives, the passengers can step out on the other side and the new passengers can step in. First one foot is placed inside the vehicle, then the other foot, then you can take a seat.	
Gondola rollercoaster	The gondola rollercoaster and boat rollercoaster have the same movement. The vehicle will rotate around one point and passengers can step out in the first half of the circle and new passengers can step in on the second half of the circle. In a gondola, you have to step in with one foot then with a second foot. Now you can take a seat. Because of the moving vehicle, it is recommended to use a support.	
Boat rollercoaster	The boat rollercoaster has the same movement as the gondola rollercoaster. The difference is that you have to step inside a boat. Boats are more instable, because of the water movement.	

Part B: My impressions of moments of discomfort

Vehicle	Moments of discomfort
Scooter / motor cycle	- Instability when placing both feet on the scooter, easy to fix by placing one foot on the floor
Kick scooter	
Bike	- Instability when placing both feet on the pedals, solving it by placing one foot on the floor. Ideal saddle height makes it difficult to place the foot flat on the ground. - Wet saddle when starting
Recumbent bike	- Instability when placing both feet on the pedals - Instability when starting to pedal, because of the hip movements
Horse	- Instability by the horse that can start walking - Instability by the loosely connected saddle
Bus / Metro / Train	- Slippery stair steps due to weather - Steps are too high - Support is dirty and passengers don't want to use it, which makes the user more instable
Airplane	- The discomfort of waiting for each other when placing luggage in the cabins
Truck / Tractor	- Difficult to make steps on the stairs, you have to raise your knees and place one foot about 20 centimetres above the other foot. - Support is needed to climb the stairs.
Car / taxi cab	- Slippery ground makes it hard to step into the car, because the foot on the ground can slip away. - You can bump your head when you do not stoop enough.
Water taxi	- You have to make a big step to board the boat. - You need support to make the big step - It often happens that a boat is wet and slippery
Ferry	- Most ferries have no roof, so you are affected by all types of weather: rain, snow and wind are discomfortable weather types.
Motor boat	- You have to make a big step to board the boat. - You need support to make the big step - It often happens that a boat is wet and slippery
Sailing yacht	- The boat is instable, when placing your feet on the gangway the boat will wobble - There is no find support with your hands when walking over the gangway - The gangway has no joints to connect to the quay or the boat
Rollercoaster	- The seat has the warmth of the previous passenger - You need to make uncomfortable steps
Gondola rollercoaster	- The seat has the warmth of the previous passenger - You need to make uncomfortable steps - The vehicle is in movement when you have to board, this makes your movement less stable
Boat rollercoaster	- The seat has the warmth of the previous passenger - You need to make uncomfortable steps - The vehicle is in movement when you have to board, this makes your movement less stable

Vehicle	Response
Scooter	The scooter is not stable enough, when sitting on top it is not clear what the possible movements of the scooter will be. Getting on a scooter for the first time makes you focus on the scooter and forgetting the environment. It is not clear how the scooter will start working, what buttons you need to press, where to keep your feet and where to look. Placing your feet on the scooter gives an impression that there is not a lot of space.
Kick scooter	The kick scooter is way more clear in use. It makes sense where to place the hands and feet. It is comforting that both feet are close to the ground for stability. The spot to place one foot is a bit small.
Bike	Getting on this bike is not comfortable, you have to raise your leg very high to put it over the tube between the saddle and the steer. If it is too high then you have to tilt the bike to make it easier to get your leg on the other side. However getting the bike up will need more effort. Someone puts the pedal at the lowest point to use it as a step. This vehicle is familiar and that helps with finding the right use cues. Some saddles are too small.
Recumbent bike	This is a type that is not familiar. It gives the impression that it is hard to board and very instable. You have to make a big step over the bike, which is not comfortable. It is even scarier when the ground is not even. When sitting in the seat it is scary to lean backwards and lift both your legs, because you know that a bike can fall. By lying in the seat you have a different angle of view which makes it even more confusing.
Horse	The idea that a horse could start walking is scary and uncomfortable, you get afraid that you will fall on the ground. The stirrup is placed a bit too high to make a comfortable step. You have to pull yourself up, which is hard and not comfortable. Combining these elements will result in you balancing to get on the horse. The unpredictable behaviour of the horse makes it even less comfortable. The use cues of the saddle are nice and give good impression where you can grab a hold.
Train	Boarding is smooth, because of the wide open doors. You see an empty space behind the doors which gives you the reassurance that you have found the right spot to board. The stairs of the train are clear and familiar. The space between the platform and the beginning of the stairs is sometimes a bit too large, which makes it scary. It gives the feeling that you can fall in the gap. When wearing glasses with a part that is made for reading, it is very hard to see the ground right in front of your feet, this makes the gap even scarier. The handles are dirty and are not being used during boarding. The door is wide enough to not using the handles.
Airplane	The first impression of a jet bridge is that it is oppressive, claustrophobic. In the picture that is used as an example, glass walls are used and help to make it less oppressive. You start in a wide and open hall and you have to go into a small jet bridge. It is comfortable that you cannot see what is happening right below you. The door of the airplane is smaller than the jet bridge, this gives you the feeling that you are really boarding the vehicle.
Tractor	The ladder is inviting to climb the tractor. Right before climbing, you take a look at the tractor and see that it is impressive and colossal. A ladder is less comfortable than stairs, the steps are smaller and when wearing the wrong shoes it is very uncomfortable. You need to hold the support and you might need to pull yourself up, which is intensive and therefore not comfortable.
Car	This is a familiar vehicle and you know exactly what to do. The level of comfort depends on the position of the seat. When the seat is at its maximum height, you can easily hit your head when boarding. There is also limited space for your legs at the drivers' seat. In specific situations, like after a long hike, you have to put effort in raising your legs and putting them aboard. My grandmother had difficulties with raising her legs. Her way to tackle this problem was by starting to take a seat. Then she rotated and while rotating she pulled her legs one by one aboard.
Water taxi	"Ohh this looks scary". You have to make a very big step, with raising your legs very high. There is a gap in between the water taxi and the dock and there is a chance that you will slip and fall in between this step. Or by raising your legs that high, keys might fall out of your pockets into the water. Taking a better look at the image, you see that you have to pull yourself on board, which is very uncomfortable. It might feel a lot safer when you don't have to make a big step, both floors should be on the same level. The open space above the boarding spot is comfortable, because you have less risk to hit your head.
Ferry	The ferry looks like a floating way, this gives a familiar and secure feeling. The stripes on the road make clear where to drive and walk, the crossing gates show the end of the road. When getting on board, there is a lot of road next to you, which makes you feel stable. With a smaller road, it feels like you have to balance very well. The ferry is a stable and robust way of transport.
Motor boat	This vehicle has some overlap with the water taxi. It is again a big step to make. In this situation it is not clear what to grab for support. You have experienced with boats that it will rock when you step on board, that is what will make you alert when boarding.
Sailing yacht	The sailing yacht has a gangway. The function of the gangway is very clear and it gives more stability because of the even floor. One scary element of the gangway is that you see water right below yourself. You know that a boat will be rocking, that is why you will make smaller steps on the gangway. It is not possible to grab something for stability, this is a missing element.

8.11 - Analysis boarding support in attraction vehicles

The analysis on the boarding support in attraction vehicles is based on inspecting pictures of these vehicles and mark the spots that function as support.

The recurring elements are one or two holds for your hands, to make a big step. Yellow is used to draw your attention, one is to watch out for your head. The other yellow colour is to draw attention to pull the tube. When it is easier to make the step, the hold for your hands is less obvious. Most of the steps have an aluminium plate.

To determine what is needed to prevent discomforting postures from occurring at the moment of boarding, it is good to know that the level of discomfort differs per person. To find a boarding situation with the absence of discomfort, there needs to be no effort. By avoiding people to pull themselves into the vehicle or avoid making big steps there is less effort needed when boarding. This will prevent people to make discomfortable movements. Furthermore, the impression of a robust and spacious way for boarding will give peace in mind and take away scary moments.

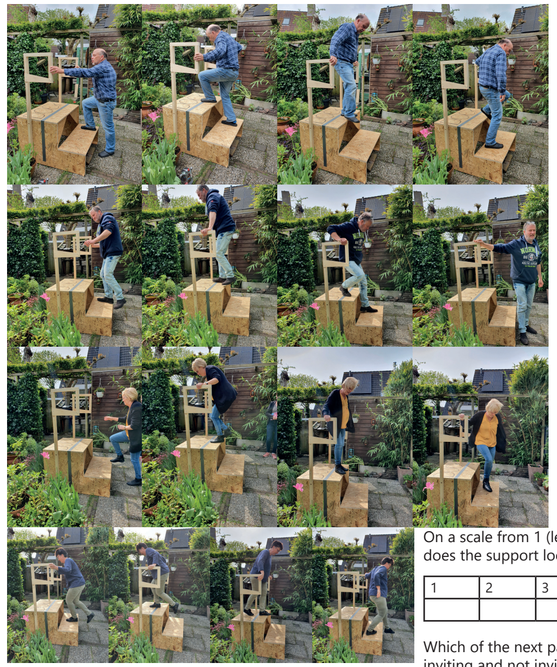
8.12 - User test boarding environment

The test for the boarding environment focuses on the way of boarding the SeaBubble. In this research twelve participants were asked to ascend and descent the stairs that represent the interior of the SeaBubble. The test is performed with ten participants in the age range of 36 to 69 years old.

Research goal
The goal of this research is to test the findings of the analysis of attraction vehicles. In this analysis was found that two supports are preferred when boarding. These two supports were placed on the end of the dock gate to support the moment of boarding the SeaBubble. By testing the support, the goal is to find the functionalities that contribute to a comfortable boarding experience.

Setup
The test is performed with self-made stairs that match the dimensions of the steps inside the SeaBubble. The object has a clear line that shows the gap between the SeaBubble and the dock gate itself. Before starting the test, the participants got an instruction story about what a SeaBubble is and how they want to leave the SeaBubble and enter the dock. After this instruction, the participant had to ascend the stairs and descend. This is performed a second time, but then focussing on how the ascending and descending felt in their bodies. During performing the activity, there is asked for permission to make a photo of how they grabbed the support. Afterwards an interview is performed.

Results
Overview of how the holds were grabbed can be seen in the figures on this page.



On a scale from 1 (least) to 5 (most), how inviting does the support look like?

1	2	3	4	5
			6 participants	4 participants

Which of the next parts make the support look inviting and not inviting to use?

	Inviting	Not inviting
Height	6 participants	4 participants
Reach	7 participants	3 participants
Distance *between the support*	7 participants	3 participants

On a scale from 1 (least) to 5 (most), was the height of the support right for you?

1	2	3	4	5	n/a
		1 *participant*	4 *part.*	3 *part.*	2 *part*

On a scale from 1 (least) to 5 (most), was reaching the support doable for you?

1	2	3	4	5	n/a
		3 *participants*		5 *part.*	2 *part*

Was it easy to use both supports?

Yes	No
9 participants	1 participant

Was it pleasant to use both supports?

Yes	No
9 participants	1 participant

Three participants have used only one support, but could imagine that two are more pleasant than using no support.

Were the moments of discomfort during ascending and descending the test setup? If yes, what caused it?

Yes	No
5 participants	5 participants

The steps are too high, and the knees have to be raised to an uncomfortable height.

When descending the stairs and keep using the supports the arm will make an uncomfortable angle backwards.

Arms are getting tired when making the step inside. The step is too big to perform in a normal way and can give unpleasant pressures on the knee. By using a firm grip to the support this can be prevented, but the arms get tired. Shoulder blades is also a mentioned location.

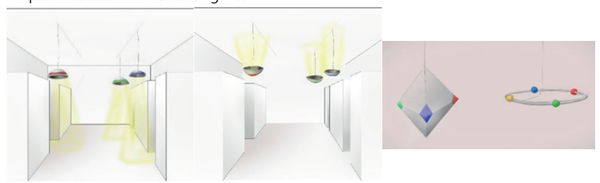
8.13 - Idea elements

The random ideas that were generated are called idea elements. This word is chosen because the ideas are small elements that can be integrated in the dock. In this chapter the idea elements will be presented per category.

Guiding

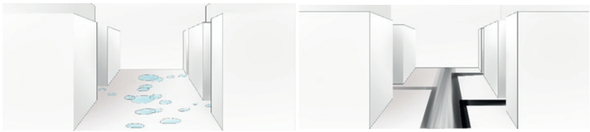
Most idea elements for guiding are based on the idea of 'clear guiding objects', which means that there are objects with a clear guiding function. In the idea elements in this report is mostly worked with colour elements. In reality other it doesn't have to be only colours, shapes can be used too. When adapting these colours in the design of the SeaBubble the colours should be distinctive for people with colour blindness.

For guiding, the location of the elements is important, just like the information that the element shows. There are multiple options for placing these elements, mostly on lamps on the ceiling, paintings on the walls on the side and projections, paintings or stickers on the floor. These two ideas are lamps that are colour coded for guiding, the difference can be found in light direction. Some iterations on the shape of the lamp can be seen in the next figures.



The two idea elements below are a lamp and an art object that projects light on the floor to guide people to the right dock.

The next two idea elements show two options for guiding elements on the floor. Both idea elements show the way on the floor, but the shape differs per option. The left idea element has bubbles on the floor and you can follow the bubbles to come to a dock, in this idea no distinction is made in pattern for different docks. The right figure has a floor with tiles. With different coloured tiles a line to the corresponding dock can be created. A disadvantage is that it is hard to look ahead on a crowded day.



The last three idea elements are wall decorations with guiding elements. The first two ideas use text and icons or colours to indicate where the dock will be, and the last idea is more like a line or wall decoration that can be followed to the corresponding dock.

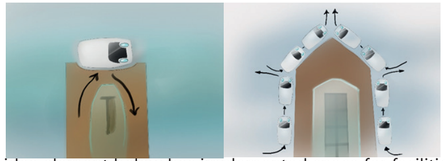
Waiting

The subject 'waiting' can be divided in two parts: the first part is the object to use when waiting and the second part is the location to wait. The moment of the idea generation session is too early in the design process to define the shape of an object for waiting. The functionalities for this object are already clear: it must be possible to sit on it and to lean against it. These functionalities are based on the research in the 'explore phase'.

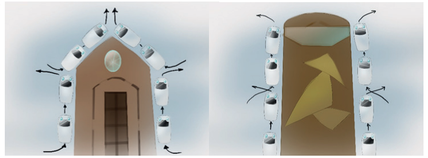
That's why the ideation will mainly focus on the location of the waiting area and how the waiting area will look like when placed on the complete dock. First some idea elements will be presented in top view and secondly some of these idea elements are translated into a 3D view.

First of all, there are two options: the first option is to let the SeaBubble dock at one location and deboard and board the passengers here, the second option is to deboard people first, then let the SeaBubble drive a bit further and then board the new passengers. In all idea elements for locating the waiting area, it is possible to implement both ways of boarding. However, you have to keep in mind that the second option need a bit more space of the dock.

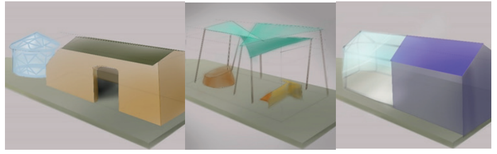
In the first idea element can be seen that the waiting area is a sheltered place that directly separates the crowd flow. In the second idea element, this sheltered waiting area is enlarged, to cover the entire dock. The element of separating the flow is lost, but there is more space to wait and a bigger area of the dock is sheltered.



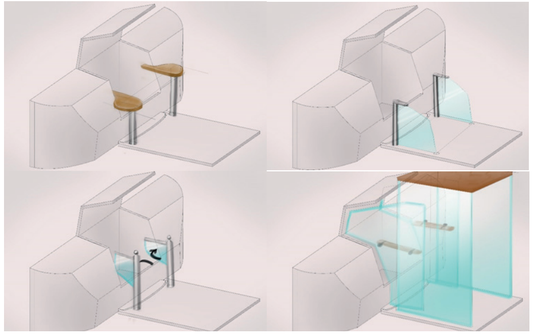
The left idea element below has implemented space for facilities. The waiting area will be placed on the end of the dock for an optimal view and has the shape of a sheltered arbour. The right idea has the same view on the end of the dock, but this idea is more connected to the nature and is more influenced by weather. On the end there is a sheltered waiting area, but also an extra option to go beyond the sheltered area and embrace the weather and the wide view. The rest of the dock is covered by tent cloths to protect from direct sunlight and rain.



The last three images show the last two idea elements and it shows an iteration on the idea with the arbour. In the last drawing, the arbour is changed into a glass house, that is connected with the facilities. When entering the dock, you will see through the facilities a light and glass area and that way you will be guided indirectly into that direction.



Boarding
By ideation on options for boarding the wish for two supports was used as a base. There are four directions for support when boarding. The first idea elements has two poles at the end of the dock to grab for support. In the second idea element these poles are combined with a glass wall, to indicate that it is a gate for boarding. In the third idea element the glass wall will be the gate, and it can rotate to indicate if you are allowed to board. The fourth idea element is a complete sheltered way for boarding, with again on both sides support to grab. The glass wall can be slide outwards when the SeaBubble arrives.



Main takeaways
These idea element are almost product like and have a defined shape. These ideas were presented to Advier. In the discussion, it became clear which preferences the company had for these idea elements.

The company has explained that the environment needs to be affected the least by different weather types, therefore the more nature based ideas are not fitting in this project. Secondly, the passengers need the most pleasant journey, and having a safe surrounding when boarding is preferable. A tunnel will give some protection from bad weather, and that will add some perception of safety while boarding. The guiding elements have all useful elements. The light projected systems were perceived as the most fancy solutions and therefore preferred the most. However, the guiding elements need to be tested to find if it will really be useful.

After this discussion, I went back to the drawing space and created three inspirations for docks. It is hard to decide if idea elements are useful if you cannot see them in the context. That is why I have chosen to make the three inspirations.

8.14 - Collage

Before creating the inspirations, a collage is created to capture the impression the buildings need to have. In this collage the memetics are presented. The memetics are elements that show shapes, materials, sizes and colours to create the feeling that the building needs to get.

In this collage light colours are used, a lot of white too. There is plenty of glass implemented and the ceiling is placed very high. This makes it feel open and a lot of light can fall inside the building. This feeling of wide and openness and brightness of the environment needs to come back in the inspirations.