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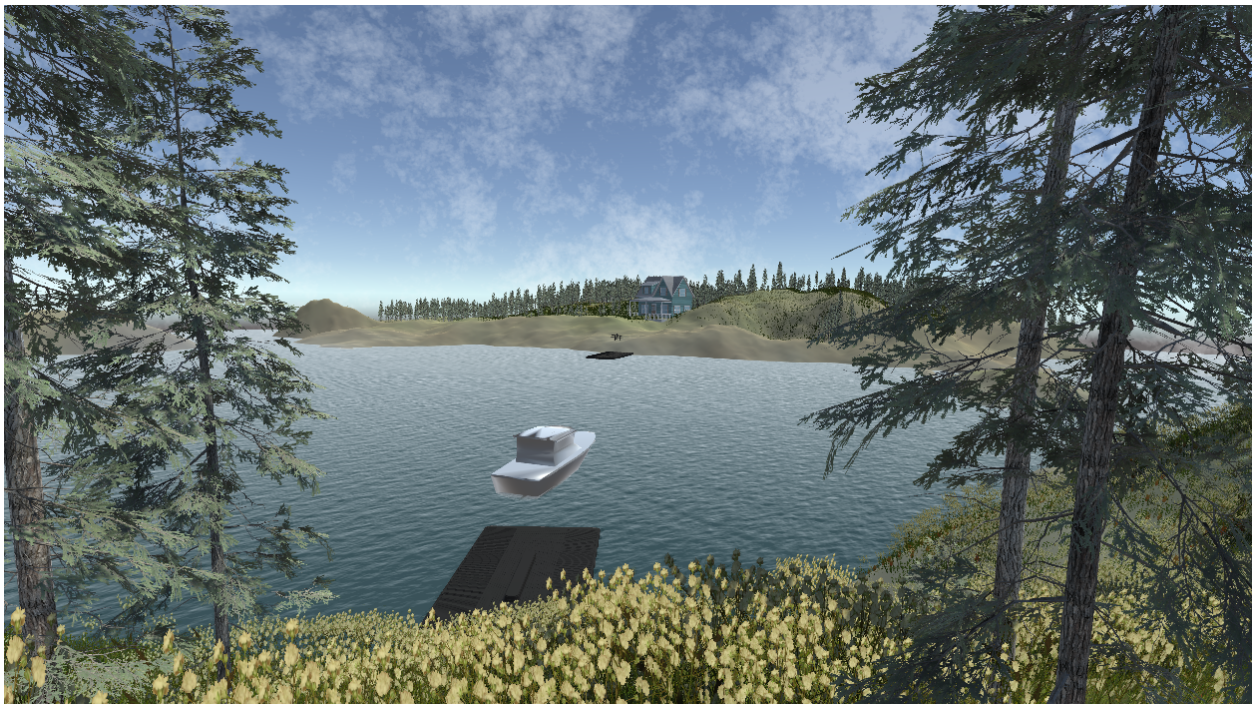

A Digital Steering Experience of the Engine in a Boat

Enhancing the User and Customer Journey

Master's thesis in Product Development

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CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2024
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Cover: Visual representation of the boat simulator environment created in Unity.

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Abstract

This Master thesis presents the development of a digital steering experience for Volvo Penta products in a boat, aiming to enhance the user and customer journey when purchasing or considering a boat equipped with Volvo Penta products.

The problem addressed in this thesis is the uncertainty and anxiety boating can cause if users are not fully comfortable with the boat, its equipment functionalities, and its environment.

Utilizing Design Thinking methodologies, the focus was on creating an efficient experience with an intuitive interface that meets the needs of both novice and experienced boaters.

The methods used to ensure user-friendliness included a questionnaire, qualitative interviews, user observations, feedback sessions, and usability tests to gather insights and validate design decisions. The findings formed the foundation for a customer needs list, leading to the creation of three personas representing these needs. This served as a basis for the development of the digital tool, with prototypes being created and iteratively evaluated through various product development screening methodologies, including Pugh and Kesselring matrices. Additional methodologies employed to examine the market potential were a PESTEL analysis, Segmentation, Target and Position analysis, a Competitor analysis and a Business Model Canvas.

The results concluded in the development of a simulator for home use developed in Unity, capable of configuring a boat, practice scenarios, and testing of Volvo Penta products and accessories. The result demonstrated increased interest in the products displayed in the simulator after its use, along with an engaging learning experience of the products. Alongside the simulator development, the market analysis identified multiple areas of market potential for the near future and for future collaborations.

In conclusion, the digital steering experience offers a compelling enhancement to the traditional boating and product exploration experience when buying a boat, providing users with an engaging customer journey. Future recommendations include further refining the simulator based on user feedback and exploring additional features to increase functionality.

Keywords: digital steering, simulator, user experience, customer journey, design thinking, boat engine, usability, interface design, product development

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Lisa Stavhagen and Lovisa Defaire, Gothenburg, June 2024

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Introduction

1.1 Background

The business landscape has experienced a significant transformation as a result of the Fourth Industrial Revolution, characterized by trends such as automation and digitalization. This shift has not only influenced management strategies and operational frameworks but has also significantly impacted customer expectations. Today's customer market seeks intelligent products delivered as services, offering a level of customization like never before (Ghobakhloo, 2018).

Organizations are consequently compelled to place a heightened focus on the end user and adopt innovative approaches to better meet customer needs and enhance the overall value within the customer journey. A central step in this direction involves transitioning from the traditional supply chain to a more customer-centric Digital Supply Chain. This shift enables a deeper understanding of market expectations, identification of opportunities, improved after-sales services, and a commitment to sustainability in decision-making (Ageron et al., 2020).

Similarly, the concept of servitization has gained momentum in corporate strategies, entailing the addition of services to the product range to enhance value throughout the entire product life cycle (Guajardo et al., 2012; Carlborg et al., 2014; Ostrom et al., 2010). Initially pursued for organizational growth and additional revenue streams, servitization is now a crucial strategy for economic stability (Visnjic et al., 2016).

This aligns with Volvo Penta's focus on the end user. The company aims to enhance users' comprehension of the product range and system operations, thereby aiding users' decision-making processes throughout the customer journey. This initiative also supports the customer service aspect, benefiting original equipment manufacturers (OEMs) and dealers in providing the most suitable boat for the users as they have a better understanding of the product range. As part of their company strategy to maintain competitiveness, Volvo Penta is also embracing servitization. This master's thesis is a part of the exploration of servitization by directly engaging end-users through a digital simulation tool. The tool offers users a simulated boat driving experience using Volvo Penta components, tailored for the marine segment with a focus on the leisure segment.

1.1.1 Environmental and Financial background

In today's environmentally conscious society, the trend towards electrification in the transport sector is evident for reaching the climate goals, specifically in lowering the global temperature of 2°and working against resource scarcity. Although moast boats still use combustion engines, there is a rising adoption of electric engines, either standalone or in combination with combustion engines (Campillo et al., 2019). The shift to electric engines is driven by their lower maintenance and repair costs compared to combustion engines. Electric engines require minimal maintenance, with fewer replaceable parts and eliminate the need for regular changes of auxiliary fluids (Liu et al., 2021).

This indicates that the revenue stream of maintenance and selling spare parts will be reduced significantly in the future. According to Volvo Group's annual report of 2021, 25,6% of Volvo Penta's total net sales come from services, including spare parts, maintenance services, repairs, extended coverage, connectivity solutions and other aftermarket products (Volvo Group, 2021). As the trend towards electrification continues, this revenue stream is at risk of significant reduction unless new revenue streams, such as services or aftermarket products like this digital tool are implemented to compensate for the potential decline.

1.1.2 Volvo Penta company description

Volvo Penta was formed in 1907 and is today a part of Volvo Group which is a global company that strives to develop sustainable transport and infrastructure solutions (AB Volvo Penta, 2024b).

Volvo Penta's product range extends across the categories of power solutions for industrial and marine assortment. The marine department offers engines, propulsion systems and accessories such as joysticks and other facilitation systems to elevate the overall maritime experience.

Since the beginning of the early 2000s, when Volvo Penta launched the Electronic Vessel Control (EVC), an electronic platform and system facilitating communication among the boat's engine, control systems, instruments, and onboard functions, the innovations in Volvo Penta's marine electrical control systems have continued to evolve. Nowadays, their developments extend beyond engines to include innovative solutions like "Docking with assistance" and advanced technology that automatically maintains a boat's position in current and wind. The latest innovations are focused on sustainability, digitalization and user-friendliness enabling users to stay connected via their smart devices (AB Volvo Penta, 2024a).

The company's customers are original equipment manufacturers (OEMs) and dealers on a global scale. These partners maintain direct connections with end users who navigate leisure boats or work in commercial marine boating.

1.2 Project description

Volvo Penta aims to provide users and customers with an exceptional experience during the anticipation and receiving of their new products. By creating a simulation tool, it would be possible for users to try out and practice driving before buying or receiving their new boat and Volvo Penta products. The tool can be distributed to end users, reducing uncertainty and showcasing the user-friendly nature of driving a boat equipped with a Volvo Penta system. This should improve the experience and increase the desirability of driving and buying a boat with a Volvo system.

The project therefore incorporated developing a Digital Steering Experience of the Engine in a Boat to enhance the user and customer journey on behalf of Volvo Penta. The digital steering experience was aimed to suit at-home use, encompassing an investigation into market potential and risks, user requirements and needs, as well as the development and programming of the simulator within a gaming engine. It was performed by Lovisa Defaire, a mechanical engineering student and Lisa Stavhagen holding a bachelor's degree in product development and innovation management, both currently in the product development master's at Chalmers University of Technology. The project was carried out in cooperation with Volvo Penta in the Digital & IT department. The work hours were limited to 40 hours per week for 20 weeks during the spring of 2024.

1.2.1 Scope

This section explains the purpose and aim as well as the objectives and delimitations of this project, A Digital Steering Experience of the Engine in a Boat. This experience includes the propulsion and steering system of the boat.

1.2.1.1 Purpose and aim

Purpose: The purpose of this project was to enable new or existing end users to try out and practice how it is to drive a motor boat/yacht with a Volvo Penta manoeuvring and propulsion system, through a digital approach. The purpose of the digital approach was to reduce the level of uncertainty and increase confidence in manoeuvring when receiving or thinking about buying a boat. Without having to visit an OEM on multiple occasions to explore various options or schedule numerous test drives to find a suitable system.

Aim: This project aimed to create a simulator that fulfils the purpose above. It should be possible to use it at home, allowing customers to familiarize themselves with the Volvo Penta manoeuvring and propulsion system while awaiting their new boat or feature. Included in the aim was also to explore how this simulator should be distributed so that it would fit and enhance the experience of the Volvo Penta customer journey, see the journey phases in Figure 1.1.

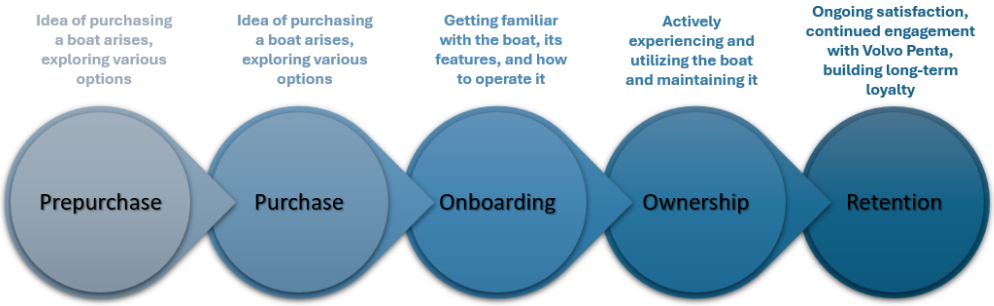


Figure 1.1: Volvo Penta's customer journey phases

1.2.1.2 Objectives

The following objectives correspond to this project's overall aim to be achieved during the spring of 2024.

1. Creating a simulator that can be used at home to simulate how to drive a boat with one type of Volvo Penta engine and manoeuvring system.
   - Decide what features are necessary for a minimum viable product
   - Design an intuitive interface
   - Develop a realistic and true-to-life experience of the simulator from the Volvo Penta product range

2. Explore if the distribution of the home simulator would increase the user's desire to choose an engine and manoeuvring system from Volvo Penta during the buying decision process and increase Volvo Penta's sales.
   - Integrate a channel where Volvo Penta has a direct influence on the user
   - Decide a distribution system for the simulator
   - Explore how Volvo Penta can generate revenue streams from the simulator
   - Improve the sustainability of the customer journey

1.2.1.3 Delimitations

Delimitations were established to frame the scope with boundaries so that the objectives were achievable within the given time frame. The following delimitations were set for this project:

- The physical motions and vibrations when driving a boat were not considered in this simulator.
- All Volvo Penta's manoeuvring and propulsion systems were not included in this simulator.
- All use cases will not be fully developed due to time limitations.
- Languages in the simulator were limited to English.
- In the context of this report, the term *boats* refers specifically to leisure motorboats and yachts.

2

Theory

This chapter outlines the theoretical foundations essential for developing the simulator. It is divided into two main sections: Technology theory and Framework theory. These sections provide the necessary context to comprehend the technical development and assess the simulator from a market potential perspective as well as the theory behind the methods of the product development and screening process.

2.1 Technology theory

This section explains the theory behind boat movements, Volvo Pentas product range, UX/UI design, and simulation.

2.1.1 Boats and manouvering

A boat's basic components for it to work are a hull which is the primary structure of the boat, steering gear, engine, propeller, and a rudder (Hardcastle, 2023). This subsection explains the basics of how these work together to manoeuvre a boat.

How the steering work: The steering system of a boat consists of a steering gear such as a wheel that is connected to a mechanical, electric, or hydraulic system that assists in turning the boat by being connected to a rudder. When the wheel rotates, the system pushes a rod that translates the movement from linear to circular where the rudder is connected. The rudder is placed behind a propeller and goes from left to right to change the direction of the boat. Normally only from -35°to 35°because otherwise turbulence occurs, maximum is -45 to 45°(Getmyboat, 2019).

Since the rudder and propellers are located at the back of a boat and traditional propulsion and rudder mechanisms are designed for forward motion and turning, it is difficult for boats to move laterally. Consequently, the turning radius of a boat is large and varies depending on the boat's shape, weight, and hydrodynamic design (Ghosh, 2024). To assist with manoeuvring, many boats today are equipped with a bow thruster. This additional propulsion device, with propellers located at the front of the boat (the bow), helps move the boat sideways, enhancing its manoeuvrability (Taylor, 2020).

2.1.2 Volvo Penta product range description

Volvo Penta provides engines and complete sets of drivelines from the helm to the propeller, within both commercial and leisure boating. For leisure boating, which is the focus area of this project, Volvo Penta has a wide selection of engines for superyachts, yachts, powerboats, and sailboats. All Volvo Pentas engines are inboard engines or sterndrive which are the types for larger boats or yachts. Volvo Penta also provides a wide range of accessories and features aside from the engines which will be walked through in this section.

Regular stern drive and Forward drive
The two main areas dividing Volvo Pentas propulsion into is regular stern drive or forward drive but within the category, there is a large range of products as well.

The sterndrive, and sail drive are traditional rear-facing propellers that have the engine on the inside meaning an inboard engine and an outboard drive.

Volvo Penta also provides forward drive, these engines are either inboard engines or sterndrive, but compared to regular rear-facing propellers the propeller is turned 180° meaning that the boat is pulled forward instead of pushed. In the category of forward drive, Volvo Penta has patented the Inboard Performance System for yachts and forward drive for power boats (Volvo Penta, 2024f).

Inboard Performance System
The invention of the Volvo Penta Inboard Performance System (IPS) is a complete steering system with twin counter-rotating propellers that face forward. It is rudderless and operates quietly in the water while the propeller thrust is parallel with the hull, so all power drives the boat forward. The individually steerable drives are linked to joystick control and an electronic control system, providing high manoeuvrability (Volvo Penta, 2024c).

Volvo Penta Joystick
The Volvo Penta Joystick serves both purposes of driving and docking. It allows for precise control, enabling manoeuvres in all directions—forward, backward, sideways, and full 360-degree rotations. It offers intuitive, one-handed steering for controlling the direction, position, and speed by simply pushing the joystick in the desired direction —forward or sideways—and when released, the boat continues on that course. Releasing it after reversing puts the boat in neutral for added safety.

Moreover, it integrates smoothly with Volvo's individually steerable propulsion system and Electronic Vessel Control (EVC). It is possible to install up to 6 joysticks on one single boat, also outdoors, making it versatile for various installations like twin, triple, or quad propulsion. The joystick is compatible with IPS, Sterndrive, and inboard shaft systems, it caters to both diesel and gasoline engines, and it can be combined with Volvo Penta's autopilot system (Volvo Penta, 2024g).

Assisted docking with the Joystick

The assisted docking is a feature on the Volvo Penta Joystick which makes docking easier by pressing the assisted docking button to start. When Assisted docking is active and the joystick is released the joystick brings the boat to a complete stand-still, without being affected of wind, waves or currents. With fine-tuning ability, it is possible to move sideways with just a touch with a desired amount of meters which users can adjust settings precisely. Rotating the joystick allows for rotating the boat on the spot. Quick forward movements followed by release result in gentle forward motion, offering versatility in all directions. Additionally, users can control the force with which the boat presses against a dock, preventing unwanted movement and ensuring precise docking manoeuvres (Volvo Penta, 2024b).

Dynamic Positioning System with the joystick
The Dynamic Positioning System (DPS) enables the boat to lie still on the water with perfect precision even when wind and current act on the boat.

The DPS allows the boat driver to maintain the boat's heading and hold on to the exact position by using the DPS button on the Volvo Penta Joystick. This feature is useful in situations such as when preparing for docking, waiting to refuel, or waiting for a bridge or lock to open.

Through twin GPS receivers in the two antennas on the boat, the system determines the boat's position and heading. Through software in the EVC system, the received data are transformed into steering angles, gear shifts and throttle positions to hold the boat's position (Volvo Penta, 2024d).

Easy Connect
Easy Connect is a mobile app where you can monitor your boat's engine status, and share data with your service dealer. The information on the engine includes performance, nautical details, fuel reserved, and gray and black water tank status (shower and sink, and toilet tank). The display can also be customized to the user's preference so that it only shows what is needed. You can also see engine speed, coolant temperature, oil level, and fuel consumption. Other things such as wind and navigation are also possible to see with the interactive map where you can see where you have been and access detailed marine charts (Volvo Penta, 2024e).

Glass cockpit
The glass cockpit integrates the engine, driveline, and navigation data into one interface for a seamless and intuitive driving experience. The system contains a customizable display layout and has two display ranges in eight sizes where the user can adjust everything from lights, music, and navigation with an inbuilt GPS system. With the help of the joystick, it is also possible to change the layout of the screen to suit different modes. Warnings and alarms are prioritized. You can also get a birds-eye view with the surround-view camera system that makes it easy to park (Volvo Penta, 2024a).

2.1.3 UX/UI Design

Designing interactive products requires a comprehensive understanding of the users, including who they are, how they will use the product, and the context in which it will be used. This involves considering the users' strengths and weaknesses, their current practices, and how the product can improve their overall experience. Engaging users in the design process through user-centered techniques is crucial for developing a product that truly meets their needs and expectations. The design must focus on usability, aesthetics, functionality, content, look and feel, and emotional appeal to create a compelling and effective user experience.

Setting clear usability goals is vital for the development process. These goals include effectiveness, efficiency, safety, utility, learnability, and memorability. Detailed questions should be asked to assess these aspects, such as how long it takes users to learn basic functions or how the product supports error recovery.

Incorporating fundamental design principles enhances the usability and user experience of the product. Feedback mechanisms inform users about their actions and progress, while good visibility ensures users can easily understand what to do next. Constraints guide user interactions to prevent errors, and consistency in design makes the product easier to learn and use. Affordances provide intuitive clues about how to interact with the product, which can be particularly important in screen-based interfaces.

Ultimately, designing effective interactive products is about creating a seamless, intuitive, and enjoyable experience for users. This involves a deep understanding of the users and their needs, careful consideration of usability and accessibility, and the application of design principles to ensure the product is both functional and enjoyable to use (Sharp et al., 2019).

General design guidelines
W. Jordan (1998) outlines some general design guidelines that should be followed to be able to achieve an intuitive interface that is easy to understand from a user's perspective.

- Consistent and coherent design. Use the same colour coding throughout the interface. Use the same type of representations and text.
- Compatible with user expectations. Similar to other everyday items, experience-based choices. Use stereotypes such as right/up to increase, left/down to decrease. Logical sequence.
- Consider the user's resources. Display only the information necessary to complete the task. Do not use more than four colours.
- Provide feedback. So the user knows they have done something and show what it results in. An hourglass is useful if there is a delay.
- Design to minimize errors and allow for error correction.
- Let the user have control over what happens.
- Visual clarity in design.
- Prioritize information and functions.

- Provide clear clues. Symbols, icons, and text that everyone understands.

2.1.4 Simulation in Unity

Unity is a game engine based on Microsoft C# that supports the development of various types of applications, including 2D and 3D games, as well as other interactive applications. It is user-friendly, making it popular among first-time developers. It supports game creation on desktop, mobile, console, virtual reality systems, and more, it also offers creation tools for aerospace, automotive, and architecture engineers, among other use cases.

Basic game creations work via "Scenes," in which developers place and arrange objects and then adjust their properties as needed. That can be relatively simple, like importing and using sprites in a 2D, or massively complex, like managing dynamic shadows in a 3D map. In most cases, users can use the engine's built-in UI to control everything or dive into the scripting API and adjust values via code (Lacoma, 2023).

2.1.4.1 Simulate boat physics

When a body is submerged in a fluid, the fluid exerts a force on the body's surface due to the fluid's pressure, which is called the buoyancy force. The pressure in water increases with depth resulting in an upward buoyancy force equal to the weight of the displaced fluid. There is also a hydrostatic force that is generally acting on a point lower than the centre, which needs to be considered in simulations. When simulating bodies, usually the surface is calculated with a lot of triangles, called a triangular mesh. Summing forces and moments for small surfaces inaccurately at their centers can lead to errors, causing instability in simulations. Accurate calculations require considering the correct application points, balancing complexity and computational cost.

The theory behind this, used in this project is a surfacic method that calculates hydrostatic pressure forces on each submerged surface element and sums their effects. This method approximates the water surface and the hull with a triangulated mesh and assesses the height of each vertex relative to the water. Vertices submerged under water are identified, and triangles are categorized as fully submerged, fully above water, or partially submerged. Partially submerged triangles are divided into regions above and below water, and further triangulated if necessary. This simplification assumes a single intersection between a submerged vertex and a vertex above water, which is not always accurate but works in practice (Kerner, 2015).

2.2 Framework theory

The theories presented in the following section will serve as guiding principles throughout the projects progression, ensuring a comprehensive and systematic approach to achieving the projects over all objectives and specific aims and procedures of individual tools and methodologies.

2.2.1 Primary data collection

Primary data collection is first-hand data collected by the researcher (Sorting Hat Technologies Pvt Ltd, 2024). These types of data can be divided into quantitative and qualitative data. Quantitative data are associated with research methods such as questionnaires and observation among others and based on the collection and interpretation of numeric data (Denscombe, 2014).

Qualitative data takes the form of words which are spoken or written, or visual images which are observed or creatively produced. They are associated with research methods such as interviews, documents and observation (Denscombe, 2014).

2.2.2 STP

The STP marketing model serves as a three-step strategy model consisting of segmentation, targeting and positioning. The model is used to effectively *segment* a business audience, typically based on characteristics such as demographics, geographics, psychographics, lifestyle, beliefs and values, behaviours, or consumer benefits. Then to find the ideal buyers or select the *target*, done by evaluating the potential and commercial attractiveness of each segment conducted by assessing size, profitability, accessibility, and the benefits each segment offers. Lastly, strategically *position* the products to maximize the influence on the targeted group. Typically, this is represented in a chart with two variables in a perceptual map, allowing for a comparison between the company and its competitors to find gaps in the market (Hanlon, 2024).

2.2.3 Customer Journey

A Customer journey can be defined as the process of purchasing and experiencing products and services. It can be thought of as "walking in the customer's shoes" (Holmlid and Evenson, 2008). To get an understanding of the service experience within an organisation one must understand the customer's journey. There are various methods and techniques to map out the journey by using visualization tools, process mapping or storyboarding, the importance of these tools is to understand all the activities and constraints involved in the specific customer journey. This journey is usually explained as the customer journey map or customer journey model, divided into the phases: awareness, decision, purchase, service and loyalty. Historically the journey has been physically and linear (Harris Patricia et al., 2020).

Meanwhile today the journey can be multi-channel and customers can move seamlessly from one channel to another during one single journey. The process could be iterative and simultaneous via different channels rather than a traditional funnel like (Harris Patricia et al., 2020). These digitalized elements increase the complexity of the customer journey as different channels are available to support and influence the customer. In the digital environment, a customer can browse and hop on a competitor's customer journey within just a click and the customer can easily configure their own journey. The services throughout the journey can be seen as touchpoints where

moments of contact in the journey take place between the customer and the organization. These are the elements where organizations have the opportunity to create customer value (Kottler Philip et al., 2016) that creates the customer experiences. This value creation has a direct influence on the customer experience and the value creation can be built on and brought to the journey in many ways, for example by excellent service or by creating customer engagement through marketing, education, and competitions.

2.2.4 PESTEL

PESTEL is a framework used to assess the factors in the macro strategic environment. These factors are beyond an organization's immediate control but can significantly influence its operations or a projects outcome. The framework can be used to gain understanding and knowledge about opportunities for growth or decline in a specific type of market. The categories considered within PESTEL are:

- Political
- Economic
- Socio-cultural
- Technological
- Environmental
- Legal

The analysis promotes a comprehensive examination of each category and advocates for various factors. For instance, within the "Legal" category, a comprehensive spectrum of considerations, ranging from employee laws to data protection should be taken into account. Similarly, the "Social" category encompasses alterations in population characteristics such as gender, age, and education levels or changes in habits and trends (Paul Debra and Cadle James, 2020).

2.2.5 Generation and Selection of concepts

A structured process for concept generation and evaluation helps maintain objectivity throughout the concept phase of the development process and guides product developers through complex decision-making processes. A well-documented and well-evaluated approach is also advantageous for creating customer-focused products because concepts are explicitly evaluated against customer-oriented criteria. This increases the likelihood that the selected concept will meet customer needs. Additionally, such documentation facilitates the integration of new team members, smooth project handovers, and rapid assessment of changes in customer requirements or available alternatives (Ulrich and Eppinger, 2016).

The theory behind some of the suggested methods for generating and evaluating concepts, as outlined by Ulrich and Eppinger (2016) is described below.

2.2.5.1 Morphological matrix

A concept combination table provides a way to consider combinations of solution fragments systematically. Subproblems identified correspond to solution fragments for each of these subproblems derived from external and internal searches, depending on what research approach is utilized. One type of combination table is the Morphological matrix. The way the morphological matrix works is to list key functions or features of a product along one axis and possible solutions or variations for each function along the other axis. By combining different solutions from each column, a wide range of potential product concepts can be generated systematically (Ulrich and Eppinger, 2016).

2.2.5.2 Pugh & Kesselring matrix

Concept selection is the process of narrowing the set of concept alternatives. Although concept selection is a convergent process, it is frequently iterative and may not produce a dominant concept immediately. The Pugh concept selection method is used to screen concepts, allowing for a quick narrowing down of options and improvement of concepts. The Pugh matrix is done in a stepwise procedure:

- Prepare the Selection Matrix - Set up a table with multiple criteria in one column followed by the concepts, one concept in each column. Written descriptions and sketches may be useful. Choose one concept to be the benchmark.

- Rate the Concepts - A relative score of “better than” (1), “same as” (0), or “worse than” (-1) is placed in each cell of the matrix to represent how each concept rates in comparison to the reference concept relative to the particular criterion.

- Rank the Concepts - After rating all the concepts, sum the number of “better than”, “same as”, and “worse than” scores and enter the sum for each category in the lower rows of the matrix. Once the summation is completed, rank-order the concepts.

- Combine and Improve the Concepts - Having rated and ranked the concepts, verify that the results make sense and then consider if there are ways to combine and improve certain concepts.

- Select one or more Concepts.

- Reflect on the Result.

The Kesselring matrix is a scoring matrix which is similar to the Pugh matrix, also used in the selection phase. Compared to the Pugh matrix, Kesselring also weights each criterion. For example, if one criterion is of high priority for the users, the weighting score is high, but for a less important criterion, the value is low, Ulrich and Eppinger (2016).

2.2.6 Business model canvas

A business model canvas describes the rationale of how an organization creates, delivers and captures value. The tool can be used to describe existing businesses such as competitors, and the company's business or create new innovative strategic alternatives. The model contains nine building blocks which show the logic of how a business intends to make money and create value. The nine blocks are:

- Customer Segments
- Value Proposition
- Channels
- Customer Relationship
- Revenue Streams
- Key Resources
- Key Activities
- Cost Structure

The tool is commonly employed in group settings, utilizing a canvas board, sticky notes, and sketches to facilitate easy rearrangement and additions to the model. This approach aims to foster creative structures in the business model and spur discussion and analysis of business elements (Osterwalder and Pigneur, 2010).

3
Methodology

The methodology used in this project had an emphasis on designing for a user experience with design thinking (UXD), prioritizing the quality of the user experience over a fixed set of methods (Allanwood and Beare, 2014). This involves considering the emotions, feelings, and overall impressions during product interaction. The principles of UXD and general Design Thinking (DT) (Kumar and Kurni, 2022) were integrated in combination with the product development funnel (Dariush Rafinejad, 2017), which has valuable methods for streamlining a multitude of ideas into a manageable quantity, starting wide and reducing concepts until a final solution. The advantages of utilizing these principles were to ensure a user focus from project initiation and extend it across the entire development process. Allowing iterative workflow by utilizing the DT principles while simultaneously using tools from the product development funnel to ensure that a manageable amount of concepts were produced for the set timeline. The six phases of DT are presented in Figure 3.1 below.

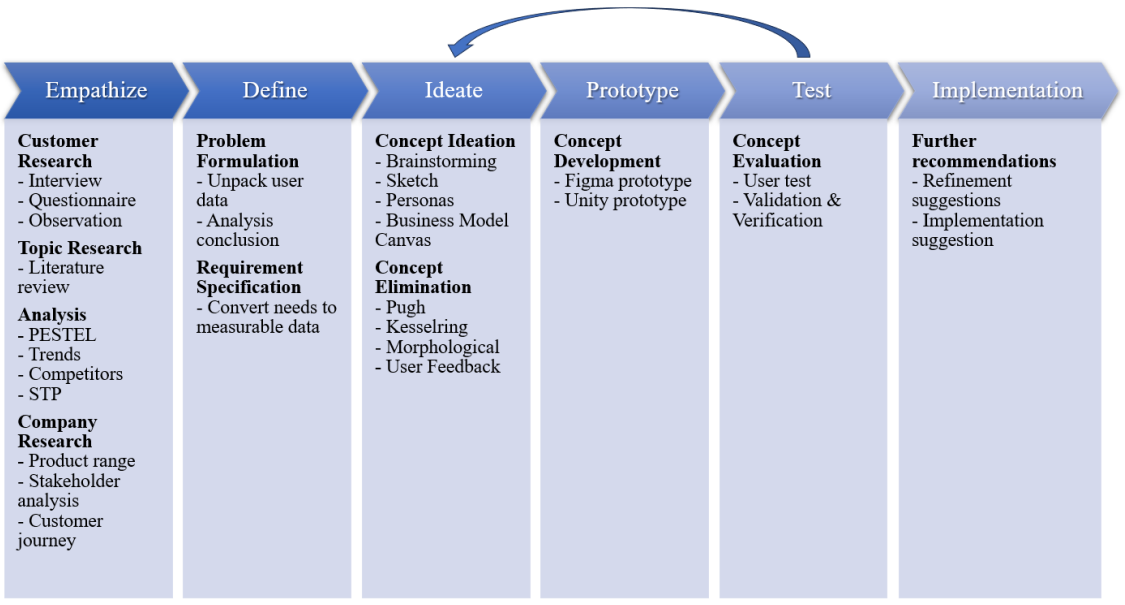


Figure 3.1: The five phases of Design Thinking with some respective tools and methods.

In the phase of *empathize*, actions included exploring the problem by investigating the user needs, researching the field and analysing the stakeholders. This was to ensure that the given problem from the company was in line with the user's needs

and to ensure the project was based on scientific facts.

Define includes concretising the problem formulation into a focus area for further development which was important to achieve the objectives. Although the overall definition was set in the beginning, the definition narrows down as the project continues.

The *ideation* phase in this project includes brainstorming solutions for the defined problem. Methods and tools used in this phase were creativity tools to widen the possibilities for finding a potential solution. To ensure a number of manageable concepts for the next phase, evaluation and elimination matrixes were used as well as user feedback.

In the *prototype* phase, interactive illustration tools were used for developing the ideated concepts. The importance of prototyping is to visualise and realize how a potential concept can further be developed.

Testing includes various feasibility tests of the prototype functions and to validate the final solution against the requirement specification.

The *Implementation* phase in this project included giving further recommendations to Volvo Penta on how the implementation process can be executed.

In the development of the simulator, it was crucial to create a product interface that is easily comprehensible and user-friendly to ensure a positive user experience. To accomplish this, methodologies and principles from the book *Interaction Design* by Sharp et al. (2019) were applied in all phases. These include design considerations for accessibility and inclusiveness, cognitive and social aspects, emotional interaction, and more.

To employ the specified methods in each phase, the project process was organized through a Gantt chart to ensure that the project was manageable within the allocated time frame, see Appendix A.

4
Primary data collection

In this section, data collected through interviews, questionnaires, and observation tests are presented. This data forms the basis for identifying customer needs and requirements for the simulator, as well as assessing the market demand for this product. The research covers both general boating topics and specific needs related to the simulator.

4.1 Interviews

Interviews were executed to gather customer and user data as a part of the phase "Empathize" in the project's methodology. During the Swedish Boat Fair 2024 in Gothenburg, interviews were conducted with exhibitors at the fair. The aim of these interviews was primarily to understand the difficulties involved in driving boats in general as a new or experienced driver and secondly to ask for feedback on how a Volvo Penta simulator potentially could ease any of the articulated problems. The questions were asked to a wide audience with a profession or interest in maritime. The second round of interviews involved in-depth interviews where maritime and boat enthusiasts volunteers were selected from the questionnaire which was distributed on various Swedish Facebook pages about boating, read more about the questionnaire in Subsection 4.2. It is important to consider that some of the interviewees were related to Volvo Penta and therefore may be biased.

4.1.1 Short interviews at Båtmässan

During the Swedish Boat Fair 2024, eight short interviews were held. The participants were a Docking and tourist information worker, Sales personnel at Volvo Penta, a leisure repair yard worker, a salesman at Nimbus, a member and worker at the Swedish Sailing Association, a boat dealer for leasing, a boat broker, and a worker at a boat rental company. This subsection contains the main takeaways from the interviews, to read the full summary of each interview see Appendix B.

The similar inputs shared from the interviews were that stress and communication are sometimes an issue when operating a boat. The rental worker emphasized more on the manoeuvring and navigation problems, while the docking worker explained multiple challenges observed during work hours regarding docking, but also own experiences regarding docking situations and lock operations. The hard part was

mainly that in narrow spaces, during high traffic, or whenever good manoeuvring skills are needed, it also requires good communication between the operator and the other people onboard to not risk colliding or other accidents.

The sales personnel at Volvo Penta and Nimbus talked about technologies and trends in the market. The Volvo Penta salesman had seen a shift towards a trend of outboard motors due to lower prices as a result of easier transportation and installation, as well as fewer regulations on emissions and environmental impacts on outboard motors. As Volvo Penta does not sell any outboard engines, it is important to reach customers through other products. For example, both of the two salesmen highlighted assisted docking to facilitate the users' needs. There were different takes on the assisted docking and the simulator from the two. The salesman at Volvo Penta saw an opportunity to use smaller OEMs to show the simulator because larger OEMs might want to be more complete and have their own simulator, and the smaller ones might be more interested. As OEMs are strong in cycles, they require a lot of attention during high seasons, but during lower times, it is important to have a relationship with the user too. During the low demand for boats, Volvo Penta must be on top of the mind of the end-user to qualify as the first choice when it comes to selecting power and driveline in the few boats produced. To work on that relationship, a simulator may be of use. The usefulness of the simulator according to the Nimbus salesman regarding technology trends was that when earlier similar simulators to display assisted docking were used, they were very appreciated by customers to try. The salesman also highlighted the importance of having the simulator intuitive and learning-oriented as in today's society people are used to technology being easy to understand. The salesman had seen a higher demand and customers asking for more technology-assisting devices when buying boats. The suggestion was therefore to use the simulator to learn more complex things so that in critical situations familiarity with the technology makes everything work smoothly.

Another interviewee with positive feedback regarding already existing simulators on the market was a worker and member of the Swedish Sailing Association. Opposed to the salesman who saw value in product understanding, the member of the sailing association had seen the benefits of a simulator in learning and boosting confidence in a child being afraid of going into the water to sail with a small Optimist dinghy. But after practising with the simulator, the child was more confident and wanted to try the real boat.

The most critical aspects discussed about integrating technology into boat practice during the short interviews were shared by the boat broker. It was highlighted that it is important to learn to not trust the technology fully because when those breaks the user needs to be able to, for example, dock anyway. Therefore it was suggested to not put too much focus on those assistive technologies in the simulator. On the other hand, the interviewee pointed out that those difficult moments can also be exercised in the simulator and therefore be very useful for that purpose.

4.1.2 In-depth interviews

Interviews were held with six people who answered the questionnaire. The interviews were conducted to gather more in-depth information about boating, purchasing/browsing new boats, the usefulness of the simulator, and general feedback. All interviews except for one were done online through Teams, where the interviews could be transcribed automatically. To ensure a diverse range of perspectives, the interviewees were intentionally selected to represent a broad spectrum of backgrounds. There was one student who was an experienced boater, one woman who owned a boat but was too scared to drive it in all situations, one who was not interested in buying a boat, one who owned a boat with a Volvo Penta engine, one boating expert with simulator experience, and one who is a high-ranking employee at Volvo Penta. The specific questions posed during these interviews are outlined in the Appendix C.

The interviews collectively highlight the simulator's significant potential as a training and educational tool. Particularly useful for improving skills in docking and manoeuvring under various conditions, increasing user confidence, pushing limits, and providing a safe environment for practising manoeuvres that would be risky in real life. Additionally, they wanted the simulator to allow users to try out different components and accessories, such as Volvo Penta's IPS system, the joystick, and familiarise themselves with the dashboard. There was a unanimous consensus that docking is the most critical situation. Two interviewees specifically highlighted the insecurities associated with docking in windy conditions, explaining that either they or their partners avoided operating the boat in such scenarios or when near docks. They thought the simulator could help overcome these insecurities. The interviewees also agreed that the simulator could potentially attract new boaters, though they differ on the extent of this impact.

Everyone thought it would be a good way of testing components in different boat configurations, it was important that the simulator had a broad range of boats to be useful to anyone. The simulator could also serve as a preparatory tool for new boat owners or those upgrading to larger or more complex boats, helping them get accustomed to their new vessels before actual use. They all believed the simulator could alleviate concerns about lending out their boat if a skill certificate could be integrated. This could also be an educational tool for boat rental companies to educate new boaters.

Differences in opinions mainly revolve around the importance of realism, with some emphasizing the need for actual controls and realistic environmental effects, while others see value in more accessible, less realistic simulators where the steering tool could be an image on the screen. All agreed that having both would be a good option, a less realistic easily accessible at home and a fully equipped one with physical components at a dealer or similar.

To make the simulator enjoyable, it was suggested to include various modes or levels with a points system to evaluate performance, along with an aesthetically pleasing interface. In conclusion, while there are varying perspectives on specific features and

applications, there is a strong overall agreement on the potential benefits of the boat simulator for both beginner and experienced boaters, with practical suggestions for improving simulator design and functionality to meet the needs of different users. To read more about each interview, see Appendix D.

4.2 Questionnaire

To gather quantitative data from the end users a questionnaire was distributed on various Swedish Facebook pages about boating and boat life to target people who would have an interest in the subject. The purpose of the questionnaire was to collect numerical data on users' ratings of the described features and scenarios in the simulator, as well as their assessments of the difficulty levels of different boating scenarios. The respondents were aimed to be individuals with different interests in boats, therefore the questionnaire was divided into three categories with questions related to the relationship the respondent had to boats. The three categories were *Own or have owned a motorboat/yacht, Considering or have considered buying a motorboat/yacht, and No interest in buying a motorboat/yacht*. If the respondent did not have any interest in the boating lifestyle, then their questionnaire ended to avoid irrelevant answers. The respondents could also leave their contact information if they wanted to participate in a more in-depth interview to gather qualitative data, which 15 people were willing to do. In total the questionnaire resulted in 91 answers, where 67% were from the first category, 8,8% from the second, from the third 16,5%, and 7,7% were not interested in boat life and were therefore not asked any questions further. The summarised results are presented in the subsections below with an analysis of the aggregated data. For a full review of each category, including statistical analysis of the responses, see Appendix E.

4.2.1 Analysis of the collected data

Depending on the participant's relation to boats suitable questions were asked. One of the questions asked to participants who "own or have owned a boat" was "What factors have been most confusing or difficult to understand when considering buying a boat?" the answers indicated no significant problems with the choice of either steering control, propeller, or engine but rather the design of the boat which is not directly linked to the Volvo Pentas product range but a concern Volvo Penta indirectly could potentially benefit of addressing if it would ease the process of buying a boat equipped with Volvo Penta's product on.

The common sentiment in all three categories of relation to boats was that there is a prevailing priority on realism over accessibility. It was also a positive response to the usefulness of the simulator with the purpose of testing components as well as for the purpose of practising boat driving.

There was a correlation between what the participants felt unsure about or thought

was difficult when driving a boat and what they wanted to see and test in a simulator. For example, in the two first categories, it was seen that docking and strong currents were two of the more difficult parts of boating and also listed as some of the top prioritized features to test in the simulator. However, the three groups of categories differed in some of the most listed difficulties and what they wanted to see in a simulator. The "Own or have owned a boat" also listed strong winds as a difficulty and as a practice to test in the simulator. They also listed testing new accessories as a priority for the test of features in the simulator, while the "considering buying a boat" listed navigation as a difficulty but manoeuvring as a priority in testing. What to keep in mind for these answers is the difference in experience levels for the categories. For the first category, the respondents were more experienced and would therefore have a more realistic view of difficulties associated with boating, while the other two could guess what they think is the most difficult. Therefore the first respondents' answers should be more accurate to how it is in reality. Important is although to consider less experienced concerns as a possibility to use the simulator to convey reality and provide more information to the less experienced.

The combined viewpoints regarding the desired features for the simulator were that docking, handling strong winds, and testing new features are of primary importance. This result was notably shaped by the preferences of respondents within the "Own or have owned a motorboat/yacht" category since they were the majority of participants in the questionnaire, see Figure 4.1

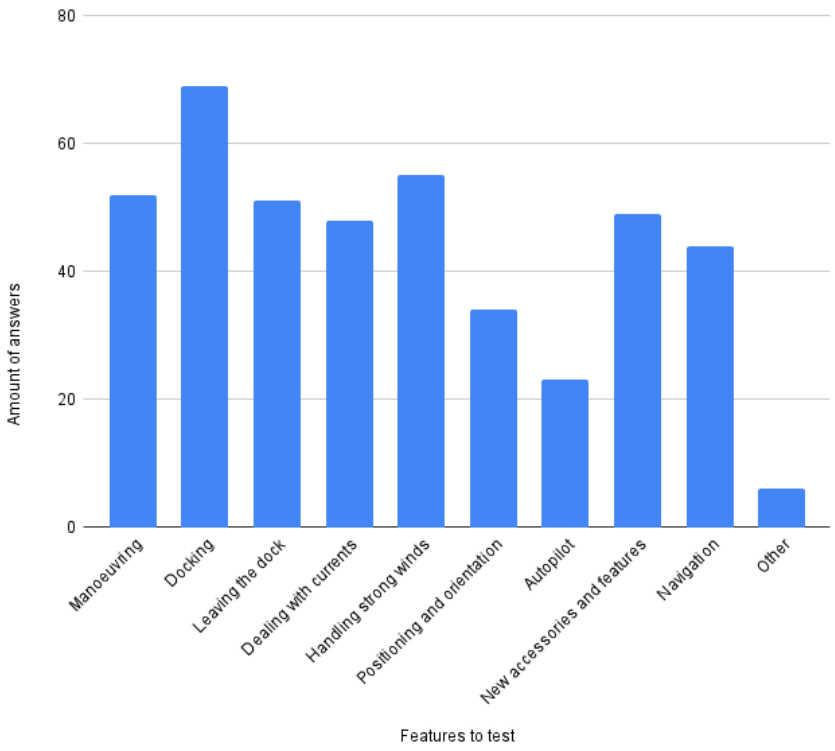


Figure 4.1: Aggregated data of all the participants' preferences for which features they want to test in a simulator

Furthermore, the combined viewpoints from the participants on the importance of having the simulator as realistic as possible versus easily accessible there is a slight preference for the importance of having the simulator realistic. This preference remains relatively consistent across all three categories when examined individually. For the combined viewpoints, see Figure 4.2

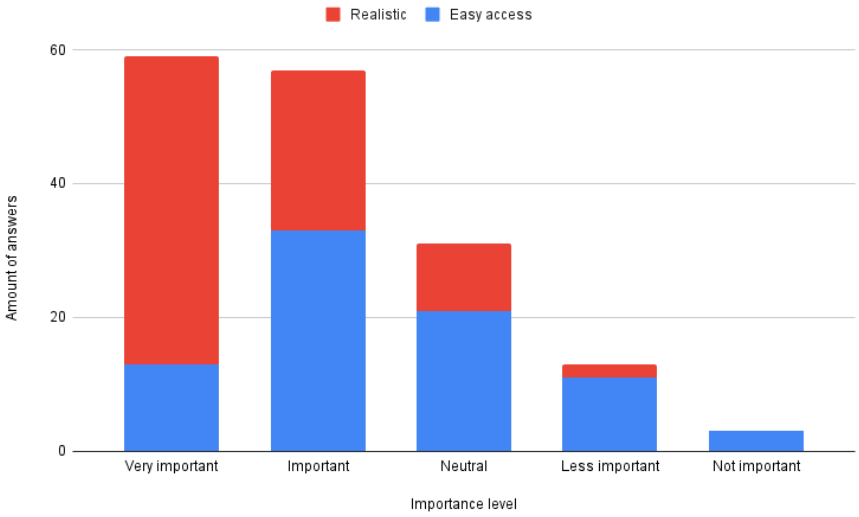


Figure 4.2: Aggregated data of all the participants' opinions regarding the level of importance of realism and easy access

4.3 Observation tests

Observations were conducted through both self-assessment and with participants outside the project group to gain a comprehensive understanding of boating simulators and Volvo Penta products.

4.3.1 Optimist dinghy

During the Swedish Boat Fair 2024, a self-observation test was conducted while trying out an Optimist dinghy VR simulator from the Swedish Sailing Association. This test aimed to gain insights into how simulators can be utilized for boating purposes. The simulator, designed for training new members of the association, proved effective in reducing children's fears and improving their performance during their first sailing experience after using it, according to the workers.

The simulation involved the user sitting on a standard wheeled stool and wearing VR goggles with connected hand controllers, creating the sensation of actually being in a boat. The goal was to learn how to sail by steering the sails and manoeuvring on the boat while maintaining a straight course.

While the simulator generally worked well, it was somewhat challenging to aim the hand controllers accurately. From an intuitiveness perspective, understanding how to operate the boat upon entering the game mode was difficult. An instructor provided guidance from the side, but the instructions felt somewhat confusing. This highlighted the need for the simulator to include integrated instructions.

The simulator resembled a game but conveyed a sense of realism through the movements and behaviour of the boat, see Figure 4.3. However, without prior sailing experience, it was hard to fully gauge its realism. Overall, the simulator seemed to be a valuable learning tool, and everyone who tried it appeared to enjoy the experience.

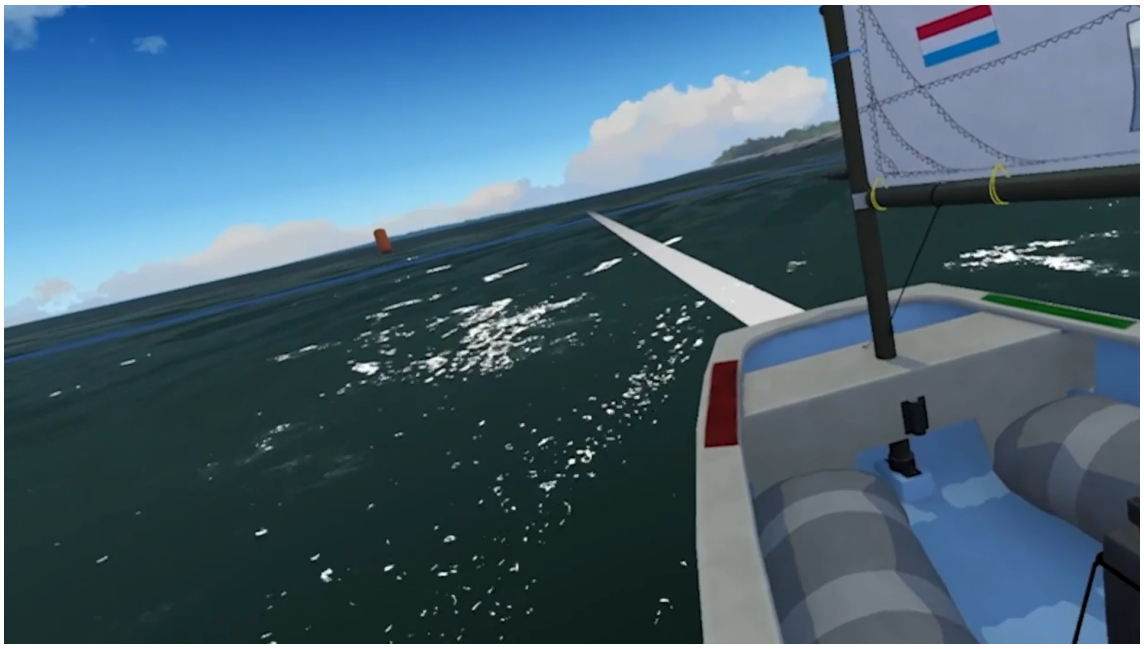


Figure 4.3: How the simulator from the Swedish Sailing Association looked like

4.3.2 Volvo Penta test facility

To gain a deeper understanding of Volvo Penta products, a self-observation test was conducted on operating a boat equipped with a joystick. Additionally, observations were made of individuals with varying levels of boating experience. The boat was configured with two Volvo Penta engines, a throttle, a bow thruster, a joystick, and a steering wheel.

An instructor began by demonstrating how to operate the boat using both the throttle and steering wheel, as well as the joystick. The initial impression was that manoeuvring with the throttle and steering wheel required considerable attention when leaving the dock, whereas the joystick operation appeared much simpler. The joystick's greatest advantage was its ability to move the boat sideways, making docking and undocking significantly easier.

External observation:
One test participant initially twisted the joystick instead of pushing it to move sideways, indicating that the controls were not entirely intuitive at first. However, after this initial mistake, the participant quickly adapted, and it did not recur. Overall, everyone managed the boat very effectively with the joystick. Nonetheless, it was

sometimes unclear if the joystick could be used at higher speeds since pressing a specific button was required.

Self-observation:
For a beginner boater, the difference between using the joystick and the throttle was significant. The joystick allowed for effortless control, almost too easy, which led to an attempt at docking using only the throttle and steering wheel. When the boat did not respond as expected and was in close to colliding with the harbour, pressing the assisted docking button immediately resolved the issue by removing the effects of wind and waves, transforming a stressful situation into a calm one with just one push.

A conclusion from this observation was that the joystick demonstrated how simple boating could be. Even for a beginner, manoeuvring the boat was remarkably easy.

5
Market analysis

This chapter provides a comprehensive evaluation of both internal and external factors affecting the market positioning and strategic implementation of the simulator. This chapter is divided into two sections: micro-level analysis and macro-level analysis.

5.1 Micro level analysis

This section delves into a detailed analysis of various aspects crucial for a successful implementation and market positioning of the simulator. The micro-level analysis focuses on stakeholder engagement and risk management, trends in the market, a competitor and STP (Segmentation, Targeting, Positioning) analysis.

5.1.1 Stakeholder register

A stakeholder register was created to identify the key players affected by this project, understand their interests, and proactively manage potential risks and challenges. Each stakeholder's interests, impact, expectations, and attitudes were outlined, along with a communication plan to foster engagement and ensure expectations were met, see Table 5.1.

In summary, the most important aspect of the register was that the project's success hinges largely on the end user's perception of the simulator and Volvo Penta's decision to pursue it. To increase the chances of this, regular feedback sessions with both stakeholders were crucial to align the simulator with user needs and Volvo Penta's expectations. Considering the potential future development of this project, it is likely to be CPAC that will continue with the development (CPAC is a subsidiary company of Volvo Penta that develops, among other things, various simulators and digital solutions for them). Therefore, it was essential to ensure that the documentation for this project's simulator was written in a clear and easily understandable manner to facilitate a seamless handover. Since CPAC already developed some accurate wave planes and winds in a simulator, this could be used in this project to save some time and make the simulator as realistic as possible, in exchange for creating parts of a boat simulator that they will benefit from in the future.

An important risk involved is the risk of upsetting Dealers or OEMs if the simulator promotes some over others when buying upgrades or accessories. To address this,

the solution was to avoid promoting any specific dealer or OEM in the simulator and instead refer users to Volvo Penta's website for information on their nearest OEM or dealer.

Table 5.1: Stakeholder register including top-five stakeholders

Stakeholder:	Internal or External?	Which is the stakeholder's interest in the project?	Stakeholder's potential impact on the project:	What does the project expect the stakeholder to provide?	Stakeholder's preceived attitudes and/or risk	Inputs on stakeholder's communication plan
Volvo Penta	Internal	Ensuring their components are accurately represented and positively showcased to increase sales	High, as they will decide if the project will be pursued or be shut down	Technical specifications, assistance in simulator development, and feedback on component functionalities	Positive if the simulator accurately represents Volvo Penta products; negative if there are inaccuracies or technical issues	Weekly development meetings, progress reports, and technical documentation
Chalmers	External	Interested in fostering practical applications of theoretical knowledge, promoting industry collaboration	Moderate, since they provide the time frame for the project and provides external deadlines to meet	Academic guidance throughout the project and access to resources such as laboratories or research databases	Positive if Volvo Penta find the project successful; negative if the project is performed poorly which might affect future project collaborations	Regular progress reports, academic presentations, and meetings with academic advisors to ensure alignment with research objectives
OEMs and Dealers	External	Interested in a tool that assists in selling boats equipped with Volvo Penta components	High impact, as they are the direct sales channels for Volvo Penta products	Insights on customer preferences, feedback on market demands, and potential future collaboration in simulator integration	Positive if the simulator aids sales; negative if there are integration issues or not advertisement for all OEMs or Dealers	Regular feedback sessions to support decision making during the development
End users	External	Posibility to gain knowledge and learn about and test different components of Volvo Penta, to see how easy boating can be and to faciliate their decision to purchase a boat	High impact, as their experience can lead to increased sales for Volvo Penta	User feedback, usability insights, and insight if the project is worth implementing	Positive if the simulator effectively showcases ease of use; negative if the simulator doesn't align with actual user experiences	Regular feedback sessions to support decision making during the development
CPAC	External	The simulator can be used by them in future projects as they want to have an accurate driving simualtor for boats, but don't have the time to develop it themselves at the moment	High impact, since if the simulator will be executed in the future they will be the ones continuing developing it. So the simulator programming language needs to be understandable and easy to modify if needed	Simulator bases in programming language, such as accurate waves and wind	Positive if the project is sucessfull and the code can be used by them in other projects related to boat driving	Feedback sessions during the development of the simulator to support decision making and get assistance if needed

5.1.2 Trend analysis

In the leisure boat industry worldwide, a notable trend is the unexpectedly high demand for joystick control systems in boats. This innovative technology allows the synchronization of engines, enabling the driver to manage both steering and thrust with a single hand. Particularly beneficial in navigating tight marinas and channels, the joystick ensures a seamless and efficient boating experience, as highlighted in a report by Business Research Insights (2024). The increased need for precise manoeuvring of ships and boats has fueled the popularity of joysticks, offering users responsive control during various maritime activities, as observed by Dion Collins (2023). Stacey Hill (2024) also emphasizes that this enhanced control reduces the

risk of accidents.

Another noteworthy trend in the industry is the adoption of Dynamic Positioning Systems (DPS). This technology addresses the demand for convenient anchoring and precise positioning of ships relative to wind and waves, as reported by HTF Market Intelligence (2023). The DPS utilizes GPS monitors to automatically maintain heading and position, employing thrusters and propellers to counteract the forces of wind and waves (Future Market Insights, 2022).

The integration of joysticks and advanced positioning systems enables boats to execute lateral movements, rotate around their own axis, and maintain a stationary position, as shown in Figure 5.1. The simplified boat control provided by the joystick and DPS has not only made boating more accessible but has also introduced a sense of safety among a broader audience. This increased ease of boat operation aligns with the focus of the simulator and should be emphasized within its design.

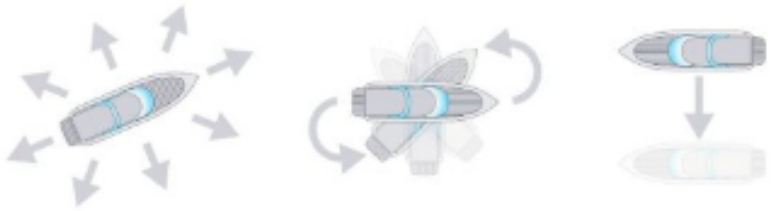


Figure 5.1: Manoeuvers facilitated by the joystick

5.1.3 Competitor analysis

A competitor analysis was conducted by researching the market for companies offering a similar product range as Volvo Penta. Since the simulator serves as an additional accessory within Volvo Penta's product range, the analysis focused on competitors that not only provided engines but also offered boat accessories and additional features such as the joystick. Information was gathered from the main competitors' respective websites, product pages, and product sheets, and the findings are presented in Table 5.2 below.

Table 5.2: Comparison of accessory offerings between Volvo Penta and their main competitors.

Company / **Functions**	Volvo Penta	Mercury	Yamaha	Xenta	Cummins	Yanmar
Joystick control docking	Yes	Yes	Yes	Yes	Yes	Yes
Joystick driving	Yes	No	No	No	No	No
Assisted Docking	Yes	No	No	No	No	No
Glass Cockpit	Yes	Yes	Yes	No	No	No
Interceptor system	Yes	Yes	Yes	No	No	No
Dynamic positioning system	Yes	Yes	Yes	Yes	Yes	Yes
Water sport control	Yes	Yes	No	No	No	No
Easy connect	Yes	Yes	No	No	No	No
Inboard motor	Yes	Yes	No	No	Yes	Yes

According to the findings, Mercury emerges as Volvo Penta's primary competitor, offering similar accessories with one notable exception. The Mercury joystick control is designed for use at lower speeds, specifically during docking, and is not intended for driving the boat at high speeds (Mercury Marine, 2024). It does, however, serve as a tool for angle correction when automatically maintaining a course with their "auto heading mode" option.

Upon closer examination, it was discovered that the remaining accessories differ between Volvo Penta and Mercury. To gain a better understanding of these differences, an in-depth analysis was conducted. The key distinction is the fact that the Volvo Penta joystick is suitable for both driving and docking while Mercury's joystick is limited to low speeds. Another distinction was that Volvo Penta's Assisted Docking feature allows the user to manoeuvre the boat without having to think about currents and wind while docking, while Mercury's DPS can maintain the boat's position while allowing changes in heading, or maintain the heading but let the boats drift in position; however, it is not designed to withstand winds and currents during driving. While other accessories exhibit similarities, there are some nuanced differences, as mentioned in Table 5.3 below.

Table 5.3: Comparison of accessory offerings between Volvo Penta and Mercury Marine.

Company / **Functions**	Volvo Penta	Mercury
Joystick control docking	Movement: 360° control. Functions: Driving, Docking, Autopilot, DPS	Movement: 360° control. Functions: Skyhook, Auto heading mode with way-points, ajdust heading angle
Joystick driving	Engage the gear, speed up, slow down, keep speed	No
Assisted Docking	Removes dynamics of wind and current	No
Glass Cockpit	Engine, driveline and navigation data, warnings and alarms, control lights and music. Cusomizable. Plan routes, inbuilt GPS. Smartphone sync and remote control. Wifi and ethernet outlet and usb outlets. Garmin surround view	Critical engine data, navigation. Wifi, Smartphone sync. Connect audio systems, digital switching, GPS, radar, and sonar. Control: Troll Control, Smart Tow®, AutoPilot, Active Trim, Advanced Sound Control, Cruise Control
Interceptor system	Trim system for increased stability, minimized fuel consumption automatically or manually	Five built-in trim profiles that can be selected based on driver preference. Improve performance, fuel economy and ease of operation, automatic or manual
Dynamic positioning system	Keeps your boat stable, in spite of wind and current.	Maintains position or maintaining direction
Water sport control	Customize the wakes with speed and trim, individual profiles for up to 21 riders, preset engine speed and maintain the rpm in turns	Lock in speed and launch intensities, five preset launch intensities
Easy connect	Real-time data on engine performance, nautical details, fuel reserves, and grey and black water tank status. Customizable. Map view and jouney monitor. Wind view. Service manager.	Critical engine data and routine maintenance schedules, plug-and-play bluetooth.
Inboard motor	Multiple engines, single or dual thrusters	Multiple engines, single or dual thrusters

5.1.4 STP market anlaysis

A Segmentation Target and Positioning (STP) analysis was performed to analyse Volvo Penta's current and potential customer segments, target persons, and positioning. This was also to navigate the market and find opportunities for where and for whom the simulator could be suitable.

Customer segmentation focus: Volvo Penta's customers are primarily OEMs and dealers. However, the simulator's main audience is individual boat enthusiasts, who may also be potential end users of Volvo Penta's products. Consequently, this segmentation incorporates end users alongside OEMs and dealers. Since OEMs, dealers and end users are significantly different segments for Volvo Penta, it was simply chosen to look further into the segment of end users for this analysis and how Volvo Penta can attract smaller segments too. Volvo Penta's restrictive approach to handling user data prompted the necessity for certain estimations about their largest segment. These estimations are based on available research data on general boat owners and not internally provided data about Volvo Pentas customers and end users.

The larger existing user segment is estimated to be:

- Demographic segmentation: Male middle age or plus which is based on "Båtlivsundersökningen 2020" Markus Lagerqvist (2021) research, which concludes that it is mostly men in the middle age owning and driving boats.

- Geographic segmentation: While Volvo Penta enjoys significant prominence in the United States, the project's focus is primarily centred on Swedish data, thereby limiting the geographical segment to Sweden.

- Behavioral segmentation: This segment is characterized by individuals with high socioeconomic status which is based on interviews and questionnaires indicating that boating is an expensive hobby.

- Psychographic segmentation: Users within this segment are generally classified as mid to late adopters, frequently displaying brand loyalty to Volvo Penta due to family traditions. This assumption and estimation are derived from interviews that highlight a family-oriented approach to the boating lifestyle. Respondents expressed sentiments such as it is a family tradition to use Volvo Penta products and thereby the interviewees have continued to do so too.

Segmenting the users by gender and age indicates one large segment of men, middle age and above, and a small segment of women and young users. This together with the intention for the simulator to attract new people without extracting the current segment to learn about Volvo Penta products and driving boats, it was suggested to look into the opposite group of people for inclusion in this project and how to develop the service suitable for this audience too.

Potential newly added user segments:

- Demographic segmentation: Female, young

- Behavioral segmentation: Individuals with any socioeconomic status and interested in boats

- Psychographic segmentation: Early adopters, not aware of Volvo Penta

Target: By examining potential new segments as target groups such as females, younger individuals, and early adopters, it is evident that targeting these groups could expand Volvo Penta's overall user base. Given that the simulator is an online-based service, it is suggested to initially target younger individuals and early adopters. Therefore, it is suggested to look beyond the current user segments Volvo Penta already possesses, even though some current users may fall into the suggested target groups, despite not being extensive according to the research of boat owners and drivers.

Selecting an appropriate target group from the start can effectively trigger word-of-mouth, thereby expanding the reach of the simulator's services and enhancing the marketing of Volvo Penta's products. By broadening the focus to include new demographic groups, it is possible to improve the overall customer and user experience. The objective is not to exclude the current user base in the process of developing the simulator but to enhance the experience for both current and potential users. Including more individuals and offering solutions that appeal to a diverse audience is therefore believed to enhance Volvo Penta's overall customer journey.

In line with Volvo Penta's initiative "Boating for Everyone", which aims to make boating more accessible, simple, and safe for a broader audience, targeting these new segments aligns with the company's mission of future boating. The initiative reflects a commitment to developing user-friendly systems, enhancing safety, promoting sustainability, and improving service and support (Volvo Penta, 2023), thereby ensuring a better boating experience for both new and existing users. By integrating these principles, the simulator can further embody the spirit of "Boating for Everyone" by attracting a diverse range of users and fostering a more inclusive boating community.

Position: To position Volvo Penta in the market, a broader range of competitors was considered compared to the competitor analysis. This included companies specializing in only accessories or even boat rentals to gain a comprehensive perspective. The objective was to assess Volvo Penta's current position and potential future position after implementing the simulator. Therefore the axis chosen was "Additional features - Essential features" to see if the competitors offered more than their main components, and whether they were "Product oriented - Service oriented" to see if the companies provided value in the shape of products or services. The result is presented in Figure 5.2, where it is indicated that not many companies are in the middle and provide both products and accessories, and either they provide strictly products or services and not many in between. By continuing to provide accessories and services like the simulator, Volvo Penta can move towards the middle offering value by providing a more complete boating and service system throughout the journey as the simulator provides both educational aspects of boating and commercial aspects of their products to the user segment.

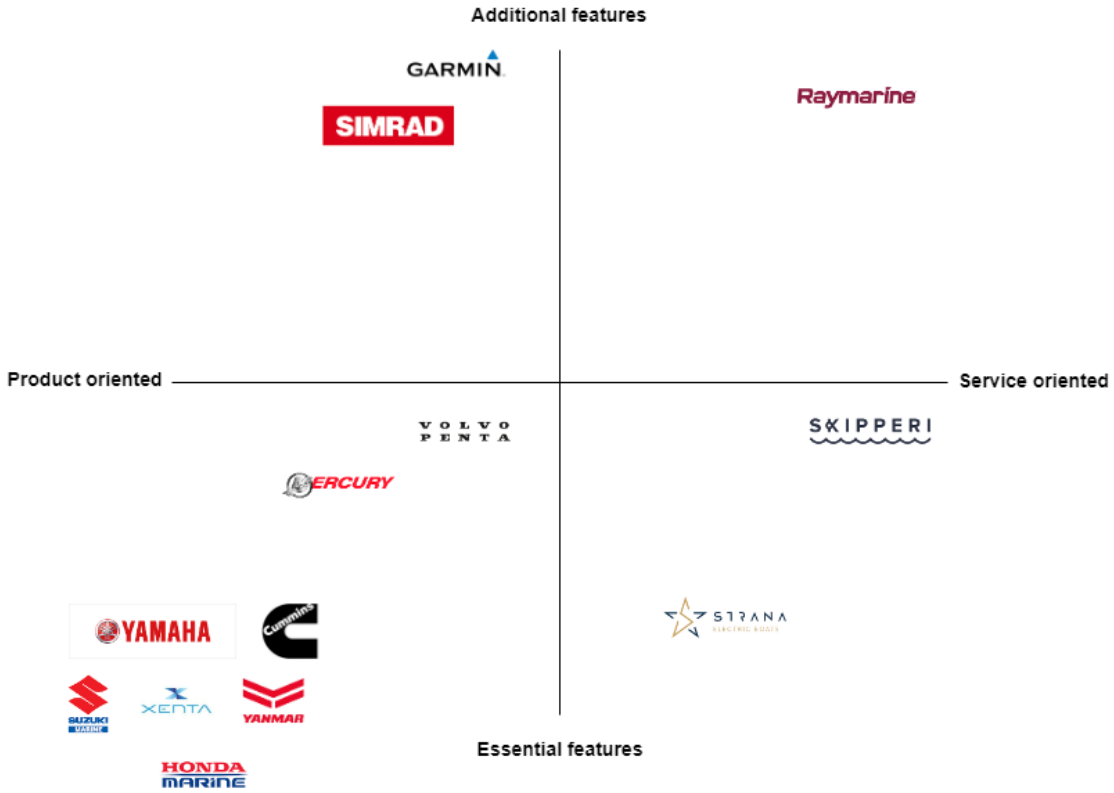


Figure 5.2: Positioning of Volvo Penta relative to competitors with the same customers or end-users

This analysis resulted in an insight that a simulator developed initially to attract younger and early adapters would enlarge the diversity of Volvo Pentas services. The development of the simulator would also create a more engaging and service-oriented customer journey compared to competitors also providing products.

5.2 Macro level analysis

To gain a broader perspective on external influences impacting the project, a macro-level analysis was conducted. This involved a PESTEL examination of political, economic, societal, technological, environmental, and legal factors.

The analysis focused on a boat simulator for commercial and educational purposes for at-home use, primarily considering Sweden's geography but international issues were also discussed due to Volvo Penta operating all over the globe.

Political
In the development of a simulator for commercial purposes, it is important to consider the factors politics may influence. As the simulator intends to be distributed online, regulations and requirements on cybersecurity may impact the company. Investments to maintain the right security are expected to protect user data and also to shield the company from sensitive information leakage in case of data breaches

(dataskydd.org, 2020). Additionally, international laws and agreements on data protection and cybersecurity can affect how Volvo Penta should handle user data and personal information across borders, therefore a need for knowledge of how different countries take stances on these issues is important. For all organizations operating within the EU, compliance with the General Data Protection Regulation (GDPR) is mandatory. According to Statens Offentliga Utredningar (2021), failing to adhere to the required cybersecurity standards can make the company liable for fines. Additionally, it could tarnish the company's reputation. Politically, companies operating in the global market are also more vulnerable if conflicts between countries lead to unstable relations, potentially making them a target (Allianz Trade, 2021), which increases the need for a secure system for companies that offer online login and services.

Economic
The high inflation in Sweden has affected the private economy and purchasing power lately and will continue to do so until 2025 according to a forecast for economic development (Finansdepartementet, 2023). The common man has to pay more in mortgage interest rate, daily food items and other general costs of living during 2023 (Industritorget, 2024). As leisure boating is an expensive hobby it might be one of those things which can be down-prioritized and therefore the whole boat market including the need for a simulator would be less attractive for educational purposes and product exploration. But potentially more attractive as a game or hobby. However exclusive boats are not as sensitive to recession according to Mats Eriksson, CEO of the boating industry's national association, Sweboat (Industritorget, 2024). This trend indicates that there is still a demand for boats in the more premium segments.

Other costs incurred when entering the boatlife community is the cost of a Skipper's exam. The exam including course material and examination in Sweden is approximately 3000 kr (Medborgarskolan, 2024). This is a small amount of money in comparison to the expense of purchasing a boat and is not a necessity for smaller boats.

It has been discussions in the Swedish Parliament about stricter laws for driving boats in Sweden (Redéen, 2022). If the laws change and the license is needed the cost of entering the boat community would arise. That could affect the need for a simulator positively if it can be used for training purposes before the exam, but there is also a risk of people refraining from the boating lifestyle if it becomes too demanding and costly and then the need for a simulator could decrease.

Since Volvo Penta is a component supplier to OEMs manufacturing boats, Volvo Penta's performance is significantly influenced by the success of its OEMs and in the end their customer's economic situation. During economic fluctuations, the actors are impacted differently, and when OEMs are strong, Volvo Penta experiences positive effects. On the opposite, if there is less demand for Volvo Penta's OEMs but still high demand from potential end users, then Volvo Penta might not gain as much as they potentially could. As Volvo Penta is a part of the complete purchased

product and is therefore in a vulnerable spot if they must rely entirely on the OEMs performance. For this aspect, a simulator could potentially alleviate dependence on the OEM's performance and instead spread the risk and potential between both end-customers and OEMs and dealers.

As the technology to develop a simulator is cheap due to the possibility of utilising commercial game engines the world's economy does not affect as much in the development and distribution of the simulator, today the cost of the yearly prescription for "Unity Industry" is approximately 50 000 kr (Unity, 2024).

If components are added to create a more advanced simulator the sensitivity in economic aspects could arise due to the fluctuation in the price of technical components as well as production and distribution cost. The fluctuation in price of technical components has been seen during and after COVID-19, especially for semiconductors which are commonly used in gaming consoles. However, the shortage of semiconductors diminished at the beginning of 2024 and the chipmaking boom in some industries experienced relief (CLN, 2024). This could be a necessity to implement to mimic the real feeling of driving a boat with joysticks etc. but then threats like component shortage and fluctuation in component price increase.

Society and Culture
Social aspects influencing who might be interested in a boat driving simulator were based on who is interested in boat life in general. In boating, there are clear gender differences for who operates the boat. Nearly 91% of men are in charge of operating the boat, either alone or together with someone else in the household, compared to 45% of women according to the answers in Båtlivsundersökningen (Markus Lagerqvist, 2021).

Boatlife is deeply rooted in social connections and community. If boatlife gains popularity, both Volvo Penta and the simulator could seize the opportunity to capitalize on the trend. Like many other leisure and travel markets, the boat market has had shifts in trends due to the COVID-19 pandemic. It began with a decrease in boat purchases due to closed factories (Trygg-Hansa, 2023) then increased interest in boat life due to regulations for travel.

According to a boating lifestyle survey by the Swedish transport agency Transportstyrelsen (Markus Lagerqvist, 2021), most boating households have owned a leisure boat for many years, and nearly half have owned a boat for at least 20 years. Barely one in ten in the survey are entirely new boat owners who have had the boat for a maximum of one year. This together with statistics from the same survey, that people who are interested in buying a new boat within the next five years already own a boat indicates that it is not a trend to join boat life to purchase an own boat if there has not been a boat in the household before or if you are young.

It is also widely known about the environmental impact of Yachts and powerboats in today's society which could decrease the demand for boats. Therefore, there is

also a potential decreased interest in using a Volvo Penta simulator for educational and product exploration purposes.

Another trend which affects consumer behaviour and the company is the latest development within service. The integration of physical products with value-added services gives rise to the concept of Servitization. Connecting products and services can traditionally for example be seen in financial service companies, retailers and other motor manufacturers providing services with their products. However, the current trend relies heavily on connecting products with data, artificial intelligence, cloud computing, and the rise and use of the Internet of Things (IoT) (NTT DATA Group Corporation, 2023). As this trend grows one can assume that this will be the new normal and expectation from the consumers. To maintain relevance in the industry, integrating the simulator into such a concept offers promising opportunities amidst the current trend.

Technology
Considering that yachts and motorboats are luxury products rather than necessities, it is reasonable to assume that the overall technical accessibility for individuals owning or considering the purchase of a boat or yacht with a Volvo Penta engine is high. Therefore technical accessibility poses no threat in the issue but rather gains from the current trend of technology being more accessible. By utilizing the trend and innovative technology Volvo Penta can display their product in new ways and increase curiosity through the simulator everywhere.

Environment
The Swedish Transport Agency measured recreational boat emissions in 2019, which measured 177 000 tonnes of carbon dioxide and 2 100 tonnes of hydrocarbons. Lina Petersson, an environmental officer at the Swedish Transport Agency points out in her interview that with simple means, the individual driver could influence the environmental impact when driving the boat by for example finding the best way of driving the boat consuming less fuel (Transport Styrelsen, 2021). If this is possible to train via a simulator and also replace certain exercises that are otherwise practised at sea and also to become generally better at driving so there will not be any collisions leaving environmental impacts as for example oil leakage at sea, then a simulator can be considered to have a positive effect in practising to reduce the driver's environmental impact.

Via TT (2023), summarises WWF's Climate Barometer which shows that there is public support for protecting more nature in Sweden. Just over seven out of ten (71%) state that it is important to them that Sweden protects 30% of the Swedish nature by the year 2030, the goal that world leaders adopted at the UN COP15 meeting in Montreal in December 2022. A majority (52%) state that they would like half or more of Sweden's land and lakes to be protected. A majority (56%) wishes that half or more of Sweden's sea and coastal areas receive protection. There is also a clear majority (64%) who want the government to invest more resources in Sweden living up to the UN's global goal of stopping and reversing the loss of

biological diversity by 2030. The listed requested actions could be less favourable for a Volvo Penta's simulator for educational and product exploration purposes thus these answers indicate a higher priority on nature and wildlife.

Legal
The legal regulations differ significantly in various countries regarding where the boundary lies for operating a boat with or without a license (Safety & Navigations gruppen, 2023). In Sweden, it is allowed to operate a boat as long as 12m and 4m wide without a specific license or certificate. A certificate is not a requirement for the smaller range of boats which Volvo Penta provides power solutions for in the range of around 20 ft boats, (AB Volvo Penta, 2024c). As Volvo Penta provides engines for much larger boats as well they have customers within the leisure category who both do not need a licence as per today's regulations but also many who need to.

The discussion about stricter laws for driving boats in Sweden differed significantly in the party's position (Redéen, 2022). But the only changes lately have been for operating jetskis, for which a license has been required since 1 May 2022 (Transport Styrelsen, 2023). If it is a transition in the education system and it becomes mandatory to possess a license for handling vessels of all sizes too then the demand for a simulator could be higher for training purposes.

About 3 out of 5 boat owners do not have any qualifications related to boating, according to Markus Lagerqvist (2021). If the legal requirements change and it becomes mandatory to have a license there could be a rising trend to use simulators to prepare for the exam, as the digital trends also rise and the trend for taking the course online remains nearly as preferred as taking the course in-person according to the same analysis. But even without a license, the operator is expected to follow the Swedish Maritime Act (Transportstyrelsen, 2023). The expectations of following the law regardless of possession of a license could affect the demand for a home simulator positively even as the regulations are today. On the other hand, since there are already established methods and procedures for assessing boat handling skills to pass the exam there is a risk that a simulator can be considered an unnecessary addition and consequently less appealing. But with easy access, it could instead be used as a complement to prepare for the exam.

Driving a boat with an ability of more than 25 knots also requires a specific certificate, a High-Speed Craft Handling Certificate. There is also an international certificate for operating leisure boats, the International Certificate for Operators of Pleasure Craft, (ICC) (Svensk Båtutbildning AB, 2024). Because of all the different regulations in different countries and categories of boat sizes and power, the need for a simulator might change if political regulations regarding the different categories change. As the laws differ in the different categories the demand for a simulator might increase if the user wants to advance into a more demanding boat or visit countries with different regulations and therefore use the simulator for educational purposes.

6
Concept Development

This project's concept development phase primarily consisted of transforming customer needs from the primary data collection into measurable wishes and demands, building conceptual solutions and evaluating them.

6.1 Customer needs to criteria

In the process of "Defining" the problem and developing a simulator that is useful for the customers and users, all relevant data from the questionnaire and the interviews were taken into consideration during this phase. This methodological approach resulted in a customer needs list of essential criteria required to enhance the desirability and functionality of the simulator for its users.

When creating a customer needs list, all inputs from the primary data collection were grouped by similarity and then translated into customer needs, where similar inputs could become one need. To refine the needs into more quantifiable and practical statements, a criterion for every need was established where one need could lead to multiple criteria. See an example of multiple inputs becoming criteria regarding the difficulty to dock for the simulator in Figure 6.1. This methodology was used for all gathered data resulting in 51 criteria. The criteria were then sorted into four different categories: Boat Practice and Testing, Customization and Options, User Experience and Engagement, and Sales and Marketing. For the full list of all needs becoming criteria see Appendix F.

Source I - Interview Q - Questionnaire	Input	Need	Criterion	Solution
Q	"Docking is a difficult situation when boating"			
I	"Y-bars are difficult to dock in"			
I	"Avoids new harbors because of insecurities when docking"	Become more comforable with situations in different harbours	Test drive different scenarios	
I	"One of the most critical moments are docking, practice is key"		Test drive in different environments	
Q	"People think docking is difficult when boating"			
I	"One of the most critical moments are leaving the dock, practice is key"			

Figure 6.1: Example of some inputs from interviews and questionnaires interpreted into user needs and criteria.

6.2 Creating personas

During the interviews and the questionnaire, different needs based on experience levels and expectations for the simulator were identified. Therefore, three distinct personas were established to reflect the diverse needs of users and customers. Within the creation of personas, elements of the target group and the current main segment identified during the STP analysis were taken into consideration. The first persona represents an inexperienced boat driver, the second an experienced boat owner, and the third one a boat buyer. For a full description of each persona, see Figure 6.2.

Since there were three different types of personas with different desires for the simulator, it was important to determine the relative importance of each criterion for each persona. Therefore, each criterion was weighted according to the specific preferences of the personas. This was based on how frequently the need was expressed by a type of user during the primary data collection as well as the depth of detail, high desirability, and emotions expressed. The weightings ranged from low to high on a scale of five, reflecting the importance of each criterion to the simulator's functionality, with five indicating high importance of existence in the simulator. See all sorted criteria weighted for each persona in Appendix G.

	Persona 1 The unexperienced boat driver	Persona 2 The experienced boat owner	Persona 3 The boat buyer
Demographics	Maria: A 38 year old woman, living in Stockholm. She is a middle class citizen.	Karl: A 61 year old male, living on the west coast outside Gothenburg. He is a CTO for a upcoming tech company.	Eva: 46 year old woman who lives in the Stockholm archipelago. Working as an CEO at a well known company.
Behaviour & Habits	During sparetime she loves being out in the nature looking out at the Swedish archipelago. She likes watching people on boats, imagining taking part of the boating lifestyle on day. She is currently saving up for her dream.	During the summers, he spends a lot of time on his middle sized motor boat with his wife and two teenagers. They are a very active family and loves to invite friends to join them on the ocean.	She is a very busy business woman who loves to gather collegues for after work activites. She recently got divorced and sold the family boat to her ex-husband. Now she want to find the perfect boat for her new life to bring her friends on.
Pain Points & Frustration	She would love to one day own her own boat, but fears to take the step because of her lack of experience. She would not want to damage the very expensive product she has spent so long saving for.	He is uncomforable letting anyone drive the boat after they upgraded to a bigger one, because he himself feels a bit insecure driving it in certain situtions. This limits his ability to relax and enjoy the company while at sea.	She struggles to find a boat that suits all her needs and refuse to settle for less. She does not have the time to test drive every different boat or accessory. She find the accessory descriptions hard to understand and are boring to read about.
Needs & Goals	She needs to learn how to drive boats and practice rules, laws, navigating, maintenance, and other general boat related things before getting one. She would love to meet up with people with the same experience level and interests to share the jouney with.	He wants to feel comfortable and sophisticated when driving his boat, even in difficult situations. He also wishes for his family to be able to take out the boat when he is busy working. For that, he wants them to practice without fears of damaging the boat.	She wants to configurate her own boat to suit her needs, and find a fun, not time consuming way to test different boat and accessories.

Figure 6.2: Three different personas reflecting the users' and customers' inputs and needs.

6.3 Idea Generation

Parallel to the ongoing interviews and research phase, ideas for future concepts were being gathered. To avoid prematurely jumping to solutions while researching the problem during the "Emphasize" phase, yet also ensuring that no emerging ideas were lost, an idea bank was created and continuously updated throughout the project, see Appendix H. This idea bank contained notes and suggestions from interviews and questionnaire respondents, internal solutions, and numerous ideas shared by Volvo Penta employees during a feedback session at a company fair aimed at enhancing the customer journey for Volvo Penta's customers.

In the phase of starting to conceptualize solutions, called the "Ideation" phase, an internal brainstorming session was held before revisiting the built-up idea bank. This was to enlarge the perspective and bring as many rough concepts to the table as possible before diving into already-gathered ideas. The idea bank and new brainstormed concepts were then integrated and refined, with parts of ideas being extracted to fit the project scope. This was an important step as many of the gathered ideas from external sources were interesting but extended beyond the initial scope and the current maturity of the simulator, and were therefore screened out. These ideas are still considered during the Business Model Canvas in section 7.3,

but no further development on these ideas was pursued.

6.4 Generating rough concepts

From the generated ideas, initial rough concepts were developed that fit the project scope and addressed the needs of each persona. These concepts encompass essential features and functionalities desired in the simulator for each user type. For a detailed description of each concept, see Figure 6.3.

	The unexperienced boat driver Concept:	The experienced boat owner Concept:	The boat buyer Concept:
Characteristics	The simulator should enable practice features where the user can learn boat basics, and how to drive a boat in different situations and various weather conditions. It should include different difficulty levels so the user can enhance their skills until they become a comfortable boat driver.	The simulator should enable configuration of a boat similar to their own, so they can practice and learn how to drive it in different situations and adjust to various weather conditions. It should also include testing of accessories in certain situations, to find upgrades for the boat which simplifies the driving.	The simulator should enable configuration and testing of different boats, components, and accessories, to get a feeling for the products so the user can find a suitable boat for their needs. It should include information about the products and where they can be bought.

Figure 6.3: Rough concept ideas devised for the three personas

6.5 Evaluating rough concepts

These concepts underwent evaluation against each criterion, with a rating scale from 1-5 indicating how well they fulfilled each criterion. The weighting factor for each persona was then multiplied by the evaluated value and summarized for each persona, providing insight into how well the tailored concept for each persona met the diverse needs of all three types of users. Concept Two emerged as the most promising, as it demonstrated nearly equal fulfilment across all personas and was therefore, the most suitable concept to further develop. For a demonstration of the methodology used with an example of the criterion “Be able to practice boating” see Figure 6.4. For the full evaluation and scoring table see Appendix G.

Version 1.0	Weight factor Importance of existence for each persona 1 = Low 5 = High			Estimated Criteria Fullfillment 1 = Low 5 = High	Weight factor Importance of existence for each persona x Estimated criteria fullfillment		
Sorted Criteria	**The un-Experienced boat driver**	**The Experienced boat owner**	**The Boat buyer**	**Concept 2:**	**SUM C2 Persona 1**	**SUM C2 Persona 2**	**SUM C2 Persona 3**
Boat Practice and Testing							
Be able to practice boating	5	4	3	4	20	16	12

Figure 6.4: A part of the concept evaluation matrix demonstrating weighting of the different criteria per persona, along with estimated criteria fulfilment of Concept Two

6.6 Generating detailed concepts

The promising concept was then broken down into more detailed, brainstormed solutions to address and ease the areas identified as challenging during the primary data collection. These solutions were designed as separate functions, enabling diverse operations within the simulator. At this stage, the four previously explained categories of criteria (Boat Practice and Testing, Customization and Options, User Experience and Engagement, and Sales and Marketing) were merged and expressed as two distinct areas of solutions: “Practice” and “Configuration and Marketing”. Given the significantly contrasting use scenarios for the two areas, each area was addressed separately. The brainstormed functions and tailored solutions for each area are explained below.

Practice concept: To get a complete concept for the practice option, a Morphological matrix was used. This matrix utilized solutions for practice-related functions, resulting in the generation of 252 concepts. To streamline and reduce the generated concepts to a more manageable amount, the focus was directed toward concepts including practising docking, as it constituted the most crucial aspect of boating according to the earlier research phase.

This constraint narrowed the selection down to seven concepts, see Figure 6.5. To ensure the selection of the most promising concept among these, a Pugh matrix was utilized. This matrix facilitated the evaluation of concepts against various criteria such as user-friendliness and learnability. This was an iterative process where one of the concepts served as the reference to which all other concepts were evaluated against. If a concept performed better in a criterion, it received a “+”, if it performed similarly, a “0”, and if it performed worse, a “-”. After each iteration, the

reference concept was switched out to the best-performed concept. For a full evaluation of the Pugh matrix, see Appendix I.

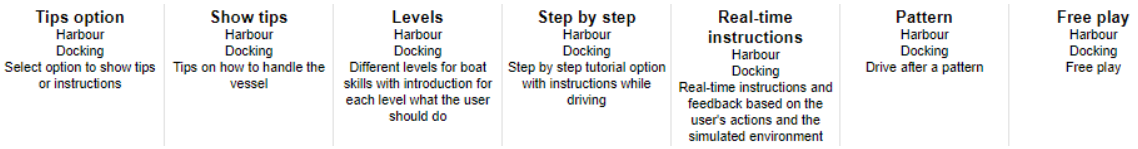


Figure 6.5: The seven remaining concepts to evaluate

After three iterations it became evident that the concept *Levels* was the most beneficial for practising boating, although it exhibited deficiencies in certain criteria, notably in providing support. Therefore it was combined with other concepts such as *Tips option* to address its limitations and evolve into a more comprehensive and refined concept.

Description of the practice concept: The practice mode is structured around various levels, each with different difficulties and missions, see Figure 6.6. Users receive a brief introduction on how to complete each level, and in-game options are available for additional tips or instructions to enhance the learning experience. These aids could include driving patterns, video tutorials, and more. The strengths of this concept include a high level of engagement, enjoyment, and the ability to track user progress. However, potential weaknesses include a lack of "free play" options, which could impact user enjoyment, and adaptability to individual user preferences.

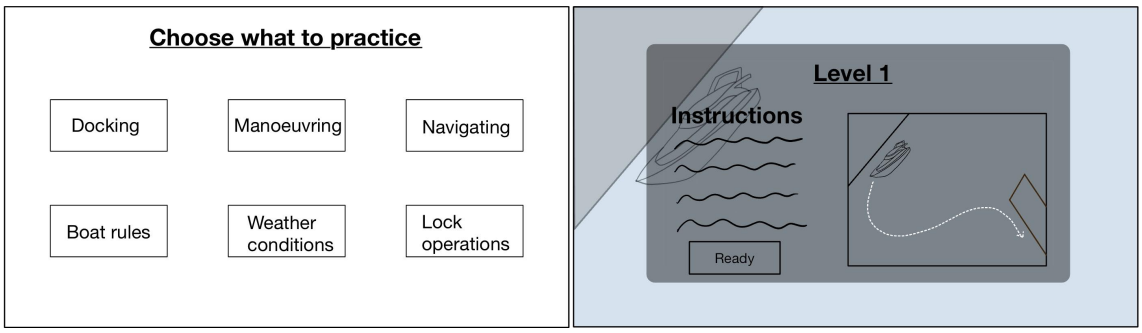


Figure 6.6: The basis of the rough practicing concept

Configuration and Marketing concept: Given the desire to test accessories and new features, as well as configure a boat according to individual preferences, the simulator allows users to select the boat's shape and size and choose components such as the engine, propulsion, and steering system, see Figure 6.7. This customization enables users to configure a boat similar to their own. Additionally, the concept also includes a feature for users to find out more about where the products can be purchased or obtain technical specifics.

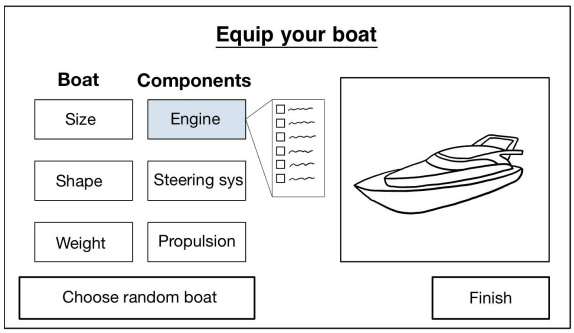


Figure 6.7: A rough concept for configuring a boat

The concept also enables users to test and learn about different accessories and new features to evaluate their value and functionality. Recognizing that docking is the most significant challenge in boating and as an early-stage concept with development limitations, it was reasonable to prioritize accessories and steering options that facilitate docking. Notable features provided by Volvo Penta to aid in docking include Assisted Docking and the Dynamic Positioning System, which are controlled via the joystick.

Acknowledging that some simulator users may visit the platform strictly to configure and test accessories without engaging in game levels, a decision was made to include a free-play mode. This mode allows users to freely drive and test the boat's functions. This mode allows users to adjust various weather conditions, including wind, waves, and current strength, as well as their respective directions, as these were identified by users as factors contributing to the difficulty of docking. This also provides the possibility to explain how the joystick and assisted docking features can ease these challenges.

6.7 Final concept

Considering the diverse needs of the personas, which included both practising and purchasing elements, the final concept incorporated both the *Practice Concept* and the *Configuration and Marketing Concept*. This approach allows users to both configure a completely new boat with accessories and components for purchase and use the simulator for educational purposes, depending on the users' desires. For the inexperienced persona, there was a need for boat basics and practising in all situations which might not be completely fulfilled but is entirely feasible in further development if providing an educational platform about boats is of Volvo Penta's interest.

What was left to decide were enablers necessary for this concept to function effectively, such as how to manipulate the boat and what devices should be included in the simulator. The decision was based on whether the simulator should be as realistic as possible by incorporating Virtual Reality (VR) and physical steering components. Including these would make the home simulator more realistic but less accessible since these components are not commonly found in households, thereby

limiting its availability to all potential customers. Time limitations, competence regarding VR, and distribution aspects of these objects also played a role in this decision. The decision was therefore to rely on standard computer devices and components typically owned by the average person, such as mouse and keyboard, thus excluding VR solutions and physical steering components. With this decision, it was well understood that realism would decrease but it would enable a higher level of product maturity with other options, allowing the simulator to be easily distributed to potential users and customers of Volvo Penta.

To achieve a realistic experience without physical components, the joystick or steering wheel and throttle should still be used to manipulate the boat as in real life. Therefore, as suggested by interviews, images of these components are displayed on the screen for the user to manipulate. This method allows for the correct use of the components without providing physical devices. Although it is not as realistic as possible, this approach is recommended for an early-stage product to include as many users as possible.

6.8 Evaluating the final concept

To assess how well the final concept would meet users' expectations, a reevaluation of each criterion was conducted from the users' perspectives, particularly focusing on the experienced boat owner persona. This evaluation measured how well each desire was fulfilled in terms of quality. The quality was divided into two levels: acceptance and target. The acceptance level represents the bare minimum for the simulator to be considered useful, while the target level represents the ideal quality desired by the persona. Both levels were rated from poor to outstanding for non-measurable criteria and assigned numerical values for measurable criteria.

For instance, the experienced boat owner persona was assigned a weighting factor of four during the evaluation of importance in existence of "Be able to practice boating". In terms of quality, the acceptance level for this persona was expected to be *Good*, while the target level was desired to be *Excellent*. This means that while users wish for the quality of practice boating to be excellent, they would accept it if it is only good. See Figure 6.8 for an example of the criterion "Be able to practice boating". For a full list of acceptance and target levels for each criterion, refer to Appendix G.

Version 1.0	Weight factor Importance of existence for each persona 1 = Low 5 = High			Estimated Criteria Fullfillment 1 = Low 5 = High	Weight factor Importance of existence for each persona x Estimated criteria fullfillment			Quality 1 = Poor 2 = Fair 3 = Good 4 = Excellent 5 = Outstanding		
								Demand	Wish	User Test
Sorted Criteria	**The un-Experienced boat driver**	**The Experienced boat owner**	**The Boat buyer**	**Concept 2:**	**SUM C2 Persona 1**	**SUM C2 Persona 2**	**SUM C2 Persona 3**	**Acceptance Level**	**Target Level**	**Actual Level**
Boat Practice and Testing										
Be able to practice boating	5	4	3	4	20	16	12	Good	Excellent	

Figure 6.8: A part of the concept evaluation matrix demonstrating weighting of the different criteria per persona, along with estimated criteria fulfilment of Concept Two plus Acceptance level and Target level

To evaluate the actual level of how well the final prototype met the criterion in terms of quality, user tests were established during the prototyping development phase. That way it was possible to measure to which level of quality it holds in comparison to the user and customers' preferences. The user tests are explained further in Section 8 as well as the results.

7
Prototypes

The prototypes were initially made in Figma as a 2D model to capture visualisation of the concept, then advancing the prototype in Unity where a 3D environment enhances the prototype. To ensure all criteria are implemented into Unity as technical features, a list of building blocks with actions to include in Unity was created, see Appendix J. Multiple iterations were made during the development process, although only the final solutions are presented in this chapter. The prototypes were based on User Interface (UI) theory by Sharp et al. (2019) and W. Jordan (1998).

7.1 Figma prototype

In order to conceptualize the simulator's design and functionality effectively, a prototype was crafted using Figma, following the structure illustrated in the flowchart in Figure 7.1. The simulator consists of various frames, each offering different choices and interactions. These frames are explained in detail in the sections below.

In all frames, users encounter buttons enabling them to navigate backwards or forward between the frames allowing the user to change boat, mode, or level. To ensure a consistent brand representation of Volvo Penta, images, buttons, and other UI elements were made similar to the aesthetics showcased in Volvo's promotional materials and videos. These buttons are interactive, triggering specific actions upon being pressed. To enhance user intuitiveness, the buttons are colour-graded, dynamically shifting to a lighter shade when hovered over, signalling their pressable nature. When it is pressed, the colour changes again to indicate it has been pressed. This approach aligns with the principles of interactive design, as advocated by W. Jordan (1998).

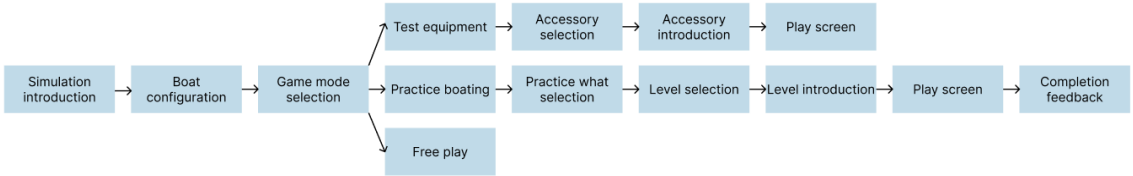


Figure 7.1: Flow chart over the simulator events

7.1.1 Simulator introduction frame

The simulator initiates with a welcoming frame, offering a brief introduction to its functionality. Users are provided with the option to either proceed further into the simulation or exit. An illustration of the welcoming frame can be seen in the top left section of Figure 7.2.

7.1.2 Boat configuration frame

Moving forward, users encounter the boat configuration frame. Here, it is empowered to tailor the vessel to match the user's preferences or simulate a desired model. Customization options include altering the boat's size, shape of the hull, engine specifications, steering mechanism, and propulsion system.

Due to the lack of 3D models and limitations in Figma, certain configurations, like real-time updates to the 3D model could not be implemented fully. However, the intended workflow was for the *Size* option to provide a range of boat sizes, ideally enabling users to input their desired length, prompting the 3D model to adjust accordingly. Similarly, the *Shape* option should allow users to modify the hull, ranging from flat to narrow. When selecting components, the *Engine* category presents appropriate Volvo Penta engines tailored to the chosen boat size, along with optional features like a bow thruster and propeller in the *Propulsion* option. Lastly, the *Steering tool* could be either equipped with a joystick or a steering wheel, offering users flexibility in their preference.

Additionally to the choices, a 3D model of the configured boat is displayed, with the intention to update dynamically with each selection to provide a visual representation of the chosen specifications, accompanied by detailed specifications such as horsepower, see top right section in Figure 7.2.

7.1.3 Game mode selection frame

Once the boat configuration is finalized, users proceed to the game mode selection frame where two primary options are presented: *Train my boat skills* or *Test equipment*. Alternatively, users can revert to the boat configuration stage for further modifications, see the bottom left section in Figure 7.2.

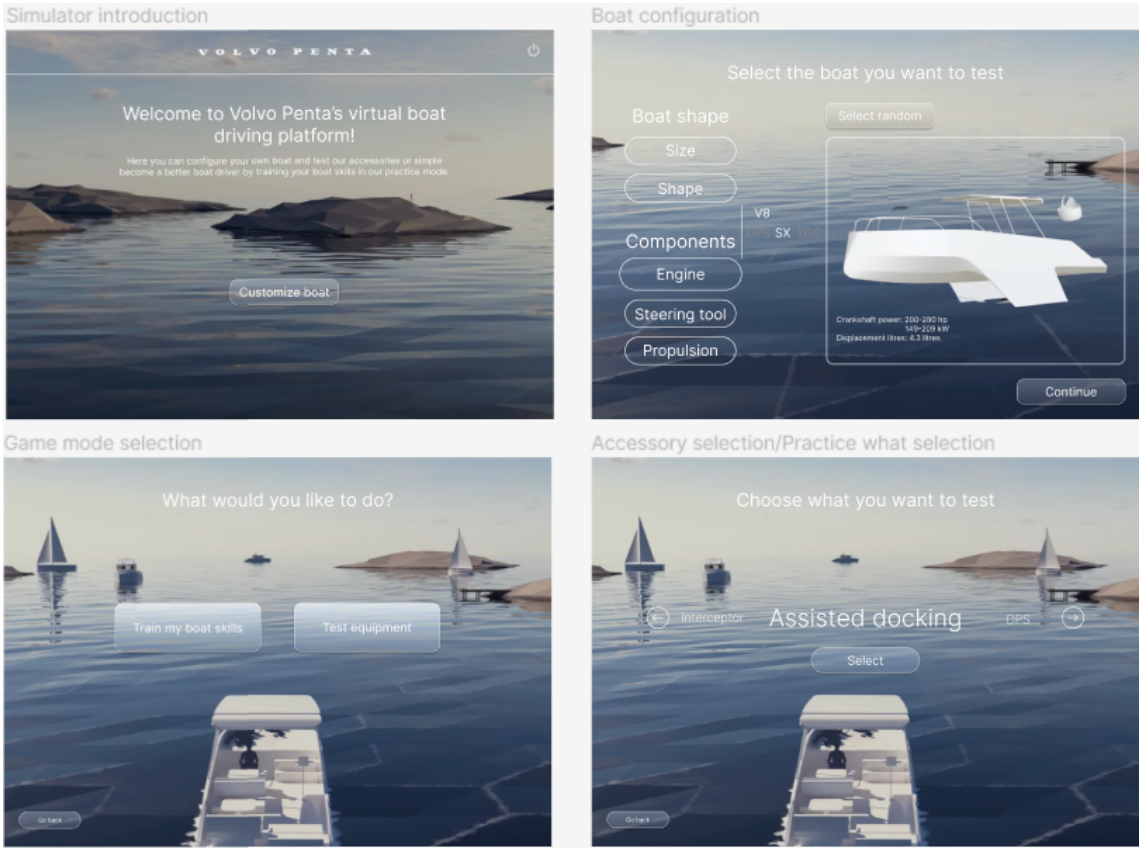


Figure 7.2: Figma prototype of the introduction, boat configuration, game mode selection, and accessory/practice what selection

7.1.4 Test equipment frames

Following the established flowchart, for testing equipment, there are three frames. Initially, users select the specific accessory wished to test. Following this selection, users are provided with an introduction to the chosen equipment, accompanied by an illustrative video demonstrating its functionality to ensure a clear understanding of the accessory before testing it. In the final frame, users are presented with an environment resembling a simulated test scenario. Although Figma does not support driving functionalities, this frame includes visual representations of the selected steering tool and adjustable sliders for modifying environmental factors such as wind, waves, and currents, to get an idea of how it should work in Unity, see the top right section and bottom left section in Figure 7.3.

In the final frame, users encounter buttons for various functions, including accessing information about the accessory, resetting the environment to the initial boat position, receiving tips on accessory usage, and returning to the accessory selection screen or exiting the simulation. These buttons are made with visually appealing icons rather than text, a design choice that, while potentially less intuitive, is mitigated by the utilization of standardized icons and accompanying text prompts upon hover, ensuring user comprehension (W. Jordan, 1998). Additionally, the interface includes a map providing an overview of the boat's location and a speedometer in-

dicating its velocity.

To assist users in utilizing the selected accessory, descriptive text is situated at the top centre of the screen, dynamically adapting based on user interactions, and offering guidance throughout the simulation.

7.1.5 Practice boating frames

These frames offer a similar interface to the *Test equipment* frames but with other instructions and options suited to the practice options. However, this option encompasses two additional frames. Following the selection of what to practice, users are presented with a level selection frame showcasing their progress of completed levels and available challenges. Here any level can be selected depending on the user's preferences. Upon completion of a level, the last frame shows up where users receive feedback regarding their performance. If the user, for example, hits an object on the way to dock the boat, the user should only get one out of three stars, see top left section and bottom right section of Figure 7.3. These frames are to motivate further engagement with the simulator and foster a sense of accomplishment.

This approach aims to provide users with an intuitive structure and engaging experience, facilitating effective learning and skill development within the simulated environment.

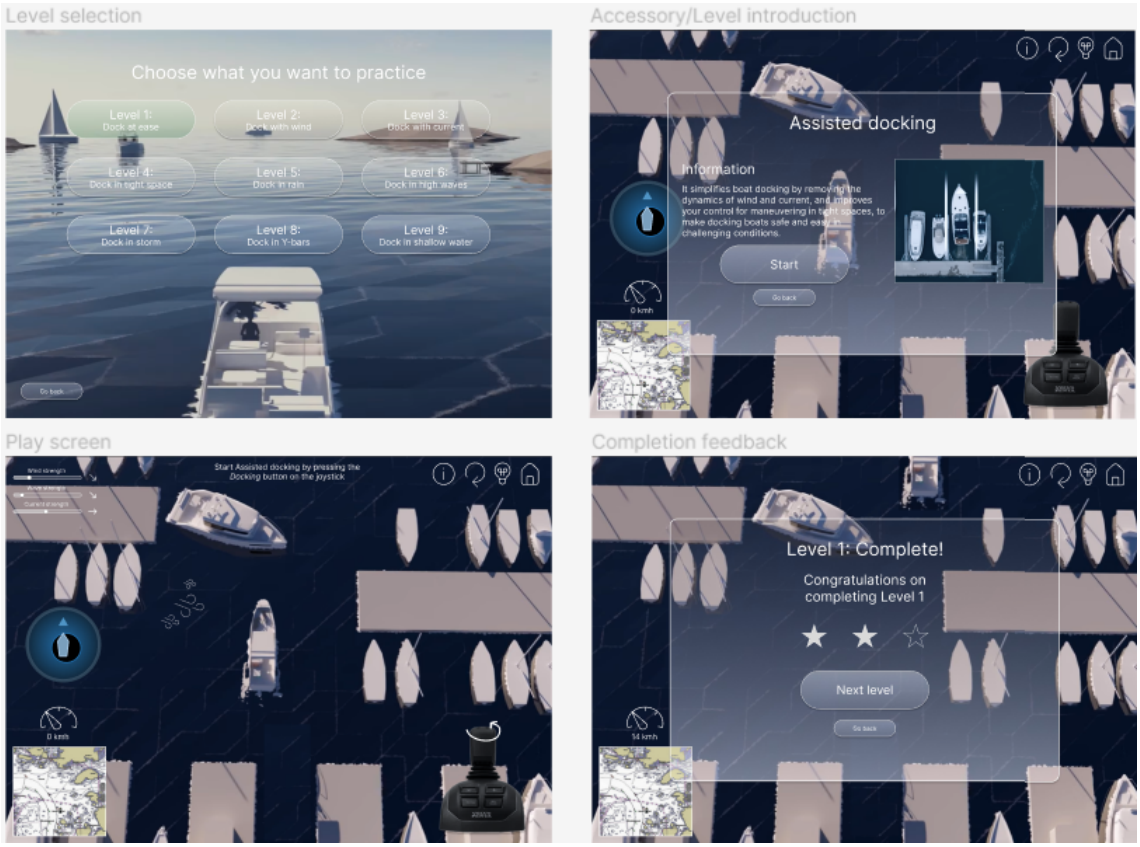


Figure 7.3: Figma prototype of the level selection, accessory/level introduction, play screen, and completion fedback

7.2 Unity prototype

The project's final prototype was developed in Unity. This iteration builds upon the groundwork laid by the Figma prototype and its flowchart, see Fig 7.1. However, Unity introduces significant advancements by transitioning into a 3D environment, thereby enabling users to interact with the simulation similar to a gaming experience. During the development, supporting resources such as video tutorials on YouTube, freely available prefab assets for boats and environmental elements, as well as ChatGPT and programming articles were utilized. To facilitate future development efforts, each code segment is accompanied by explanatory text detailing its functionality.

7.2.1 Architecture and Unity basics

The simulator's architecture is structured around three distinct Unity scenes, complemented by various UI canvases. This segmentation facilitates the efficient management of diverse interfaces and scalability enhancements. By loading one scene at a time, computational resources are also conserved. The basis of these scenes are the introduction frame, the boat selection frame, and an open 3D world with terrain and objects such as islands, harbours, boats, etc. for the play mode where canvases

are used for the UI objects.

Unity's UI canvases are vital in crafting the user interfaces, ensuring that elements like headlines and buttons remain consistently visible. These canvases function similarly to placing UI elements directly onto the camera lens, enabling seamless transitions between different interfaces while maintaining a live background. This is utilized when generating distinct canvases corresponding to various frames based on user interactions and choices. These canvases can be deactivated when not needed and activated as required.

Designing buttons in Unity involves importing images with transparent backgrounds, and converting them into Sprite (2D and UI) textures, thereby rendering them interactive within the Unity environment.

The core principle of interaction design in Unity revolves around creating game objects and associating them with C# scripts to dictate their behaviour. For instance, pressing a button triggers the attached script to execute predefined actions, such as transitioning to another canvas or moving an object.

Each Unity game object contains a Transform to define its positioning, scale and rotation. Box Collider, Sphere Collider, and Mesh Collider all share the fundamental purpose of defining collision areas between objects including the mouse pointer. Together the Transform and Colliders enable interaction such as moving, scaling or rotating an object during the game. The choice of collider depends on the intended use and the geometry of the selected object. A Mesh Collider utilizes the exact mesh of the geometry, making it suitable for complex shapes like the boat, while for example, a Sphere Collider is suitable for interactions enabling tilting movements of a joystick executed by the mouse pointer interactions. This approach of handling game objects, canvases and scenes serves as the foundation for the entire design of the simulator.

7.2.1.1 Scene 1 - Introduction interface

The initial scene serves as the introduction frame to the simulator, comprising a Canvas housing explanatory texts and a button called *Customize boat*, see Figure 7.4. This action deactivates the current scene and transitions to the subsequent one. Alternatively, users have the option to exit the application by selecting the "Off" icon.

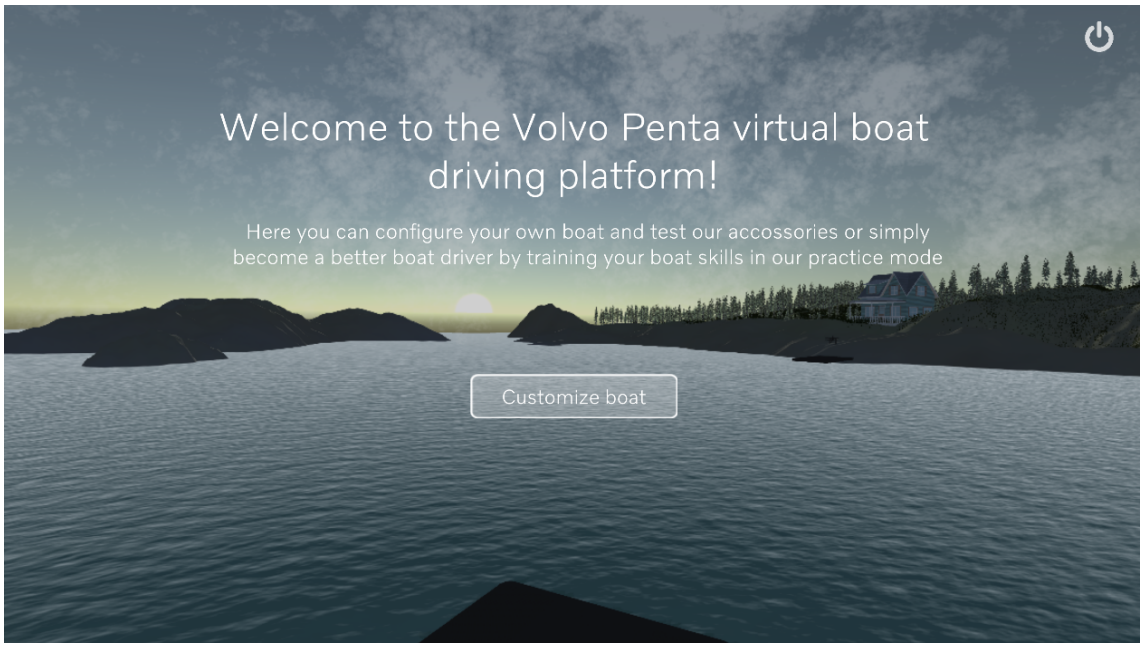


Figure 7.4: Introduction scene in Unity

7.2.1.2 Scene 2 - Boat configuration

The subsequent scene allows users to configure their boats via a single canvas containing multiple deactivated buttons for each configurable option. Mirroring the Figma prototype's interface, when hovering over an option such as "Size", three buttons for each size become visible, enabling users to alter the boat's characteristics. These options remain initially concealed but become accessible when the user hovers the mouse pointer over the corresponding button, triggering a script to show the button's options. Unity's Event trigger system, integrated with each button, detects when the mouse pointer enters the button's boundary, prompting the execution of a predefined script to manage the ensuing action.

However, deviations from the original plans were necessitated by the absence of certain 3D models, resulting in incomplete configurations. As a workaround, temporary objects and solutions were utilized to showcase functionality, some of these objects were then replaced iteratively to the intended objects. Currently, users have access to options such as size, engine, propeller, and steering tools, but the implementation of hull shape remains to be implemented.

The temporary solutions to address these limitations were, for instance, the size option enables scaling of the boat model to simulate various lengths. Similarly, the engine option currently features a D6 engine, adjustable in size to represent different engines. Additionally, the propeller system rotates 180° depending on the selection between IPS and regular systems, see Figure 7.5. Although these temporary measures enable the demonstration of scene functionality, further development is required once the appropriate 3D models become available.

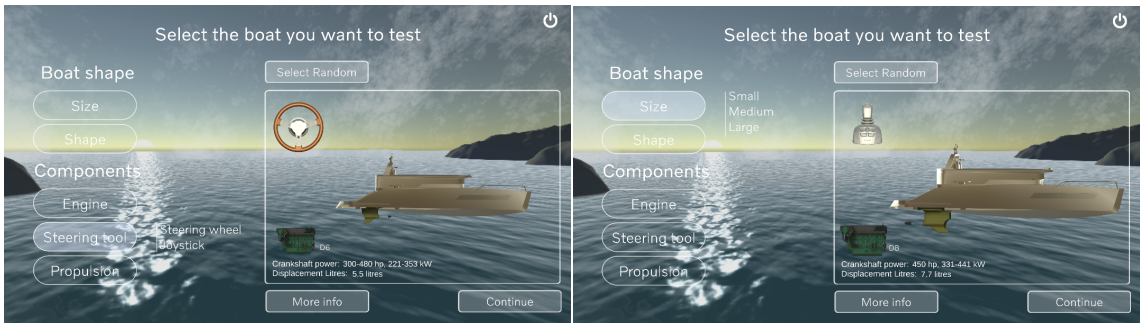


Figure 7.5: Two different boat configurations in the Unity simulator

To provide users with technical information about the engines, the crankshaft power and displacement in litres for the selected option are displayed. This feature can be expanded to include additional details if desired by Volvo Penta. Additionally, a button labelled *More Info* directs users to Volvo Penta's propulsion system website, where they can find comprehensive information about the products and where to purchase them.

If the user does not know what boat to choose or simply wants to test any possibility, users have the option to select a random boat by pressing the "Select random" button. Upon completing the boat configuration, users can proceed to the next scene by selecting the "Continue" button.

Additionally, the boat continuously rotates slowly to allow users to view it from all angles. During boat size selection, the rotation speed briefly increases to create a smooth transition.

For enhanced user-friendliness, once a boat is selected and the user proceeds with the simulation, they can return to modify the boat configuration without losing the previous settings. This eliminates the need to start the configuration process from scratch.

7.2.1.3 Scene 3 - Practice, Test equipment, and Free play options

This scene contains multiple UI canvases, each controlled by a single script to ensure only one is visible at a time. This script enables activation and deactivation for all buttons, allowing users to toggle between canvases upon button pressed.

The first activated canvas features four buttons, one for practising boating, one for testing equipment, one for driving freely, and one *Go back* option in case the user wants to make changes to the selected boat.

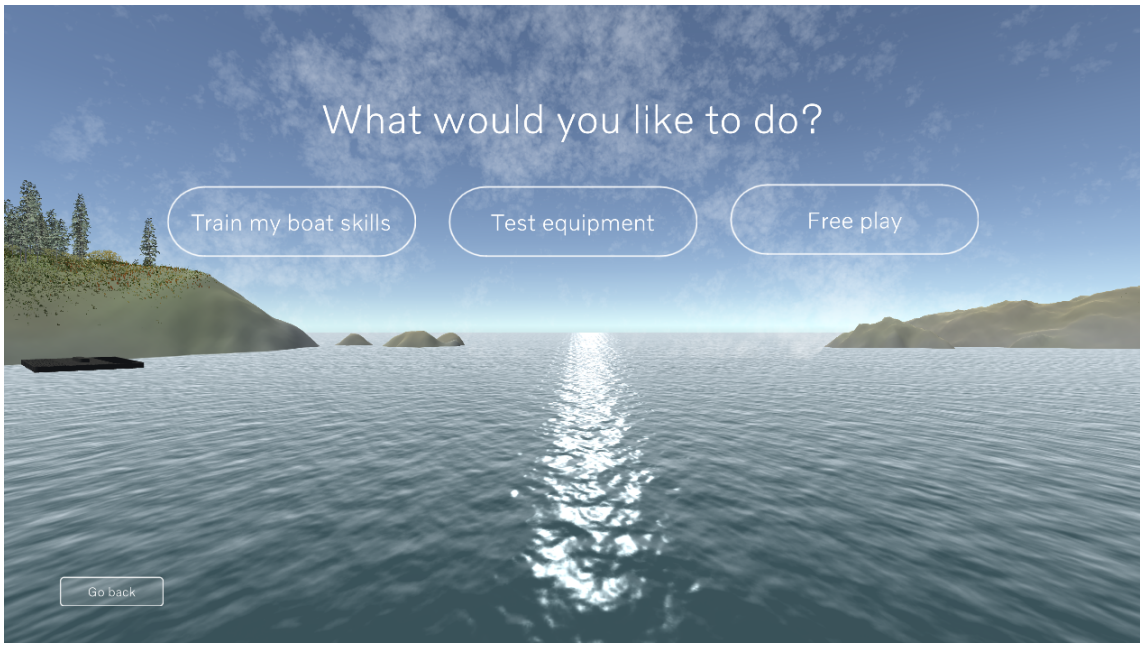


Figure 7.6: The canvas with the three types of game options in Unity

Test Equipment
Upon pressing the *Test equipment* button, the current canvas is hidden, revealing a canvas containing options for testing, such as Assisted Docking. Users navigate between options using arrows to the left and right, with three options visible simultaneously. The options have different scales and transparency levels to emphasise the middle option, ensuring clarity for the user regarding the selected option, see Figure 7.7. To achieve this effect in Unity, specific characteristics are assigned to the positions of the texts, with varying scale and transparency levels ensuring visibility, certain positions have 100% transparency, rendering them invisible until they are in either the middle position or the adjacent positions. The script associated with these buttons saves the positions of the various options and monitors which one is set to be selected. In this prototype, only Assisted Docking is currently functional, as the primary focus is on docking. However, the code for other options is complete, awaiting the creation of new canvases and integration with the script.

Upon selecting this option, a canvas providing an explanation of Assisted Docking's purpose along with a demonstrating video is displayed, see Figure 7.8. Once the user is ready, a *Start* button can be pressed to access a canvas containing the joystick and wind and wave configurations. Now the user can use the joystick and its buttons to manipulate the boat and adjust the wind and waves with sliders on the screen. This is further explained in the sections below. This frame also includes an introduction text as well as the same UI buttons as in the Figma prototype, providing tips on how the user can test the accessory, see Figure 7.9.

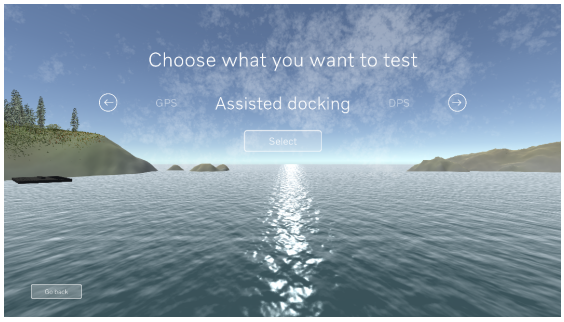


Figure 7.7: Accessories options frame in Unity

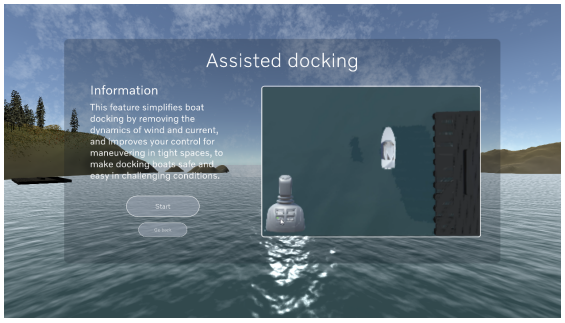


Figure 7.8: Introduction frame to Assisted docking in Unity

Figure 7.9: The game mode in Unity for the Assisted Docking accessory

Practice boating

If the user chooses *Practice boating*, they are presented with the same canvas as the test equipment options. However, the options now relate to practice scenarios, such as *Docking* instead of *Assisted docking*.

Since Docking is the implemented practice at this time, upon selection, users are directed to another canvas displaying various levels for the chosen option, see Figure 7.10. Here the user's progress over previously completed levels should be shown, but this is yet to be implemented. Upon selecting the first level, *Dock at ease,* a canvas appears providing an explanation of the level objectives and instructions on how to complete it, accompanied by an explanatory image, see Figure 7.11.

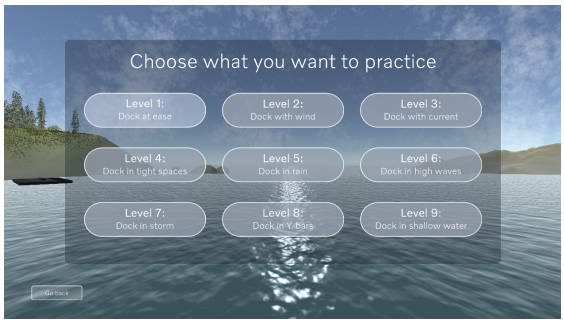


Figure 7.10: Different levels for docking in Unity

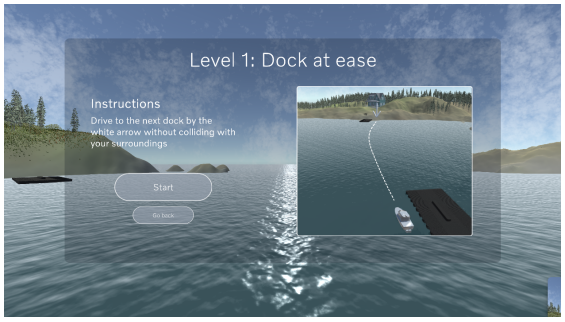


Figure 7.11: Introduction frame to Level 1 for docking practice in Unity

Upon pressing the *Play* button, the canvas with the steering tools along with an indicator for docking the boat and completing the level is shown, see Figure 7.12. This indicator, a 2D sprite model of an arrow, is placed in the 3D environment and features a script to bounce up and down and rotate slowly for user clarity.

After docking the boat at the arrow, a new canvas appears, indicating level completion. Users can then proceed to the next level or return to the main menu. This automatic canvas display is triggered by a hidden Box Collider near the dock, activated when the boat enters the area.

Additionally, the canvas should include completion feedback regarding the user's performance in the task, like the stars in Figure 7.13. This feedback can be generated using a script that i.e., tracks instances of the boat colliding with other objects using a Mesh Collider. However, this feature has not yet been implemented due to time constraints, only a representation of how it could look.

Figure 7.12: The game mode for Docking Level 1 in Unity

Figure 7.13: Completion and feedback frame in Unity

Furthermore, several buttons are available to assist the user during the task. One button displays level information, another provides tips on completing the level, and there is one to reset the level. The reset level feature is not yet implemented but is illustrated. Lastly, a button allows navigation back to the boat configuration, level selection menu, or Test equipment options, see Figure 7.14.

Figure 7.14: The four icons in Docking Level 1 in Unity

Free play
An additional feature not presented in the Figma prototype is the *Free play* mode, where users have the freedom to navigate using all available steering tools and adjust wind and wave conditions. This mode enables users to test different boat configurations, practice without specific levels, or simply enjoy driving around for fun.

7.2.2 Environment

The primary objective was to create a realistic environment within the simulator, prioritizing realistic water dynamics to simulate boat movement authentically. Due to time constraints, aesthetic details were given lower priority. Certain objects, such as the harbour and houses, were obtained as free .fbx models from various online sources and Volvo Penta's collection of models. See a part of the environment in Figure 7.15 below.

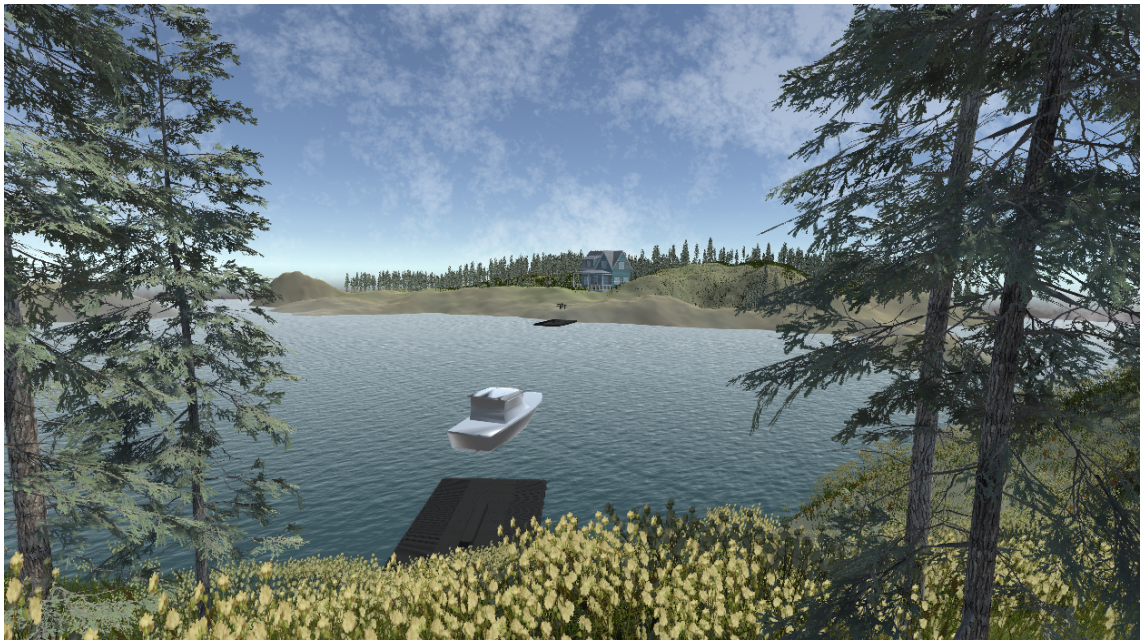


Figure 7.15: Image of the environment in Unity

7.2.2.1 Islands

The physical environment such as the islands was created with Unity's Terrain tool. Starting with a flat plane, the islands were sculpted to form their contours and elevations. A brush tool was then employed to simulate mountainous terrain, with adjustable parameters for size and intensity. To enhance the visual appeal, freely available tree and grass objects were incorporated, although their quality varied due to their free nature.

7.2.2.2 Ocean

The water used in the simulator was based on the theory by the software engineer Jacques Kerner who looks into boat physics and calculates the most important forces acting on boats in water. In this approach, a triangular mesh is utilized to represent the water's surface. By comparing the vertices of this mesh with those of the floating object's triangular mesh (hull), it can be determined which meshes should be submerged below water and which should remain above. Forces are then applied to these meshes to simulate buoyancy and maintain the object's flotation Kerner (2015). Some forces of this theory were omitted due to time constraints. To enhance the simulator further, incorporating water resistance, pressure drag, and slamming forces acting on the boat above the water's surface should also be considered.

To enhance the realism of the water's appearance, a prefabricated water shader was utilized. This shader not only dictates the visual aspects of the water but also governs its movement. It consists of four Gerstner waves, which simulate realistic wave patterns by moving in different directions with varying amplitudes, similar to actual water dynamics.

7.2.2.3 Wind and Waves

Adjustable waves were implemented using the water shader and an Ocean controller script, allowing users to modify amplitude and direction. Unity's UI Sliders facilitated user adjustment, programmed with a range from 0 on the left to increasing values on the right. Directional adjustments span from 0°-360°, enabling waves to move in any direction, and the amplitude ranges from 0-1 and is adjusted using a power factor to achieve noticeable changes.

The wind is implemented similarly but operates independently of the water shader. It functions as a force added in the desired direction. For future iterations, displaying the wind strength in meters per second (m/s) is suggested to provide users with a clearer understanding of wind intensity.

7.2.3 Boat object

The main game object in the simulator is the boat, which consists of a Rigidbody, a Mesh Collider, and multiple scripts. One of the scripts is connected to the water

and makes the boat float, while another handles the external forces acting on the boat, as previously explained. Additionally, two more scripts are attached to the boat to manage its engines, enabling user control. Further details on these scripts can be found in the following section.

7.2.4 Steering

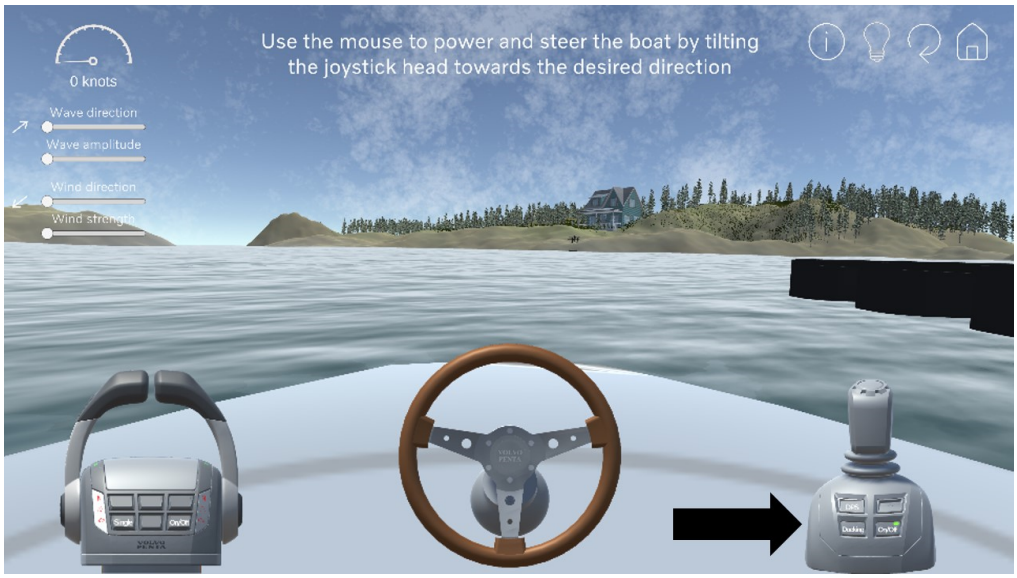
To enable lifelike steering, the steering components were strategically positioned on a canvas to replicate the view from inside a cockpit. Except for testing Assisted Docking where a bird's view is more suited to see the value of the accessory. All components in the scene for operating the boat are part of the Volvo Penta accessory collection. The components for controlling the boat were 3D objects consisting of a Dual Lever, a Steering Wheel, and a Joystick which enables steering as well as the Assisted Docking function and Dynamic Positioning System, see Figure 7.16. This subsection delineates the operational mechanics of these steering tools and their cohesive interaction with the boat's engines.

Figure 7.16: The view from inside the cockpit, including a Volvo Penta Dual lever/Throttle, Steering wheel and Joystick

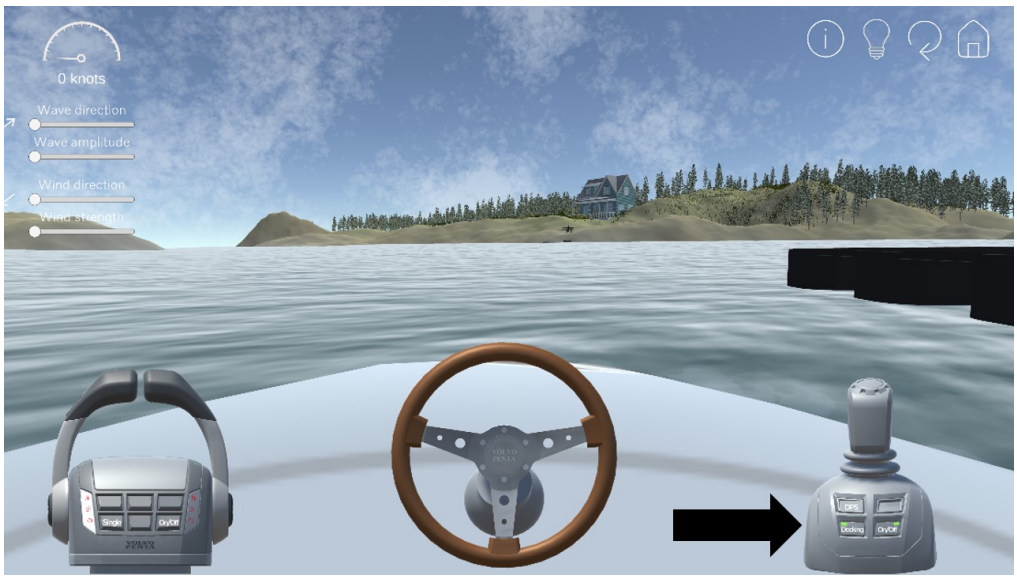
7.2.4.1 Joystick

The joystick was separated into primary and child components, featuring a Rigid body and Mesh collider in its parent entity, while its child component consists of a tiltable and rotatable joystick handle, including a Sphere collider and a Transform component to facilitate mouse pointer interactions. The Joystick controller script attached was designed to translate inputs from the mouse movements upon left button activation and scroll wheel detection. The mouse movements were then translated to tilt the joystick handle around the x and y axes in the scene or z axis

with the scroll wheel. The vertical and horizontal outputs from the pointer served as inputs to the two engines which power the boat while the scroll wheel served as inputs for the bow thruster. The joystick has an on-and-off button which enables toggling between steering with the lever plus steering wheel or using the joystick, see Figure 7.17. The mouse pointer interaction was chosen as the method to steer the joystick with, due to the computer mouse's ability for at-home use and to mimic the feel of using the real joystick as much as possible.



Instructions for using the Joystick, with green light indicating the Joystick is on.



Indication that the Joystick is on and that Assisted Docking is active and DPS deactivated.

Figure 7.17: Illustrations showing the Joystick control status and Assisted Docking status plus DPS status.

Assisted Docking

The *Assisted docking* button on the joystick manages the operations to dock with assistance, see Figure 7.17. The insight of docking being an anxious moment many boaters struggle with, the Assisted docking feature out of all possible features for the joystick was prioritized in the development to enable displaying for the user how easy docking can be with a Volvo Penta joystick. The Assisted docking feature was programmed to hinder forces from wind and waves to relocate the boat.

The feature is explored in the simulator by intensifying the force from waves and wind which the user can adjust with the Slider connected to the Ocean controller script. The user can then test and practice docking with or without the Assisted Docking being activated. When the assisted docking is deactivated, the forces from the wind and waves relocate the boat in the force's direction. When the assisted docking is activated, the boat instantly locks onto its precise location and remains unaffected by external forces and only the user's input from the joystick affects the boat. Programming-wise this was done by enabling the Assisted docking button to deactivate the Ocean controller script which adds force to the boat's rigid body. The real Assisted docking feature utilizes the combination of maintaining the position with the help of GPS coordinates while employing counteracting forces from the propeller and engine against the current. To future develop the simulated Assisted docking to a real-life scenario, it should be the programmed engine working against the current. It should also include the expanded function of the Assisted Docking which is to enable the progressive movement of the boat in a lateral path within a user-desired span, for example, 1m per push/tilt on the joystick.

Dynamic Positioning System (DPS)
Volvo Penta's Dynamic Positioning System is in many ways similar to Assisted docking. The DPS system is a virtual anchor to lock the boat in its precise position to prevent drifting due to wind and waves. This was enabled by the Assisted docking script with modifications to its button positioning and functionality to only keep the boat still to demonstrate the feature's usefulness. This function is useful in for example lock operations, bridge openings, during anchoring or fishing when a high demand for an exact location is of preference. The DPS button is included and deactivated in Figure 7.17.

7.2.4.2 Dual lever/Throttle

The Lever control's function is to power the engines when the control is on. To enable this the control was separated into one primary part which has a Rigid body and two children, left and right lever with one Transform and Sphere collider for each. The control has one On and Off button enabling toggling between using the Steering wheel plus Levers or using the Joystick for driving. The "Single" button enables toggling between using both levers simultaneously when it is active or steering each lever separately when it is deactivated. The levers were programmed to rotate forward around the x-axis by using the keyboard letter "W" and backwards when pressing "S" when the "Single" lever is activated. By pressing the keys, vertical inputs were sent to the engine script enabling forward and backward power of the engines and tilting of the levers. If the "Single" lever button is deactivated, the levers are steered separately which was done with the "W" and "S" for the left lever and "E" and "D" for the right lever. Furthermore, the choice of using the keys for controlling the lever was to enable the possibility of using the mouse for interactions with the Steering wheel while simultaneously being able to handle the levers as in a real cockpit in a boat. Limitations in comparison to how the real-life lever works is that the the simulation lever facilitates a seamless rotation without any transitions, making no difference in which gear it is in, as opposed to the real lever which has

distinct positions for different modes. To simulate as real-life interaction as possible and display the lever for the user accurately the next prototype should also have distinct transitions for the different gears and also to enable operation across all available modes initiated through the buttons on the lever, not only On and Off and activation/deactivation of “Single” mode.

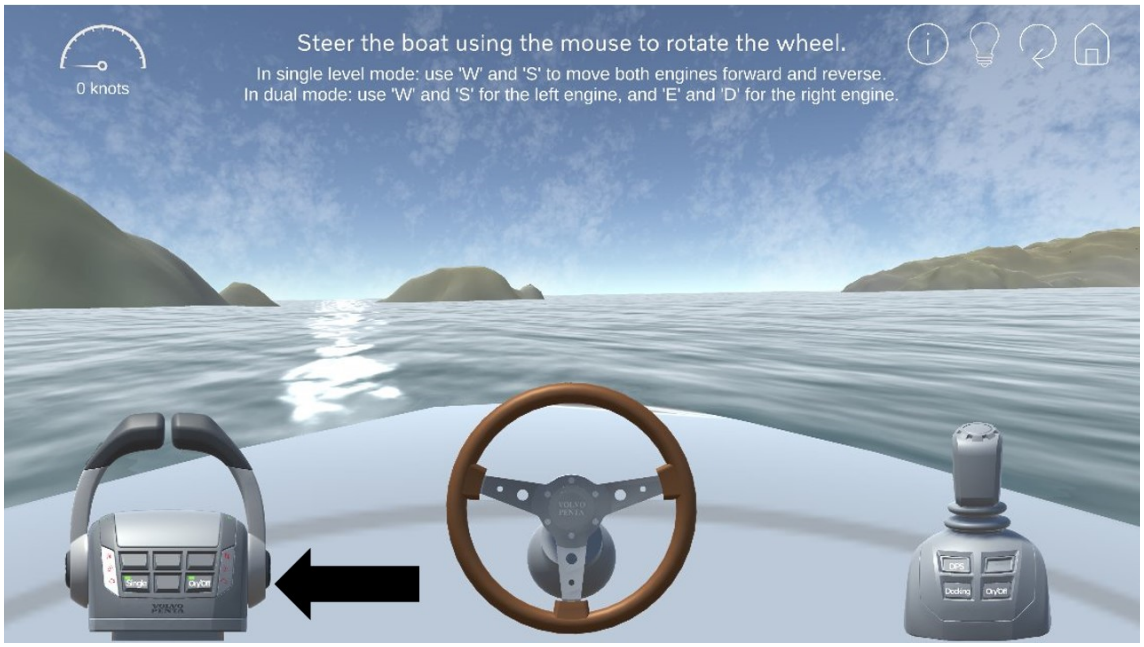


Figure 7.18: Instructions for using the Dual lever and Steering Wheel, with green light indicating the lever is on and single lever mode is active.

7.2.4.3 Steering wheel

The steering wheel contains a shaft and a rim together with a Wheel controller script. The function of the rim is to rotate around the shaft when horizontal inputs from the mouse pointer are detected. The parent part has a Rigid body and the rim which is the child has a Sphere collider, enabling the movement of the rim when interacting with the mouse pointer. The position of the rim during Steering wheel rotation serves as the input to control the rotation of the propeller. The Steering wheel is only enabled when the Lever is on and the Joystick is off.

7.2.4.4 Engine and Propeller

The propulsion systems attached to the boat have 3D models from Volvo Penta’s product range consisting of an engine and a propeller. However, to simulate the boat’s propulsion while playing, the objects containing the programmed motion were modelled as simple boxes, which responded to the inputs from the desired steering devices described above. The engine power in the script consists of two water jet components, each controlled independently. During play mode, the engine continually monitors the user input to modulate engine power and steering of the propellers. When using the Joystick control, vertical input determines the forward

or backward thrust, horizontal input adjusts the steering angle for the propeller's rotation, and scroll wheel inputs regulate bow thrust power and direction. Conversely, when using Lever controls, lever rotation dictates engine power by the vertical inputs, and the steering wheel's horizontal input guides the rotation of the propulsion.

The engine script attached to the boat acts as the information manager for all the steering components to calculate the desired rotation and speed for each water jet. It then applies the forces to the boat's rigid body to propel it forward, backwards or sideways. For further development and for the user to explore Volvo Penta's engines and propellers, this feature should be separated into separate parts with a propeller model and engine from the Volvo Penta product range with specific features to test and learn about.

7.3 Business model canvas

A Business Model Canvas was established to ensure an appropriate business model for the simulator. This was done to explore how the simulator can align with Volvo Penta's strategy and add value to the business, while ensuring that its development meets the project objectives. It was segmented into two timeframes: Horizon One and Horizon Two. Horizon One encompassed the period from the initial stages of simulator development to a potential initial launch. The actions directly investigated during this period of the master thesis project were marked with a star on the canvas model. Horizon Two was set as a future exploration which would align with Volvo Penta's strategy and the findings during the project research phase. The findings and suggestions for the simulator applicable to the Business model canvas and its nine categories are walked through in this section and illustrated in Figure 7.19.

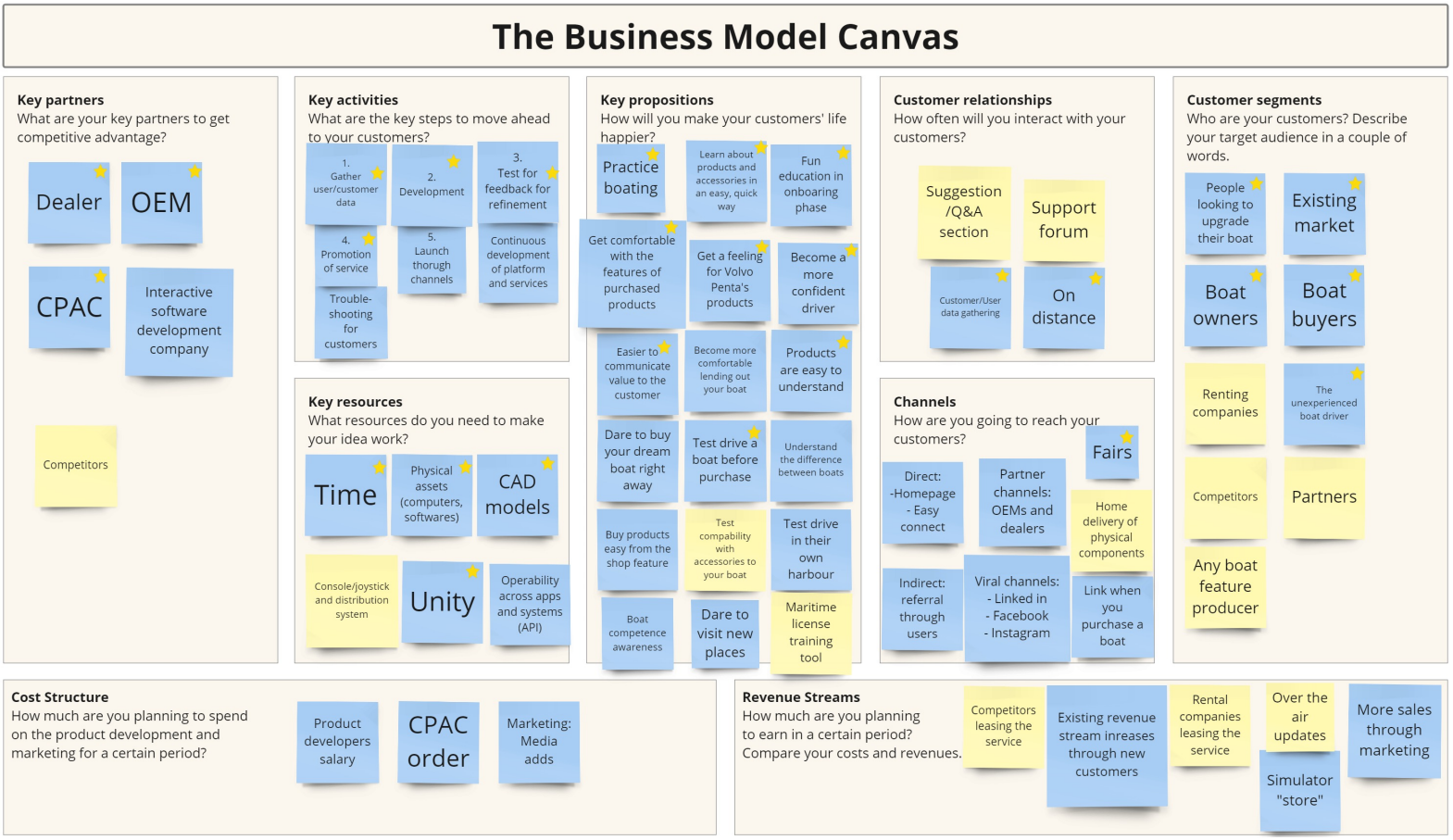


Figure 7.19: The Business Model Canvas where the blue represents Horizon One, the yellow notes Horizon Two, and the stars represent accomplishments achieved up to this point

Key Proposition: The key proposition of the simulator is to explore various boating scenarios and environments as a user and become a more confident boater. Uncover and master the features of a user's or potential user's purchased boat through interactive training sessions. Embark on an enjoyable and informative journey through Volvo Penta's product range and gain deeper insights into the value it offers, such as reducing the anxiety when docking with assistance or testing and learning about the engine before its arrival and the first boat trip. It does not only apply to the less confident driver to test and train but also to the more experienced driver to explore advanced features and upgrades for their current or desired boat.

As the simulator evolves, it is expected to encompass additional key propositions. One proposition is to facilitate users in testing compatibility with accessories customized for their specific boat, streamlining the upgrade process. Additionally, the market research identified another purpose: in response to potentially stricter maritime licensing regulations, the simulator could serve as an instructional aid during license acquisition exercises, offering an alternative approach to engagement and utilization.

Customer Relationship: The customer relationship in the simulator is on distance and through the internet. The relationship can be strengthened by Volvo Penta gathering data about the users through the simulator about their needs and by tailoring products to their desires and requirements.

Future ways of strengthening the relationship are to use the simulator as a support forum enabling a section for questions and answers.

Customer Segment: The customers in the simulator can be divided into different groups. The largest group of Volvo Penta product users is middle-aged men and above. Within this section, the simulator applies to Boat *Buyers and Owners* who can use the tool to configure a boat equipped with Volvo Penta products before or during the purchase of a new boat or the upgrade of an existing one. Additionally, the *Unexperienced driver* can test a boat with Volvo Penta products, improve their skills, develop interest and become a customer.

During the research phase, other segments have shown to be interested in the simulator, *Renting companies* can lease the simulator to verify customers' boat skills before renting agreements of the company's boats. *Competitors and partners* or any boat feature producer can lease a spot to display their products where the user can test them or visualise products in the simulator, examples could be boat manufacturers, interior or kitchen producers.

Channels: The channels used to market and reach users and customers are based on the customer journey stage. To ensure easy accessibility, it should be featured on Volvo Penta's website. During the Prepurchase and Purchase phases, distribution at fairs, OEMs and dealers could facilitate hands-on testing of equipment and accessories, aiding customers in their purchase decisions. Additionally, future iterations of the simulator may incorporate physical components to enhance realism at the OEMs and dealers. In the Onboarding phase, distributing the simulator along with boat purchase confirmations could encourage customers to acquaint themselves with their new vessel or components. Finally, during the Ownership and Retention phase, promotion via Volvo Penta's *Easy Connect* app and regular newsletters could further engage and retain customers. Additionally, social media platforms will be utilized to promote the product.

Revenue Stream: Existing revenues from purchased products are expected to grow due to increased exposure and deeper value insights provided to customers and users. Additionally, new revenue streams will be created through the simulator itself, which can function as an online store. Users will be able to make product purchases directly within the simulator or through links to the store.

When the future customer segments described in Horizon Two are integrated into the business model, revenues will be created through service fees from competitors and partners who lease the platform to showcase their products. Similarly, a service fee or subscription will be applicable for rental companies using the service to verify

the necessary boat skills before renting.

Cost Structure: Given the low resource requirements and minimal procurement needed for the simulator development, the cost structure is anticipated to primarily entail software acquisition, development time, and support from the subsidiary CPAC or other development company during Horizon One.

Depending on the extent of graphic expansion and additional products, features and precision requirements, costs for development time are expected to increase. Integration of the simulator to different platforms and channels will also contribute to this increase in cost and time as well as licenses when expanding the simulator in the future.

Key Resources: Resources required for the initial launch of the simulator primarily include a game development program, with Unity being the current application of choice, and CAD models, which are primarily sourced internally and represent products offered to customers by Volvo Penta. Additional resources include developers, specifically two product development students during the project initiation.

Future requirements also include developers to maintain and further develop the simulator, as well as Application Programming Interfaces (APIs) to facilitate the implementation of the simulator across the various suggested platforms and channels.

Key Activities: The key activities were organized into a stepwise development process until the finalised product's realised for customers to use. The first three phases, which were part of this master's thesis project, include:

1. Gather user and customer data
2. The Development
3. Test and feedback for refinement

Steps four and beyond are for future development within Horizon One. Nevertheless, this project initiated the promotion of the service by undertaking preliminary investigations and a surface-level analysis of its potential, in both the market analyses and the Business model canvas itself. Step five focuses on launching through the suggested channels. Further activities to maintain the simulator are to continuously include newly developed features, products and implementations on desired platforms as well as troubleshooting to maintain customer relationships.

Key Partners: The key partners during the initial phase are dealers and OEMs who enable a seamless customer journey when purchasing a boat featured with Volvo Penta products. Dealers and OEMs should be considered as prioritized partners in all stages of the simulator, as well as in the expansion of the simulator, as the dealers can use the simulator on-site to showcase their products and compatibility with Volvo Penta products, making them more competitive in their field. CPAC is also considered a key partner to develop, realise and support the development of the

simulator during Horizon One and Horizon Two.

For future partnerships, competitors and other boat-related manufacturers should also be considered as key partners to open up the possibility of expansion for favourable collaborations, such as boat interior, kitchen solutions, or other space-related collaborations to generate revenue from other sources than customer purchases.

8

Test

To evaluate the usefulness and quality of the simulator, its prototypes were tested throughout the development process. Feedback was provided on improvements to make the simulator more intuitive, user-friendly, and accurately displayed. The test participants included individuals from the initial interviews as well as third-party individuals with no prior knowledge of the simulator. This approach ensured a fresh perspective on the feedback, closely mirroring the experiences of potential future users.

8.1 User test with the Figma prototype

As a first-stage prototype, there were numerous ways to address the same problem. For instance, various interface designs were created for selecting practice options. Multiple solutions were developed within this simple 2D interactive prototype and presented to test participants for feedback, see Figure 8.1. The four testers interacted with and provided feedback on all three designs separately. They unanimously agreed that the first option was the most appealing and easiest to understand. Consequently, this design was used in subsequent prototypes. Similar tests were conducted with other interface options to refine the overall user experience.

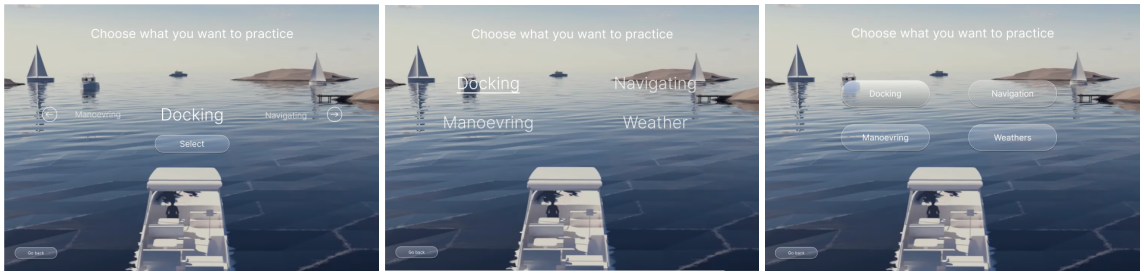


Figure 8.1: Three options on how to select what to practice

8.2 User test with the Unity prototype

More comprehensive user tests were conducted with 10 participants, including two who had participated in in-depth interviews earlier in the development process. The user tests were performed in slightly different ways across two rounds.

In the first round, the simulator was demonstrated by project members. Participants were asked to interpret the icons, buttons, and next steps in the simulator before any explanations were given. This approach provided honest and clear feedback about the UI.

In the next round, after further adjustments, the simulator was functional enough for participants to try it themselves, with a walkthrough provided if necessary. Those who had prior knowledge from the interviews did not require the same level of introduction or walkthrough. Instead, they tested the simulator while being observed with some questions asked, allowing for the documentation of any incorrect behaviours. They were also asked to talk about their thought processes throughout the test and provide feedback.

Testing participants with prior knowledge offered valuable insights primarily into their expectations but also on how to be guided better throughout the simulator, while feedback from those unfamiliar with the project helped primarily identify how to guide new users effectively.

The general feedback was that most understood the interface very well. Some users did not understand how to start the joystick or lever but immediately tried to drag on them, after this input some guidance text was placed on the top of the screen guiding the user through the steering.

The user who chose i.e., the joystick in the boat configuration, then got also the lever and wheel in the play mode was a bit confused. Sensitivity of the lever, steering wheel and joystick was also feedback given to enhance the accuracy and smooth movements. The user also got to answer questions about what they initially thought the four icons did in the up-right corner. Which all test people were 100% correct about. All feedback was gathered in Table 8.1 with actions taken for improvements, for the full review of what the participant provided as feedback see Appendix K.

Table 8.1: Inputs from user tests with actions taken for improvement

Inputs	**Actions taken**
When selecting a random boat, it was difficult to understand what has been chosen	None
Did not understand that the steering tools needed to be turned on	Implemented instructions
Did not understand if the steering tools were turned on	Implemented green light when turned on
Tried to manipulate the lever with the mouse instead of the keyboard	Implemented instructions
The user selected the Joystick in the configuration step, but the lever and wheel also showed up in the game mode	None
Did not want to see both steering tools simultaneously	Fixed when testing Assisted Docking
The wind was too strong	Lowered the max strength
Lever rotation was 360°	Adjusted to a range between +70°and -70°
The steering wheel sensitivity is too low	Adjusted
The arrows for wind and wave direction got confused with the goal arrow	Changed their location
The joystick can not be twisted	Implemented
Wanted different views for the boat while driving	Different views for testing equipment and practice mode
More information about IPS and Regular propulsion system	None
Information about what boat configurations are recommended for different purposes	None
Lower the sensitivity on joystick movements	Adjusted
Does not work on Mac	None
Add sound effects to elevate the experience	None
Some texts were difficult to see because lacking contrasts	Added background to the texts

9
Results

This chapter presents the outcomes of this master thesis project "A Virtual Steering Experience of the Engine in a Boat", including insights from interviews and questionnaires, analysis of market potential, the developed simulator, and a proposed business model. The following sections will outline the extent to which the project has met the objectives, the remaining tasks needed to fulfil a complete simulator for the intended purpose, and how different user groups can benefit from the project's outcomes.

User inputs gathered during the initial phase of the project were interpreted as criteria for the simulator, evolving from a text-based story to a 2D prototype in Figma, and finally into a 3D interactive world in Unity. The developed simulator in Unity has an intuitive interface enabling users to test drive a boat with Volvo Penta products in different scenarios. In its current state implementations enable practice docking, manoeuvring, test Assisted Docking, the Dynamic Positioning System, and learning about the features, navigating freely, adjusting wind and wave conditions, and controlling the boat using 3D components from Volvo Penta's product range on a screen. Additionally, users can receive extra help within the simulator which has been developed with the intention to fulfil the criteria of being able to practice boating in a fun and engaging environment with elements such as game levels and scoring.

Even though the simulator was primarily designed for one of the three personas, evaluations have shown it to be useful for the other personas as well. While it may not fully meet their needs, it effectively incorporates most of the desired features.

To facilitate the simulator's market presence, the Business Model Canvas was utilized, resulting in a comprehensive business model with step-wise suggestions for the project during its development and for further actions for Volvo Penta. The model resulted thereby in timeframes for the near future and a proposed path forward. The outcome indicated that minimal additional development is required from the company to advance the simulator for marketing purposes. In the near term, key resources, cost structure, and key partners can be maintained in a resource-efficient state. In addition to the utilized resources in the project so far, it was identified that Volvo Penta should take additional steps to finalize the product based on user inputs, promote the service, and launch it through channels, which will involve the cost structure of product development and marketing. Moreover, the results of the simulator facilitated the key propositions identified in the Business Model Canvas, such as providing an opportunity for boating practice and offering a fun and educa-

tional onboarding experience in the Volvo Penta customer journey. Additionally the suggested enhancements for customer relationships and channels including utilizing the simulator remotely for home use, thereby enabling a collection of user data beneficial not only for the simulator but also for tailoring products in the future.

The final test results indicate a successful development of a simulator, with 58.8% of the criteria meeting or exceeding the acceptance level, and 15.7% reaching the target level. However, not all criteria were implemented at this stage; 19.7% of the criteria remain for implementation if they align with Volvo Penta's strategy. During the prototyping phase of approximately two months, 73.2% of the implemented criteria met or exceeded the acceptance level. For a comprehensive evaluation of each criterion, See Appendix G.

9.1 Objectives fulfilment

This section presents how each objective is accomplished throughout the work of this project. Each objective is examined in detail, highlighting the steps taken, the findings, and the resulting outcomes.

9.1.1 Objective 1: Creating a simulator that can be used at home to simulate how to drive a boat with one type of Volvo Penta engine and manoeuvring system

This objective was effectively achieved through the development of the simulator. The simulator's online distribution makes it accessible from home, providing users with a convenient platform for simulating the experience of driving a boat equipped with a Volvo Penta engine and its manoeuvring system.

Design an intuitive interface
In line with the initial objective to "Design an intuitive interface," it was clear that an intuitive interface was successfully implemented, with 100% of testers understanding the intent of all icons. Additionally, most testers understood the procedures and operations in the updated versions of the simulator.

Decide what features are necessary for a minimum viable product
The objective to "Decide what features are necessary for a minimum viable product", was thoroughly explored from a user perspective through extensive user research, primarily conducted via interviews and a questionnaire. The results from the questionnaire highlighted which features and training scenarios the broad audience wanted to test. Additionally, the interviews led to a more comprehensive understanding of how the simulator should be designed to fulfil these desires regarding features and training scenarios. The aggregated user inputs in the questionnaire showed prioritizing docking as an operation of training in the simulator, other top requests from the questionnaire were:

- Trying out different steering controls
- Testing accessories
- Practice strong winds
- Practice manoeuvring
- Practice navigation
- Practice leaving the dock

Additionally, key inputs from the interviews included:

- Enabling the configuration of the boat with a range of options to mimic the user's own boat.
- Incorporating training scenarios involving wind and waves to help users practice handling difficult conditions.
- Focusing on docking exercises, as this was a high priority for users.
- Creating a fun and engaging environment to enhance user experience.

These preferences formed the foundation for the chosen concept, which led to the implementation of all the mentioned features in the final simulator, with the exception of navigation. From a technical standpoint, this can be reviewed by the corresponding list of technical actions and inclusion in Unity aiming to fulfil the criteria. The list ensures that technical actions address user needs, to result in a minimum viable product, although each feature may need improvements, more on this in Section 9.2. This approach makes the simulator an attractive product that meets users' expectations.

Develop a realistic and true-to-life experience of the simulator from the Volvo Penta product range

The objective to "Develop a realistic and true-to-life experience of the simulator from the Volvo Penta product range" has been achieved by implementing Volvo Penta's D6 Engine, IPS 10, a dual lever, steering wheel and joystick as 3D models within the simulator. These components are placed in a boat, providing a true-to-life representation of the products, given the aim of being a digital steering experience and thus manipulated through a screen.

9.1.2 Objective 2: Explore if the distribution of the home simulator would increase the user's desire to choose an engine and manoeuvring system from Volvo Penta during the buying decision process and increase Volvo Penta's sales

The second objective was also fulfilled as shown by the primary data collection. Participants expressed that providing an effective and easily accessible way of getting familiarised with Volvo Penta's product range could increase people's interest in purchasing their products, especially when noticing how easy boating can be.

Integrate a channel where Volvo Penta has a direct influence on the user
This objective was fulfilled by providing Volvo Penta with a functional simulator that enables direct influence over users and customers, without the need to go through an OEM or dealer. This direct channel helps users gain a comprehensive understanding of the product range and can enhance the desire to purchase boats compatible with Volvo Penta's products. Additionally, the simulator includes a link to Volvo Penta's product range website, allowing users to read more about the offerings or find purchase location. To ensure a clear representation that the simulator is from Volvo Penta, their brand is prominently showcased throughout various stages of the simulator. This includes the consistent use of products, logos, and detailed feature explanations.

Explore how Volvo Penta can generate revenue streams from the simulator
Furthermore, the objectives were investigated in the Business Model Canvas, with the result of increasing the existing revenue streams by attracting new customers via the simulator and more sales through marketing. Additionally, it identified potential revenue streams from competitors leasing the service, rental companies, and utilizing the simulator for over-the-air updates. While these opportunities require further development before they can be implemented, at least one affected stakeholder in each proposed revenue stream is confirmed with high interest.

Decide a distribution system for the simulator
From the Business Model Canvas, various distribution strategies for the simulator emerged, based on the customer journey stage. These distribution channels were:

- Volvo Penta's website
- Social media
- OEMs
- Dealers
- With purchase confirmation
- Easy connect
- Newsletters

By distributing the product across these diverse locations and stages in the customer journey, it becomes easily accessible and ensures extensive marketing coverage, thereby promoting the broad usage of the simulator.

Improve the sustainability of the customer journey
The fulfilment of the objective was achieved by users not being forced to visit dealers or OEMs to interact with Volvo Penta products. Enabling at-home use of the simulator saves environmental load in transportation and test drives to explore products in action, which users also found inconvenient and time consuming. This also entails a larger inclusion of anyone with access to a computer being able to test the products by its nature of being an online service.

9.2 Simulator capabilities

With the initial objectives being met in this project, there are still improvements to be made for the simulator to become a minimum viable product. The development of the simulator along with tests and evaluation of the product led to areas of improvement being identified throughout the process. The areas of improvement were gathered as suggestions of further recommendations:

- Add more practice situations
- Add more boat basics
- Include all Volvo Pentas components
- Investigate purchasing options straight from the simulator
- Online gaming, interact with others to learn together
- Add functionality for Mac computers
- Refine forces and steering
- Implement correct 3D models
- Implement different camera views in the same scene
- Display wind strength in m/s
- Implement a feedback system on how well a level was performed
- Include transitions of gear for the lever and other subfunctions
- Implement more of the joystick's subfunctions

Overall, the outcomes of the project were highly positive, with each objective successfully met, confirming the simulator's usefulness and attraction beyond the anticipated customer base. The research discovered additional use cases beyond Volvo Penta's initial expectations, indicating the product's potential as a strategic tool for attracting new customers. Furthermore, it provides an opportunity for Volvo Penta to diversify its revenue streams in the future.

10
Discussion

This chapter discusses methods and approaches used during the project, highlighting the challenges and insights from navigating the project's broad scope, balancing company objectives with user needs, and optimizing simulator performance. It also provides recommendations for future development and discusses ethical considerations, including inclusivity and environmental impact.

10.1 Navigating the Broad Project Scope: Challenges and Insights

The project had a broad scope, requiring a wide range of competencies and extensive management aspects throughout the project period. The scope resulted in a long learning curve, including mastering complex software like Unity and programming in C#, areas in which the team had limited prior experience, which prevented the implementation and refinement of all desired features within the given timeframe.

While the methodology was extensive and based on Design Thinking, it was well-suited for the broad project scope, enabling investigations of many possible use areas. This approach required extensive user research, where the collection of end-user data from Volvo Penta proved to be challenging. Consequently, estimations were necessary for the market analysis, which could potentially be misleading even though the data was on boat owners and drivers in Sweden but not necessarily owners of Volvo Penta's products.

However, by directly reaching out to boat enthusiasts and customers, extensive and valuable data from potential users could be obtained. This data alone is valuable for Volvo Penta since they normally have more contact with OEM and dealers than the end-users. If continuing to develop the simulator, it does not require much supplementation for continued work since a lot of necessary information is already available including participants and user groups eager to try out the simulator and give feedback.

A more detailed technical approach would have limited the potential to discover new areas of usefulness and have an increased risk of overlooking the crucial step of empathizing with the users before diving into development. Instead, significant potential was identified across various market segments due to the broad project scope. Therefore, the project was approached with a broad perspective throughout its en-

tire duration. While this outlook is essential for a comprehensive understanding in an early stage, it resulted in less precise and detailed answers in the market analysis.

10.2 Balancing Objectives and Enhancing Performance: Insights from Simulator Development

The development of the simulator was guided by both the project description and user preferences, encompassing practice, configuration features, and component testing. However, the inclusion of various modes within the simulator also arose from a minor clash between user needs and company objectives. While Volvo Penta's primary focus is product sales, ensuring user satisfaction throughout the customer journey. Users prioritize skill development in boating when using the simulator, thus requiring a balance between the two objectives. Additionally, during the research phase, emerging needs were translated into criteria for the simulator's design based on input from interviewees and questionnaire respondents. However, combining multiple needs into a single criterion may have resulted in some needs being overlooked or less fulfilled, which is important to consider when evaluating the product.

As an early-stage prototype, the testing of the simulator did not require highly structured approaches, since early-stage prototypes typically require more improvements compared to later-stage products. However, as development progresses, it is advisable to incorporate additional features and products for testing, introduce more levels to the practice mode, and conduct similar user tests until a minimum viable product is achieved. At that stage, testing should transition into a more structured format to thoroughly evaluate the product.

Considering that two non-programmers reached 73% of the acceptance level for the implemented features within roughly two months, the remaining 27% could be feasibly developed within the same time frame or even less by an experienced programmer. However, since neither of the developers are simulation experts or programmers, the code may not be fully optimized due to the variety of problem-solving approaches. Thus, optimizing the code could benefit Volvo Penta by potentially enhancing performance. Additionally, fine-tuning the forces and steering could lead to more realistic and smoother manoeuvring of the boat.

10.3 Further recommendations

It is recommended to continue the development of the simulator, as it has generated significant interest from various user groups such as customers, potential customers, and rental companies where most respondents in the primary data collection recognized the high value of this product.

To advance the development, the first step is to read this report and become fa-

miliar with the customer needs list. This will help guide the development process to meet the needs of users and align with Volvo Penta's goals, ensuring a product that is both market-ready and user-friendly. As noted, several improvements and expansions are necessary before the product is ready for release. Therefore, it is recommended that programmers, UI designers, and other experts continue to work on enhancing the simulator to make it even more appealing, useful and intuitive.

Before launching the product decisions on to whom it should reach should be made, since this research had a broad perspective. A good start could be to reach a broad audience by featuring the simulator on Volvo Penta's website, and then having it available at OEMs and dealers with physical components that would enhance realism and complement the home simulator experience. If deciding to provide it to rental companies or other boat companies, it is recommended to do a similar primary data collection to find their needs and desires to ensure a good partnership where every stakeholder's needs are being met. Additionally, users' interest in improving their driving skills has shown significant potential during this project. Coupled with the macro analysis revealing proposals for stricter regulations, it is recommended to follow these trends and shifts in licensing rules. This could enable the simulator to be used for practice purposes before or during the process of obtaining a license, as users expressed strong interest in its usefulness for training boat skills.

10.4 Engineering ethics

As an early-stage product, the simulator could not accommodate all specific needs and abilities, such as colour blindness or different languages. Nevertheless, these considerations should be evaluated in the future to create an inclusive product. Additionally, the simulator might be perceived as promoting environmentally harmful products. However, as Volvo Penta continues to develop more environmentally friendly products, the simulator presents a great opportunity to showcase these innovations. Demonstrating how new products minimize environmental impacts can make them more attractive to consumers and drive interest in purchasing them. Therefore, it would be beneficial to transparently display the environmental impacts of their products to enhance environmental awareness through the simulator.

11
Conclusion

The project concluded with the creation of a simulator primarily as a proof of concept rather than a tool for selecting and exploring all kinds of engines, steering equipment, boats, and scenarios. Nevertheless, it successfully demonstrated the possibility of simulating and communicating the value of Volvo Penta products, confirming a heightened interest in products such as the Joystick and Assisted Docking after using the simulator.

It was also concluded that the simulator opens up opportunities for new and diverse revenue streams. Currently, Volvo Penta offers products such as engines, propulsion systems, and aftermarket services with some additional services like Easy Connect. With the simulator, an innovative service-product and marketing of their product range is created, plus a market potential beyond the initial scope.

Extensive data collection provided a robust foundation for how to create user-friendly services throughout the customer journey. This is valuable as Volvo Penta primarily engages with OEMs and dealers, with less direct contact with end users. The direct link established through the simulator to end users enhances understanding and user engagement. It also enables product development tailored to user needs and effective communication with the users.

Moreover, the data revealed a disparity between user expectations and Volvo Penta's simulator objectives, highlighting the need for clearer communication.

The final conclusion is that the result will benefit Volvo Penta in communicating the value of their products and assure users that using Volvo Penta products can reduce uncertainties and ease the operation when driving and docking boats, which could increase their sales.

Bibliography

AB Volvo Penta. History & Innovation, 2024a. URL https://www.volvopenta.com/about-us/history-innovation/.

AB Volvo Penta. About Volvo Penta, 2024b. URL https://www.volvopenta.com/about-us/.

AB Volvo Penta. Leisure boating, 2024c. URL https://www.volvopenta.com/marine/leisure-boating/.

B. Ageron, O. Bentahar, and A. Gunasekaran. Digital supply chain: challenges and future directions. *Supply Chain Forum: An International Journal*, 21(3):133–138, 7 2020. ISSN 1625-8312. doi: 10.1080/16258312.2020.1816361.

G. Allanwood and P. Beare. *User Experience Design*. Fairchild Books, 2014.

Allianz Trade. What is political risk and how to protect against it?, 2021. URL https://www.allianz-trade.com/en_global/news-insights/business-tips-and-trade-advice/what-is-political-risk-and-how-to-protect-against-it.html.

Business Research Insights. Marine Joysticks Market Size, Share, Growth, and Industry Growth by Type (Single-axial Joysticks and Multi-axial Joysticks) By Application (Civil Boats, Municipal Boats, Commercial Boats, and Others) Regional Forcast To 2028. Technical report, 2024. URL https://www.businessresearchinsights.com/market-reports/marine-joysticks-market-101458.

J. Campillo, J. Dominguez-Jimenez, and J. Cabrera. Sustainable Boat Transportation Throughout Electrification of Propulsion Systems: Challenges and Opportunities. In *2019 2nd Latin American Conference on Intelligent Transportation Systems (ITS LATAM)*, pages 1–6. IEEE, 3 2019. ISBN 978-1-7281-0021-0. doi: 10.1109/ITSLATAM.2019.8721330.

P. Carlborg, D. Kindström, and C. Kowalkowski. The evolution of service innovation research: a critical review and synthesis. *The Service Industries Journal*, 34(5): 373–398, 4 2014. ISSN 0264-2069. doi: 10.1080/02642069.2013.780044.

CLN. ARE SEMICONDUCTORS STILL IN SHORT SUPPLY? CURRENT STATUS AND OUTLOOK, 2024. URL https://clnusa.com/2024/01/28/are-semiconductors-still-in-short-supply-current-status-and-outlook/.

Dariush Rafinejad. *Sustainable product innovation : entrepreneurship for human well-being*. J. Ross Publishing, Inc, Plantation, Fl, 2017. ISBN 9781604271478.

URL https://app.knovel.com/web/view/khtml/show.v/rcid:kpSPIEHWB1/cid:kt012JXRU5/viewerType:khtml//root_slug:6-the-product-concept-and-development-process/url_slug:product-concept-development?b-toc-cid=kpSPIEHWB1&b-toc-title=Sustainable%20Product%20Innovation%20-%20Entrepreneurship%20for%20Human%20Well-Being&b-toc-url-slug=product-concept-development&view=collapsed&zoom=1&page=21.

dataskydd.org. Personuppgiftsincidenter, 2020. URL https://dataskydd.org/dataskyddslagen/personuppgiftsincidenter/.

M. Denscombe. *The Good Research Guide*. Open University Press, 5 edition, 2014.

Dion Collins. Marine Joysticks Market Trends and Market Analysis forecasted for period 2023–2030. 2023. URL https://medium.com/@dioncollins8227/marine-joysticks-market-trends-and-market-analysis-forecasted-for-period-2023-2030-85c0b71d0ba1.

Finansdepartementet. Inflationen ger vika och konjunkturläget försvagas, 2023. URL https://www.regeringen.se/pressmeddelanden/2023/12/inflationen-ger-vika-och-konjunkturlaget-forsvagas/#:~:text=%C3%84ven%20om%20inflationen%20nu%20ger,stiger%20%C3%A5terh%C3%A4mtar%20sig%20konsumtionen%20gradvis.

Future Market Insights. Dynamic Positioning System Market Outlook (2022-2032). Technical report, 2022. URL https://www.futuremarketinsights.com/reports/dynamic-positioning-system-market.

Getmyboat. How boat steering works. *getmyboat*, 2019. URL https://www.getmyboat.com/journal/how-to/how-boat-steering-works/.

M. Ghobakhloo. The future of manufacturing industry: a strategic roadmap toward Industry 4.0. *Journal of Manufacturing Technology Management*, 29(6):910–936, 7 2018. ISSN 1741-038X. doi: 10.1108/JMTM-02-2018-0057.

S. Ghosh. Understanding Turning Circle Of A Ship. *Marine Navigation*, 2024. URL https://www.marineinsight.com/marine-navigation/understanding-turning-circle-of-a-ship/.

J. A. Guajardo, M. A. Cohen, S.-H. Kim, and S. Netessine. Impact of Performance-Based Contracting on Product Reliability: An Empirical Analysis. *Management Science*, 58(5):961–979, 5 2012. ISSN 0025-1909. doi: 10.1287/mnsc.1110.1465.

A. Hanlon. The segmentation, targeting, positioning (STP) marketing model, 2024. URL https://www.smartinsights.com/digital-marketing-strategy/customer-segmentation-targeting/segmentation-targeting-and-positioning/.

C. Hardcastle. Parts Of A Boat: Essential Components Explained. *Seamag*, 2023. URL https://www.seamagazine.com/parts-of-a-boat-essential-components-explained.

Harris Patricia, Pol Harald, and van der Veen Gerrita. Customer Journey From

Practice to Theory. In B. B. Schlegelmilch and R. S. Winer, editors, *The Routledge Companion to Strategic Marketing*, chapter 5. Routledge, New York, NY: Routledge, 2021. | Series: Routledge companions in business, management & accounting, 11 2020. ISBN 9781351038669. doi: 10.4324/9781351038669.

S. Holmlid and S. Evenson. Bringing Service Design to Service Sciences, Management and Engineering. pages 341–345. 2008. doi: 10.1007/978-0-387-76578-5{_}50.

HTF Market Intelligence. Global dynamic positioning system market. 2023. URL https://www.htfmarketintelligence.com/press-release/global-dynamic-positioning-system-market.

Industritorget. Exklusiva båtar har medvind trots lågkonjunktur, 2024. URL https://www.industritorget.com/news/exklusiva+b%C3%A5tar+har+medvind+trots+l%C3%A5gkonjunktur/39521/.

J. Kerner. Water interaction model for boats in video games. *Game Developer*, 2 2015. URL https://www.gamedeveloper.com/programming/water-interaction-model-for-boats-in-video-games.

Kottler Philip, Armstrong Gary, Harris Lloyd C, and Pericy Nigel. *Principles of marketing*. Pearson Education, Edinburgh, 7 edition, 2016.

K. Kumar and M. Kurni. *Design Thinking*. CRC Press, Boca Raton, 6 2022. ISBN 9781003189923. doi: 10.1201/9781003189923.

T. Lacoma. What is Unity? *Android Police*, 2023. URL https://www.androidpolice.com/what-is-unity/.

Z. Liu, J. Song, J. Kubal, N. Susarla, K. W. Knehr, E. Islam, P. Nelson, and S. Ahmed. Comparing total cost of ownership of battery electric vehicles and internal combustion engine vehicles. *Energy Policy*, 158:112564, 11 2021. ISSN 03014215. doi: 10.1016/j.enpol.2021.112564.

Markus Lagerqvist. Transportstyrelsen Båtlivsundersökningen 2020. Technical report, 2021.

Medborgarskolan. Kustskepparintyg, 2024. URL https://www.medborgarskolan.se/arrangemang-sok/kustskepparintyg-1404335/.

Mercury Marine. Joystick piloting, 2024. URL https://www.mercurymarine.com/eu/en/gauges-and-controls/joystick-piloting.

NTT DATA Group Corporation. A paradigm shift: from creating products to offering services. 2023. URL https://www.nttdata.com/global/en/insights/focus/defining-product-servitization-and-why-it-matters.

A. Osterwalder and Y. Pigneur. *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. Wiley, Hoboken, New Jersey, 2010. URL https://books.google.se/books?id=UzuTAwAAQBAJ&lpg=PP1&ots=yZBTxfF6Zt&dq=business%20model%20generation%20osterwalder&lr&pg=PP4#v=onepage&q&f=true.

A. L. Ostrom, M. J. Bitner, S. W. Brown, K. A. Burkhard, M. Goul, V. Smith-Daniels, H. Demirkan, and E. Rabinovich. Moving Forward and Making a Difference: Research Priorities for the Science of Service. *Journal of Service Research*, 13(1):4–36, 2 2010. ISSN 1094-6705. doi: 10.1177/1094670509357611.

Paul Debra and Cadle James. *Business Analysis*. BCS Learning and Development Ltd, Swindon, 4 edition, 2020.

L.- Redéen. Riksdagspartierna om båtlivets frågor – olika meningar om Förarintyg för fritidsbåtar, 2022. URL https://www.batliv.se/2022/09/05/riksdagspartierna-om-batlivets-fragor-olika-meningar-om-forarbevis-for-fritidsbatar/.

Safety & Navigations gruppen. Krav för att framföra båt i Europa, 2023. URL https://sngruppen.se/krav-for-att-fa-framfora-bat-runtom-i-europa/.

H. Sharp, J. Preece, and Y. Rogers. *Interaction Design*. John Wiley & Sons, Incorporated, 5 edition, 2019. ISBN 9781119547358. URL https://ebookcentral.proquest.com/lib/chalmers/reader.action?docID=5746446&query=interaction+design.

Sorting Hat Technologies Pvt Ltd. Primary and Secondary Data, 2024. URL https://unacademy.com/content/difference-between/primary-and-secondary-data/.

Stacey Hill. Marine Joysticks Market Trends and Market Analysis forecasted for period 2024-2031. 2024. URL https://medium.com/@staceyhill187/marine-joysticks-market-trends-and-market-analysis-forecasted-for-period-2024-2031-be32744aa059.

Statens Offentliga Utredningar. Sveriges Säkerhet. Technical report, 2021.

Svensk Båtutbildning AB. Båtutbildning, 2024. URL https://batutbildning.se/fragor-svar/vad-ar-icc/.

C. Taylor. Imtra Learning Center, 2020. URL https://www.imtra.com/learning-center/articleid/38/what-are-bow-thrusters.

Transport Styrelsen. Fritidsbåtarnas utsläpp har kartlagts, 2021. URL https://www.transportstyrelsen.se/sv/om-transportstyrelsen/pressrum/nyhetsarkiv/2021/fritidsbatarnas-utslapp-har-kartlagts/.

Transport Styrelsen. Vattenskoter, 2023. URL https://www.transportstyrelsen.se/sv/sjofart/fritidsbatar/vattenskoter/.

Transportstyrelsen. Utbildning fritidsbåt, 2023. URL https://www.transportstyrelsen.se/sv/sjofart/Fritidsbatar/Kunskap-och-kompetens/Utbildning-for-fritidsbat/.

Trygg-Hansa. Förändrad båtmarknad, 2023. URL https://www.modernaforsakringar.se/artiklar/forandrad-batmarknad-i-sparen-av-pandemin/.

K. T. Ulrich and S. D. Eppinger. *Product Design and Development; Sixth Edition.* 2016. ISBN 9780078029066. URL www.mhhe.com.

Unity. Unity pricing, 2024. URL https://unity.com/pricing.

Via TT. WWFs Klimatbarometer 2023, 2023. URL https://via.tt.se/pressmeddelande/3345447/wwfs-klimatbarometer-2023-okat-tryck-pa-att-politikerna-ska-agera-for-klimatet-och-naturen-sarskilt-utanfor-storstaderna?publisherId=3236436.

I. Visnjic, F. Wiengarten, and A. Neely. Only the Brave: Product Innovation, Service Business Model Innovation, and Their Impact on Performance. *Journal of Product Innovation Management*, 33(1):36–52, 1 2016. ISSN 0737-6782. doi: 10.1111/jpim.12254.

Volvo Group. REPORT ON THE FOURTH QUARTER AND FULL YEAR 2021. Technical report, Gothenburg, 2021. URL https://www.volvogroup.com/content/dam/volvo-group/markets/master/news/2022/jan/4169226-volvo-q4-2021-eng.pdf.

Volvo Penta. Evolving boating together, 2023. URL https://www.volvopenta.com/marine/volvo-penta-at-sea/boating-for-everyone//future-of-boating/.

Volvo Penta. Volvo Penta Glass cockpit, 2024a. URL https://www.volvopenta.com/marine/accessories/glass-cockpit/.

Volvo Penta. Assisted Docking system – make boat docking easy, 2024b. URL https://www.volvopenta.com/marine/accessories/assisted-docking/.

Volvo Penta. Celebrating a hero innovation: Volvo Penta IPS, 2024c. URL https://www.volvopenta.com/about-us/news-page/2023/jan/celebrating-a-hero-innovation-volvo-penta-ips/.

Volvo Penta. Dynamic Positioning System (DPS), 2024d. URL https://www.volvopenta.com/marine/accessories/dps/.

Volvo Penta. Easy connect, 2024e. URL https://www.volvopenta.com/marine/accessories/easy-connect/.

Volvo Penta. Forward Drive, 2024f. URL https://www.volvopenta.com/marine/leisure-boating/powerboat-solutions/forward-drive/.

Volvo Penta. Joystick control, 2024g. URL https://www.volvopenta.com/marine/accessories/joystick-control/.

P. W. Jordan. *An Introduction To Usability.* Taylor & Francis Ltd, 1 edition, 1998. ISBN 9780748407620.

Appendices

A Gantt chart

GANT SCHEDULE

Verision: 1.0

	Activities	Duration (weeks)	Precedences
	Planning phase		
A	Create report	0,2	-
B	Delimitations	0,1	-
C	Plan reseach	0,1	-
D	Plan interviews	0,1	-
RP	**Research phase**		
E	Bakgrund	0,1	C
F	How boats works	0,4	C
G	How boats with Volvo engine works	0,6	C
H	Customer jouney	0,3	C
I	Stakeholders	0,3	C
J	UI design	0,6	C
K	Simulation (how, what is needed, language...)	1	C
L	Volvos innovation process	0,1	C
M	Product development frameworks	0,1	C
N	Observation test of driving a Volvo Penta engine boat	0,2	C
O	Consult with experts	0,2	D
MA	**Market analysis**		
P	Competitor analysis (Market positioning analysis)	0,1	-
Q	SWOT analysis	0,1	-
R	PESTEL analysis	0,2	-
S	The P's (4 or 7)	0,1	-
T	Customer research (Video/questionnaire)	0,1	-
U	Business Model Canvas	0,4	-
V	Stakeholder register	0,1	I
W	Use cases analysis	0,2	P
X	Requirement specification	0,2	T
CG	**Concept Generation**		
IP	**Ideation phase**		
Y	Unpacking data	0,4	RP, MA
Z	Personas & How might we & Point of view	0,4	T
AA	Idea generation of simulator concepts	0,4	Y, Z
AB	Idea generation of user interface	0,2	Y, Z
AC	Idea generation of different use cases	0,2	Y, Z
AD	Idea generation of steering tool	0,2	Y, Z
AE	Idea generation of environment+features	0,4	Y, Z
AF	Idea generation of tutorial	0,2	Y, Z
AG	Feasibility of ideas (Elimination matrix)	0,1	AA - AF
AH	Merge subsolutions (Morpheus)	0,1	AG
AI	Elimination of concepts (Pugh/Kesselring)	0,2	AH
PR	**Prototyping**		
AJ	Storyboards	0,5	IP
AK	Figma	3	AJ
AL	CAD/design	1	AJ
AM	Dirty prototype for pitch	0,6	AJ
AN	Programming/Simulator	5	AK, AL
AO	Manufacturing	1	AL
TE	**Testing**		
AP	Validation	0,1	PR
AQ	Observation test with experts	0,5	PR
AR	Observation test with customers	0,4	PR
AS	Verification of Figma	0,2	AK
AT	Verification of simulator	0,2	AN
AU	Verification of physical prototype	0,2	AO
AV	Compability testing	0,1	AS, AT, AU
AX	Verify tutorial simplicity	0,2	AN
	Finalization		
AY	Final validation	0,3	CG
AZ	Risk analysis	0,1	AY
AAA	Implementation strategy	0,3	AZ
AAB	Business proposition	0,3	AAA
	Volvo Penta activites		
AAC	Create a monter to a fair at Volvo Penta	0,1	-
AAD	Test driving a boat	0,2	-
AAE	Visit CPAC	0,2	-
	Hand-ins		
AAF	Planning report	0,6	-
AAG	Write Report	20	-
AAH	Opposition	0,6	-
AAI	Presentation	0,8	-

B Short interviews at the Swedish boat fair

Docking/tourist information worker
During a conversation with a dock/tourist information worker, various scenarios where navigating a boat can be stressful were discussed. The worker highlighted the difficulty in communication between the captain and passengers, particularly in stressful situations, such as docking and lock operations.

Both witnessed and experienced instances of stress were recounted by the worker. Throughout work, the docking worker observed numerous stressful docking scenarios exacerbated by wind and current conditions. Additionally, a nearly-caused incident during a lock operation with the worker and the worker's partner was shared. Communication was lacking between the two during a situation where a high demand for manoeuvring skills was required. The couple almost collided right after the last lock operation because of traffic encounters and narrow passages which was explained as a stressful moment. The worker emphasized that this can be challenging even for more experienced captains as many elements must align for everything to go smoothly.

Sales personal at Volvo Penta
During the discussion with Volvo Penta's sales personnel, a conversation took place about how Volvo Penta's relationship between the company and OEMs and dealers differs a lot in comparison to the end users, as the OEMs are Volvo Penta's first customers.

OEMs are strong in cycles, when there is a high demand for boats they are strong and require a lot of focus from Volvo Penta to retain a good relationship. But when there is little demand such as during winter they are not as strong and do not require that much focus. Therefore Volvo Penta also needs to focus on the end user to ensure that during periods of low demand for boats, Volvo Penta must be on top of the mind of the end user to qualify as the first choice when it comes to selecting power and driveline in the few boats produced. This could result in a pull for Volvo Penta's products from end users during these times and a relationship can be established.

Very large OEMs may want their own services such as a boat simulator to become more complete as an OEM. Therefore, it might be wise to invest more in smaller OEMs where Volvo Penta can display their services, such as the simulator. Another aspect which influences the demand for Volvo Penta's products is the current trend for outboard motors. Volvo Penta is currently superior on larger boats, but not on smaller ones. The smaller ones often have outboard motors where prices can be kept down due to shipping. Outboard engines are something Volvo Penta stopped producing years ago but now outboard engines have gained an upswing in the market. This trend is also due to lower prices as a result of fewer emissions and environmental regulations for outboard motors, but also an advantage for the competitors in ease of transportation, and not needing assembly on site like an inboard.

Leaisure repair yard
Many customers come to the repair yard wanting to upgrade their engines for features like assisted docking, which they can do with relatively little hassle and expenses rather than buying a completely new boat or motor. This way, they can also retain their boat, which is something many customers desire.

During the explanation of the project, the interviewee responded positively to how innovative solutions such as the simulator could ease both their work but also the customers during upgrades.

Sales man at Nimbus
The salesman at the boat manufacturer Nimbus shared that simulators similar to the one developed in this project have been well-received by customers in the past. One of those includes a joystick connected to a boat on a screen. Which has been placed at dealers for their customers to try, that way they got a better understanding of the product.

When asked what types of challenges there are when driving a boat the salesman explained how the most challenging aspect of boating is the weather, which can change rapidly at sea. The weather is however not possible to influence, but a couple of suggestions to implement in the simulator to ease the introduction to manoeuvring a boat were shared by the salesman. To ease the stress in unpredictable situations such as rapid weather changes or other events, the suggestion was to consider the importance of easily displaying and teaching the menus in the simulator since customers may find it difficult and complex if there is too much information while driving. Inlcuding a way of teaching menus etc could help the customer to be more familiar with the product and handle other things and situations while driving. The salesman thought that the trend lately has been that the customers ask for technology like services, joystick, assisted docking, etc. that facilitate boating. It is also asked for it to be simple and user-friendly as today's technology in everyday life is. This was explained by the salesman with an example of how an iPhone can transfer contacts from an old iPhone by just placing them next to each other during installation instead of adding the contacts manually. Things like that are preferable and important to consider to succeed with the simulator the salesman believes.

Members of Swedish sailing association
The Swedish Sailing Association has a virtual reality (VR) simulator for an Optimist dinghy (smaller single-handled sailing dinghy) that has shown that children find it less scary to sail for the first time. One instructor explained how a child who initially was scared to go into the water with the Optimist dinghy instead had a couple of hours playing with the simulator and then felt ready and eager to go on to the real boat.

Another member was asked to explain if the use of the simulator was comparable in any way to how it is to drive an Optimist dinghy in real life. The answer was that

it in many ways was comparable, that the muscle memory for when to do what was accurate and that it was notably easier to instruct users who had used the Optimist simulator before the water practice.

Boat dealer leasing (dealer for competitors)
When customers come to lease a boat the dealers usually take the customers for a cruise and they can practice together. This is most often done by trying to aim towards a buoy in different winds and currents to get a feel for the acceleration and to practice manoeuvring. The dealer had five different electric boats, among others. They lease out their boats and people are hesitant to go for the largest one directly, opting for a size smaller to become comfortable first, afraid of crashing a large expensive boat. The simulator would have been a great fit there if one could test beforehand how the different options felt. This company's boats did not have any IPS systems or joysticks, and probably will not have them either. Since the electric boats had a driveline that cost 2 million to develop, it is likely to remain that way for now; they suggested that development in that area was somewhat stagnant.

Boat broker (sailing boat)
In the conversation with a boat broker, it was suggested to focus on popular boats for the simulator. The feedback on which boat to use in the simulator was that small boats can be driven by anyone, but the weight matters a lot. Heavier boats are difficult to drive, so the simulator should have a sturdy boat. Furthermore, he explained that he had never seen anyone park a boat so perfectly in a storm (up to 18m/s), except the one time a friend docked a boat with an IPS system. But he pointed out that he does not think the simulator should include a lot of new technical functions like that so that everyone starts to trust them completely. In case something breaks, you still have to be able to drive the boat yourself. In his experiences, he thinks that most people who come in to buy a boat already have boating experience, but all training and experience are good and therefore he had a positive attitude towards the simulator for that purpose.

Boat rental
The boat rental company has a subscription-based business, where customers can take a course to get verified and then rent boats wherever the boat rental is located.

During the courses which the personnel at the rental holds, the instructor has observed that customers struggle with considering and managing the wind as well as current, and balancing the throttle when they are out navigating the sea for the first time.

When the explanation of the future-developed simulator was done, one of the workers suggested that it would be beneficial to have it as a part of the rental course material, which could reduce the time needed to instruct and verify new members. This way rental companies could save money on educating new customers. It could also be used to verify customers in the segment where customer-to-customer can rent boats so that the owner feels more comfortable renting out their boat.

Another aspect of the utility of a boat simulator mentioned in the interview was that it could potentially encourage more people to try boating and to become more confident. Often the workers had witnessed that women are more uncertain about their first-time driving, but they have been the most careful in execution.

C Interview questions

1. Can you tell me a bit about yourself? (Who you are, your interests, what you do during the day, etc.)
2. What is your relationship with boats?
   (a) Do you own or have you owned a boat?
   (b) How did your interest in boating arise?
   (c) Can you share your feelings and preparations when you drove your boat for the first time?
   (d) How often do you usually drive your boat?
   (e) Have you ever encountered challenges or difficulties while driving your boat?
   (f) When driving your boat, where do you prefer to be? Do you often explore new places, and how do you prepare for it?
   (g) Do you have any boat-related experiences you would like to share?
3. Have you ever chosen to lend your boat to someone else? If so, was there any specific occasion or person?
   (a) Can you tell me about your thought process when considering lending out the boat? What factors did you consider, and how did you make the decision?
   (b) How did it feel to lend it out? Were there any fears or uncertainties you felt about lending it out?
4. Have you made any upgrades or changes to your boat since you bought it?
   (a) Can you describe the process when you decided to upgrade your boat? What steps did you take?
   (b) What specific upgrades did you make to your boat and why? Were they related to the motor, accessories, or other improvements?
   (c) Was your boat used when you first bought it, and was it the same boat you upgraded? Or did you upgrade to a completely new boat?
5. Do you have any previous experience with Volvo Penta or their products in the boat segment?
6. A few questions about the boat simulator:
   (a) What are your initial thoughts on the idea of a boat simulator? Do you see any specific things you would like to be able to do with it?
   (b) How do you feel about being able to practice driving in it or test various components or products to get a feel for them?
   (c) Do you see more value in the ability to test various components or in practising boat driving itself?
   (d) How would you use the simulator to prepare for your first boat trip?
   (e) What aspects would make simulator use both fun and educational for you?
   (f) How do you think the simulator can contribute to generating interest in the use of the boat, its various components and functions, or boating life in general?
   (g) Do you see any problems or obstacles that would make the simulator less useful?

   i. How do you view the balance between having a realistic boat simulator and making it user-friendly and accessible?
   ii. How would you describe what makes a simulator feel realistic to you?
7. If you imagine that you have purchased a complete system for your new boat, what would you like to have access to while waiting for the boat to be delivered?
   (a) Are there any specific preparations or areas you would like to learn more about during the waiting period?
   (b) Is there anything specific you would like to explore or familiarize yourself with, such as the boat's display or any specific features?
8. Would you be willing to share your reasoning or thoughts on question # from the questionnaire?

D Interviews

D.1 Interview with a student who owns a boat

About the interviewee: This person was a student in the engineering field who has a big interest in boats. The interest started through his family when going on a lot of boat trips since he was a kid. Every year when he is in his home town, he drives the family boat every single week. The boat is a 7m long motorboat with an inboard engine steered by wheel and throttle.

Experiences: When he drove a boat for the first time by himself he was very young. He remembers that the boat was very big and that it did not steer/respond as fast as i.e., a bike or a car, and that the delay was very noticeable which was the hard part of driving it. The challenges and difficulties when driving a boat according to him is that the boat does not really have breaks and does not stop immediately when you want to, which is crucial when there are objects around like another boat or a jetty. Especially when there are strong winds. The most critical moments are docking and leaving the dock, it always takes practice. The most difficult docking moments are when there is a Y-bar and strong winds, usually when there are stressful moments like this the people on the boat start getting frustrated with each other because it is not easy to direct how someone else should drive or what to avoid.

His parents who own the boat have never lent out the boat either, he says it is probably because he does not think anyone has asked, but also it might be because they are a bit protective of their boat. Especially if the person does not have any boating experience since it is very special driving a boat compared to other things.

He has good knowledge about Volvo Penta's engines but has never driven one himself, but he would really want to test i.e., the IPS system. Therefore he is also very positive about the simulator being able to feel the difference when driving a straight-shaft boat to one with an IPS system with bow thrusters.

Simulator feedback: He would like to test different boat configurations to be able to get a feeling of how the boat is behaving. Both for educational purposes but also just for fun. When asked about where there is the most value between practice driving or testing components and features in the simulator, he said that they were equally important. For the simulator to be attractive and fun to drive in, he wanted a lot of different settings and configurations, test a little boat or a big boat etc. He said that the simulator would probably not increase people's interest in the boating lifestyle, who do not already have one, since that is more about the calm environment and experience rather than the actual driving. But that it would be helpful when choosing the right boat to buy for people with little experience. He said that how the boat behaves depends a lot on the shape of the hull, so the simulator should optimally have a lot of different hulls, but he understands that that can be difficult to implement.

When asked about what types of barriers or reasons for the simulator not being useful, he said that it would be either the price for it or the computer capacity. Otherwise, he is very positive about the simulator and thinks it is a very good idea.

Realistic vs easy access: He said that you could visualize the i.e., joystick in the simulator and that you could steer with the mouse to get it realistic enough, so it is similar to a driver environment. When explaining the idea of having a more robust and realistic simulator at dealers or at OEMs to compensate for the less realistic home simulator, he is very positive about the idea and thinks it would also be beneficial for the salespeople at these places, to ease their jobs a bit. That you can get a rough estimation of the differences at home since it is a very big difference between some components, and then get a deeper understanding at dealers or OEMs.

Onboarding: To test drive in a simulator with all the controls that would be in the bought boat would be beneficial, so you can practice driving it before receiving it. But here it would be necessary to have a wheel or joystick to get the real feeling of it. The most important to practice driving is docking and leaving the dock because that is the most critical aspect when driving any boat. He would not be so interested in testing the display or such while waiting because he feels that he would easily understand it, but for someone who is not as technical, it would be useful.

When buying a boat: It is usually not difficult to buy a boat, it all depends on how much you are willing to pay, but usually, you know what you want in a boat.

He did not think that a lot of stages or moments when driving a boat is difficult, but he still thinks a simulator would be useful to practice some, for example, docking or leaving the dock, because all practice is good. Especially if you could be in more difficult scenarios with i.e., stronger winds.

He thinks that usually people buy second-hand boats because boats are generally very expensive. Sometimes you buy a new engine and steering system on an old hull.

Birdview would be a really good tool, especially on a big boat since it is very difficult to see land when you might steer a few meters back. The most crucial would be to have sensors in the front and back that would hinder the driver from hitting something. The cost depends on the value of the boat, for a 10M boat, then 50k would be something you would pay. But for his boat, valued not more than 100k, then he would have a limit himself to pay 5k for it.

D.2 Interview with a man with a Volvo Penta engine

About the interviewee: The interviewee was a male in the age between 41-60 who is a project manager at an installation company. His interest in boats started when he was young when going on trips with his family. Those boats were a smaller kind but then when he got older he bought his first boat which was a day-cruiser, upgraded to a 28ft with a Volvo Penta engine, and then he bought a 33ft boat with

a Volvo Penta engine. He said that the boats he bought were bigger and bigger and therefore more expensive which is according to him, normal when upgrading boats. He knew about Volvo Penta but not much about their product range more than it was "really good products".

Experiences: Every summer he and his wife take the boat out for a ride almost every day during their vacations, and during the weekends when at work. But as the boats became larger, his wife became more scared of driving them. Therefore he has had the idea of having "training facilities" in the water where there are inflatable jetties where you can practice driving your boat without being scared or damaging them. The biggest difference when going up in size from driving smaller boats to larger ones was that you are usually under a roof in bigger boats and therefore you have less vision over the boat's edges, and it is harder to keep track of where the boat is positioned. According to him, it is all about knowing how to handle the bigger boats correctly in all situations, which becomes harder for bigger boats. Sometimes he has also avoided going to new harbours because of insecurities when docking the bigger boats when there are stronger winds. He had accidentally run aground and scratched the bottom of his boat because he thought he was driving where he had been before but when he looked at the Garmin plotter display (GPS) he saw that he was at another place, so navigation is not always easy. It can also be difficult because currents sometimes make the boat drift from the course which is not always noticeable.

Driving to new places: He likes taking the boat to new places and harbours and usually he prepares by looking at the Garmin display or apps on his phone or iPad to get familiar with the area so he knows how it looks before actually going there.

Lending out the boat: He has never lent out the boat because he cares for his boat and does not want anyone to accidentally damage it because it is such an expensive product.

Buying new boats: The interviewee has bought his boats secondhand and thinks that is the most common way to buy especially the first boat. Then when you have got used to it people might buy a new boat from a dealer because they know more about what they want, which might only exist at a dealer and not secondhand. The decision of which size etc to purchase is mostly about the price, it is very expensive to buy a boat, so usually they go up in size for each boat they purchase.

Simulator feedback: He was very positive about the usage of the simulator, especially to practice driving and be able to try out doing things you are too scared to do with your actual boat, i.e., dock with higher speed to compensate for strong winds and generally drive more rough. To see if there are any benefits to driving differently in different situations. He also stated that his wife would really want to try a simulator out to practice drive and become more confident in driving their boat again.

When talking about what is the most valuable about practice driving or testing new components or features, he mostly talked about the high value of practice driving, but also said that testing different components such as the joystick would be good to have in the simulator. It is something he has never tried before but would want to, and it is always good to be able to test all different assistive tools and features to get a feeling about them, and that the demand will increase for these. He explains that many people buy their boats without testing them before, even him, because it feels like meeting up with a boat breaker, dealer etc. takes a lot of time and energy to set up. So usually you avoid doing that because you do not have time or feel like you are a burden on those people. Therefore he would also prefer if you could test different boats in the simulator to get a feeling before buying it. He would like the simulator to be as realistic as possible, and be able to see the view as if you were standing inside the boat. A demand he said was for it to be able to roughly configure the boat to be as similar as their own, so choose between one or two motors, or bow thruster or not etc, so the practice driving could be suitable for each case. But it would be enough to only have a few choices for i.e., hull shape.

For the simulator to become fun and educational to use he said that it should look good, with nice aesthetics, interface and environment, to try to get it as nice looking as possible.

An idea to have in the simulator would be to see how the boat drifts away while driving it in different strengths of current, to learn when navigating.

He thinks that the simulator definitely would increase people's interest in boating because then they could see how easy it could be and become more confident in buying their own. He suggests having it for boating courses or schools to increase people's interest and make education more fun. He wishes that the simulator was not restricted to Volvo Penta products, so it could be useful to more people in many different scenarios. Because if someone wants to use it to practice, but does not have Volvo Penta components, it is not as useful.

Realisic vs easy access: He thinks the simulator should work from home with easy access so as many people as possible could use it. But he also wants it to be as realistic as possible and understands the challenge between them. He feels like the home simulator could be difficult to get realistic when driven by mouse or keyboard, but that the user could get some rough estimation or feel for the products. He also states that he would then want to have a more realistic simulator places somewhere where you could test it out with real components and controls for a low price. Then people who are interested in buying their first boat but do not really dare to because they feel insecure can try it out and get a feeling of it. He thought it was a good idea when explaining that the simulator could be one less realistic at home and one more realistic with the right controls at another location where a fully equipped simulator could exist, it would be good for the purpose of trying a boat before buying it.

Onboarding: While waiting for a new boat he would love the idea of being able

to go through the new display and learn how to configure it before you receive the boat because then you just want to drive it and not focus on details of the display. So that idea he would be very happy about. Reading the manual usually does not help him because they are not very good, so usually he tests his way through it nowadays. Then practice driving would also be a way to make the waiting more fun.

Birdview/sensors: The most critical aspect/moment when boating according to him was when docking, especially if there is any side wind. This becomes even harder when the boat becomes bigger because then you have less vision over the boat. Follow-up questions were asked if he thought that it would help if you had a surround view/bird view over the boat and some type of technique that would steer the boat away from objects so that it was not possible to accidentally damage the boat. He said it would be helpful on bigger boats where it is hard to see where the boat is positioned, but on smaller it is fine without them. He also added that even though he would have cameras, he would still maybe look over the shoulder because he does not 100% trust the technology, the same as sensors in a car. He also knows that 360°cameras already exist on bigger boats. To have sensors that prevent you from colliding with anything he thinks would maybe take away the feeling of steering the boat yourself, so that type of technology was not so appealing to him. Although he thought there are probably many people who would want it because it is an assistive tool which is always good. Furthermore, what to pay for that equipment he believe depends on the relation to what the boat costs. If you have a boat for 11M then of course you could pay 200k for this type of system.

D.3 Interview with boating expert who has boat simulator experience:

About the interviewee: The interviewee was a male between the age of 41-60. He has been interested in boats his whole life and found it through his family and bought his first boat at 15 years old. Then he did compulsory military service in the navy as a conscripted engineering officer. Today he works at Trafikverket as a district technician who is in charge of technical maintenance for all road ferries in Uppland.

At his workplace, they have a stationary boat simulator with real physical components to imitate the inside of a bridge/cockpit. It is used for educating maritime officers, so they can practice before controlling a real ferry, which has resulted in a reduced amount of damaged ferries. It does not have accurate waves or winds, the boat is not affected by the environment in that way.

Boating experiences: The first time he was driving the boat himself he was very scared because it is very different driving a boat from another vehicle like a car. The scariest part is that the boat does not have a break, so there are a lot of other things to consider and it is easier to make mistakes because of unforeseen surprises such as weather and wind. He shattered a window on the boat because the docking

did not go as planned because of wind he did not expect. The biggest difference between driving different-sized boats is the manoeuvring at slower speeds, which he thinks is a useful thing to test in the simulator.

He has never tried Volvo Penta's IPS system or joystick even though he tested a lot of other Volvo Penta products. But it is something he wishes to try because he has seen how easy it is and that the boat can move in ways not possible otherwise.

Visiting new places: Before going to new places with the boat, he likes to explore the area with the sea chart to see where he should be driving. He always has extra fuel with him and a plan B to go to some other harbour if for some reason the boat does not fit at the desired harbour.

Lending out the boat: He has not lent out his boat to anyone because he does not think anyone would dare to lend it because of his high expertise in boats. But he has lent many other people's boats and often got the feeling that the owners were a bit insecure about letting someone else drive it, even though he could show papers that he was experienced. He thinks this is mostly because it is much more difficult to drive boats than i.e., a car because they differ very much depending on size or model etc. He thinks that if you could show that you could drive their boat in a simulator it would make them more comfortable lending it out.

Upgrades on his boat: He has changed out the motor and the steering system himself from cable to hydraulics to get better traction in the boat and be able to keep the rudder where he wants if letting go of the steering wheel.

Buying new boats: Himself like most other people has bought their boat second-hand, the reason for this is that not many people can afford to buy a new boat. But many people who like their boat do upgrades on it such as changing the engine or drivetrain.

Simulator feedback: He thinks it is a very helpful tool, it could be a way for people to try the boating experience and get a bigger interest in joining that lifestyle. Also, it could allow people to feel more secure and buy bigger boats than they otherwise would, because many people are too scared to go up sizes today.

He also thinks that trying out and getting a feeling for different components would be very helpful before purchasing a boat to see if the boat will feel as desired. But also to see how beneficial some accessories could be on your boat.

He wishes to be able to feel the difference in how the boat behaves when driving it very slowly since that is something that feels very different from boat to boat, and has different situations with different difficulties. This is to enable and see if it is something you can actually master or where the limits are. A desire is that the simulator could be used more as a game as well with different fun tasks to perform so that it could also be very fun to use, more than just driving around in an en-

vironment which could get very boring. This could also contribute to more people wanting to own a boat because you can see how fun it could be, especially if there was an online option where you could drive with your friends.

The appeal of the simulator should be realistic with good graphics and the map is accurate to the sea chart. He would want the view to be different depending on what you want to accomplish or do, a view from inside the bridge is good for the realistic parts, but seeing it from above in the more gaming situations.

For the simulator to become realistic he says that realistic waves would be preferable but difficult to simulate because it requires advanced hardware. But it can become realistic through good images and also by testing different things and scenarios to get a feeling for it.

Obstacles to the usability of the simulator would be if it was expensive to use, then the people who do not own a boat might not want to try it out because they do not feel like they want to put money on something they might not be interested in. He wants the simulator to be accessible from home to enable as many users as possible. To use physical components would be nice, preferably it could be something people have at home. Without physical components, the simulator would not be very realistic but the user could still get a feeling for the product and see how wind and currents etc. affect the boat. But it will not be very realistic because a lot of driving is in the muscle memory and without that it will be hard to get a realistic feeling.

It would be good if the simulator had different teaching modes for situations such as docking, driving in a sea channel, or driving against current etc, to learn how to act in those situations. Another suggestion is that you should be able to adjust wind etc. and try situations you would not dare to in real life to see if it is something you could handle or get instructions on how. All types of training would be interesting, even going through a display.

Onboarding: While waiting for your boat he says it would be fun and educational to be able to visit a place with a stationary simulator with real components with some teacher that can show you how your boat works, get tips, etc. so the user will become more comfortable with what they bought and know what to do once they get into the water.

D.4 Interview with a woman who owns a boat

About the interviewee: The interviewee is a 43-year-old woman with a husband and three kids. She works as an administrator at a Swedish municipality and took her boat licence in February 2024.

Boating experiences: While she was growing up, her grandparents used to build their own sailboats where she spent a lot of her time and then her parents bought a motorboat that she used to go on trips with them in. This inspired her to do

the same with her family now and therefore she bought her own motorboat. She thought the first time driving the boat was a bit scary and she was very nervous and explained that a boat is very different from a car. She and her husband take out the boat every summer, and she drives as much as she can until she feels too nervous in certain situations where her husband takes over. One of these situations was a cold and windy summer, where she barely drove anywhere. She also has difficulties docking the boat and driving from the harbour, she explains that she once secured the boat on a buoy on a lake but it was difficult because she did not have any vision on it and her husband gave her different indications that made her confused. She mostly avoids situations where the boat can be damaged, even close to oncoming boats because not everyone follows the rules so she gets insecure on how to handle these situations.

Visiting new places: Her dream is to drive around Värnern, but so far they have been around the closer smaller islands. When going to new unfamiliar places, she looks up a route in the boat GPS first, then her husband drives and she can keep track of signs, traffic, water depths and so on, then the next time she drives the same route to practice and see what she remembers. But she always follows the route on the GPS.

Lending out the boat: She has never lent out the boat because she knows that they are responsible if anything happens, and she will not take that risk.

Upgrades on the boat: She bought a rearview mirror by the rudder to make it easier to look backwards and wifi for the kids.

Volvo Penta experience: She did not have any personal experience with Volvo Penta boat engines, but when they went to buy a boat she noticed a lot of boats containing a Volvo Penta engine but explained that they were inboard engines which she felt are more difficult to work with if anything breaks.

Simulator feedback: She immediately thought that it was a good idea where she could learn how to steer a boat with an outboard motor, how a boat responds depending on how sharply she turns, how to accelerate, brake, and reverse. She especially wants to use the simulator to be able to practice boating as realistic as possible with GPS and traffic.

She would use the simulator to prepare her for a boat trip by driving out from the dock by reading the wind speed and direction and trying to reverse out, then she would feel how the speed and reactions are depending on how fast she is driving. She wants the simulator to be as realistic as possible with challenges you find at the sea.

An important aspect she brought up was the view on the simulator, she wants it to be as if she was driving the boat where some things such as the window or chapel are in the way, and be able to mimic standing up in the simulator to get a better view.

She would especially want to get better at reading the GPS, radio, and the whole dashboard.

D.5 Interview with a high-ranking employee at Volvo

About the interviewee: This interviewee worked at Volvo Penta and has a big interest in boats, although most sailboats. He started his interest in boats when he was a child, and now he owns his own that he sails all year around.

Boating experiences: He has tried bigger motorboats which he feels are very different to drive than a sailboat. It has more power and some challenges with boating are connected to docking scenarios, especially with a lot of people or boats around. It is a stressful situation, and therefore he recommends preparing the boat for docking with the fenders etc. before the actual docking.

Visiting new places: He looks up new places on a map before going, to see that the boat will fit and to make a plan when getting there. There are also some designated spots to park that anyone can rent which makes it feel better when going to a new place when you know that there is room for the boat.

Lending out the boat: The interviewee lends out his boat to his kids because he also wants them to share his interest in boats, and he thinks that the simulator could be a good tool for them to practice in. He also thinks it can be used for rental companies or to rent out the boat where the person can prove their skills with the simulator and also needs to answer a few situational questions to get an idea of how the reaction would be in some cases. So the one renting out the boat can get an understanding of how the person who wants to rent the boat will reason and behave.

Simulator feedback: He thinks it is important that the simulator is not only used by the keyboard, he thinks it is beneficial to use the actual joystick or steering wheel to get a more realistic feeling. However using only a keyboard will still give the user some understanding of boating, so it is still useful without the physical steering tools. He recommends that some places like a dealer could have the physical tool as a complement so the user can get the more realistic feeling if desired.

He said it is good if the simulator has different types of boat configurations, big and small boats, with one or two engines etc. This will give the user an understanding of what to buy and what the differences are. Adjustable wind would also be beneficial to get more realistic scenarios and create different practice situations where the user will get feedback and tips on how it went or what could have been done better.

For the user to get engaged in the simulator he wishes it to have different scenarios and a point system to feel a need to continue until a full score. The realism is also important, so it feels like a real situation, the better the visual aspects are the more realistic it will feel. Realistic movements he thinks are very difficult to simulate, but

as close as possible would be good.

For people without a prior boat interest, the simulator can be a first step to learning about boating that could awaken the interest to buy a boat.

E Questionnaire

E.1 Own or have owned a motorboat/yacht

In total 61 participants belonged to this category. The majority of these participants were men between the ages of 41-60 and most of them were either experienced or very experienced boat drivers. See Figure E.1.

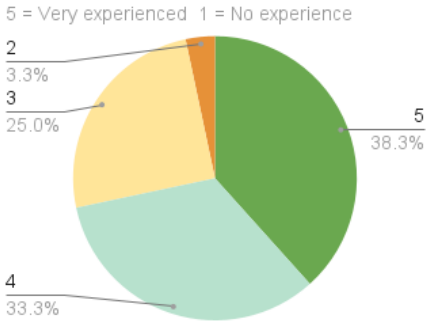


Figure E.1: Self-assessment in level of experience for "Own or have owned a motorboat/yacht" respondents

"What factors have been most confusing or difficult to understand when considering buying a boat?"
Of the respondents in this category 65% answered that there were no issues in choosing the model, boat brand, propeller system, steering system or engine. If any concerns, there was a 20% of respondents who thought "choice of model" was the most confusing or difficult when buying their boat followed by "choice of brand" 8,33%. The least concerns were about "choice of propeller system" 5%, "engine" 5%, and "steering system" 3,33%.

These answers indicate that it was few or very few concerns about the buying process of a boat which involves Volvo Penta products directly, such as the propeller system, engine and steering system. From the free writing text box the answers were mostly about compromising between functionality versus price of the boat and finding the boat that best meets the requirements and desires for usage, whether it was for fishing, swimming or both.

"What is your opinion about the usefulness of the described simulator? [Testing components]"
The majority of respondents described the usefulness for testing components as very useful 25%, or useful 41.67%. Only 11.67% thought the simulator was "less useful", 3,33% "not useful" and 18% were neutral.

"What is your opinion about the usefulness of the described simulator? [Practice on boat driving]"
The majority of respondents described the usefulness for practising driving as very useful 40% or useful 35%. None of the respondents thought that the simulator for

this case was “not useful” but 10% thought it was either less useful and 15% were neutral.

“How would you rate the difficulty level of the following situations when boating?”
The majority thought strong winds, strong currents and docking were the most difficult part of boating. The complete resulting answers are presented in Figure E.2.

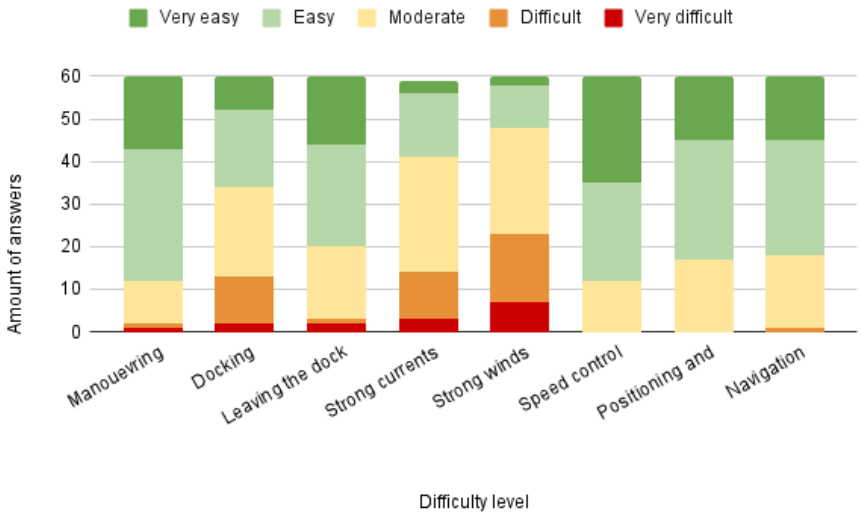


Figure E.2: Self-assessed rating of difficulty level in boating for respondents “Own or have owned a motorboat/yacht”

“Do you believe that using a boat simulator could contribute to improving your skills and reducing uncertainty when operating your boat, or someone else boat, for the first time?”
Of the participants 80% answered “Yes” on the question and 20% answered “No”.

“What features and training scenarios would you like to test in a boat simulator?”
In this question, it can be inferred that the desire to test docking and handling strong winds is of high priority. The complete resulting answers are presented in Figure E.3.

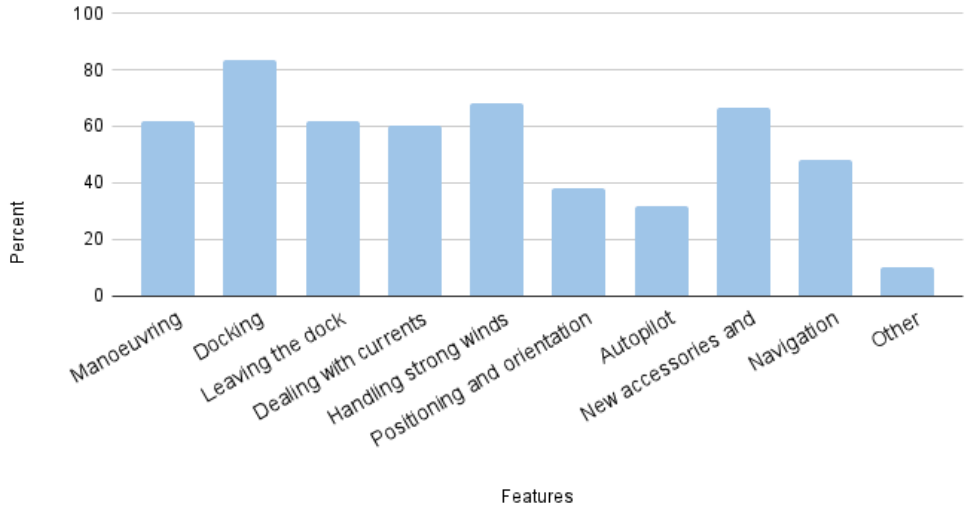


Figure E.3: Features in the simulator to test according to respondents who "Own or have owned a motorboat/yacht"

"How interesting would it be to see the following features in a boat simulator to evaluate different boat components/accessories?"
The opinions on which features the participants wanted to see in a simulator to evaluate components and accessories had a wide spread on which was the most interesting. In total the greatest importance was to see manoeuvring and different steering controls, see Figure E.4.

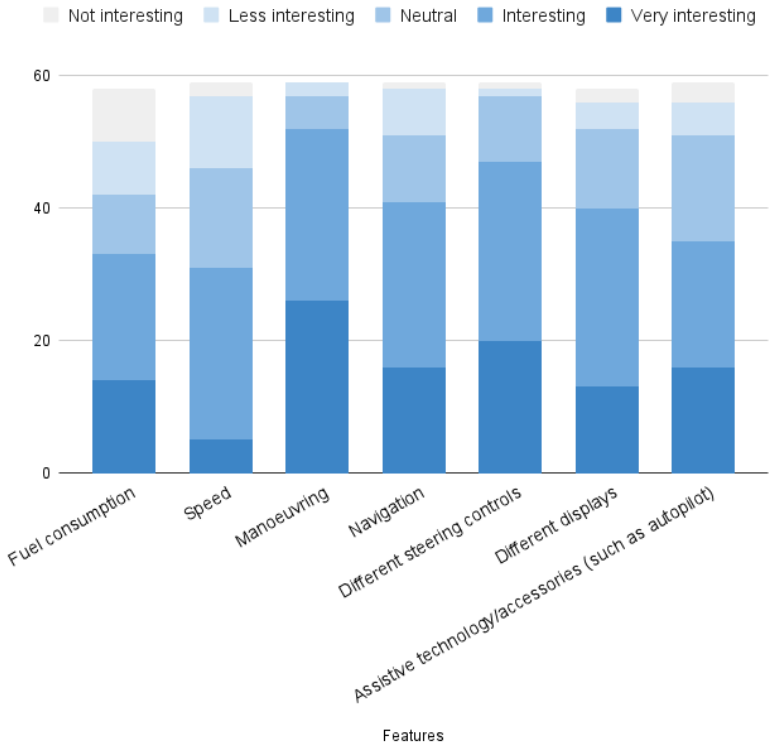


Figure E.4: Features in the simulator to evaluate boat components according to respondents who "Own or have owned a motorboat/yacht"

E.2 Considering or have considered buying a motorboat/yacht

The number of participants was eight people in this category. The majority of respondents were men between the ages of 25-40. In this category, the largest group belongs to the "non-experienced" category out of the four possible choices of experience level.

E.5

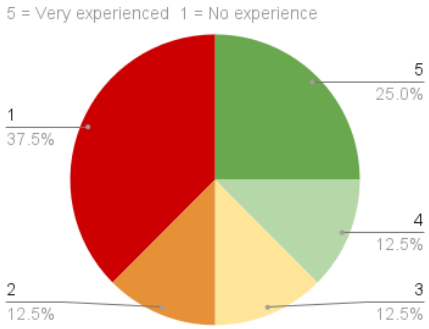


Figure E.5: Self-assessment in level of experience for "Considering or have considered buying a motorboat/yacht"

"What specific moments or situations do you feel unsure about or do you think are the most difficult when it comes to driving a boat?"
Of the participants in this category, 75% chose navigation. Docking 37,5% was the second most answered, followed by strong currents 25% and positioning and orientation 12,5%. However, no one answered manoeuvring, leaving the dock, strong winds or speed control.

"What is preventing you from buying a boat?" The biggest obstacle preventing the participants from buying a boat is mostly because of the expense or lack of time.
E.6

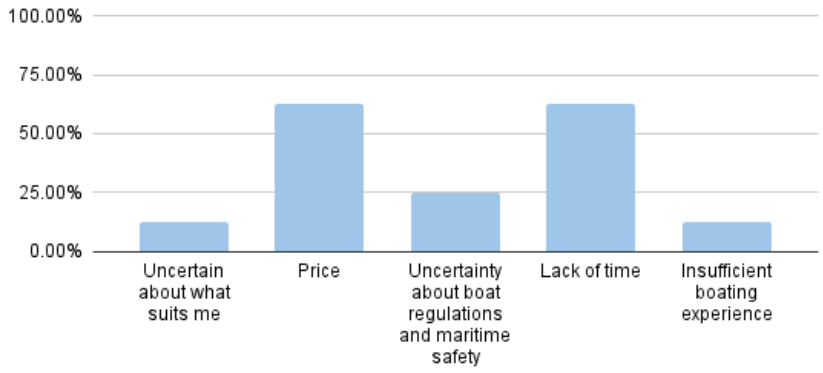


Figure E.6: Reasons that prevent a boat purchase from the respondents who were "Considering or have considered buying a motorboat/yacht"

"Do you think using a boat simulator could help improve your skills and reduce uncertainty when driving a new boat for the first time?"
Seven out of the eight respondents believed that the simulator could help improve their skills and reduce uncertainty when driving a new boat.

"What is your opinion about the usefulness of the described simulator? [Testing components]"

The opinion about the usefulness of a simulator with the purpose of testing components was 37,5% very useful, 50% useful, and 12,5% neutral and no one answered less useful or not useful.

"What is your opinion about the usefulness of the described simulator? [Practice on boat driving]"
The opinions about the usefulness of a simulator to practise driving were 62,5% very useful, 12,5% useful, 12,5% neutral, 0% less useful and 12,5% not useful.

"What features and training scenarios would you like to test in a boat simulator?"
Manoeuvring, docking and navigation were the most interesting features and scenarios to test, see Figure E.7.

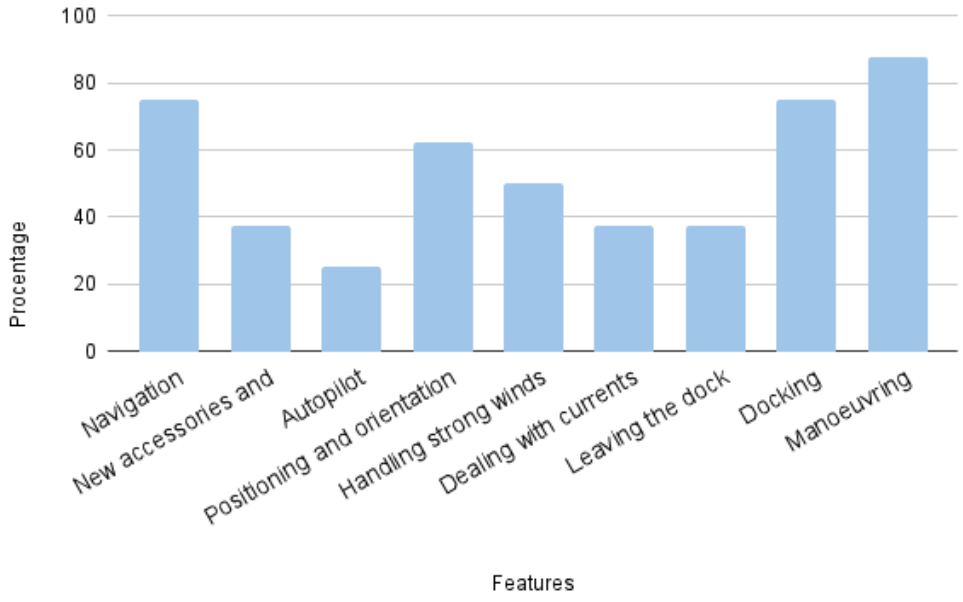


Figure E.7: Features and training scenarios in the simulator to test according to respondents "Considering or have considered buying a motorboat/yacht"

"How interesting would it be to see the following features in a boat simulator to evaluate different boat components/accessories?"
The respondents wanted to test manoeuvring and different steering controls the most in the simulator, where fuel consumption was the least attractive feature, see Figure E.8.

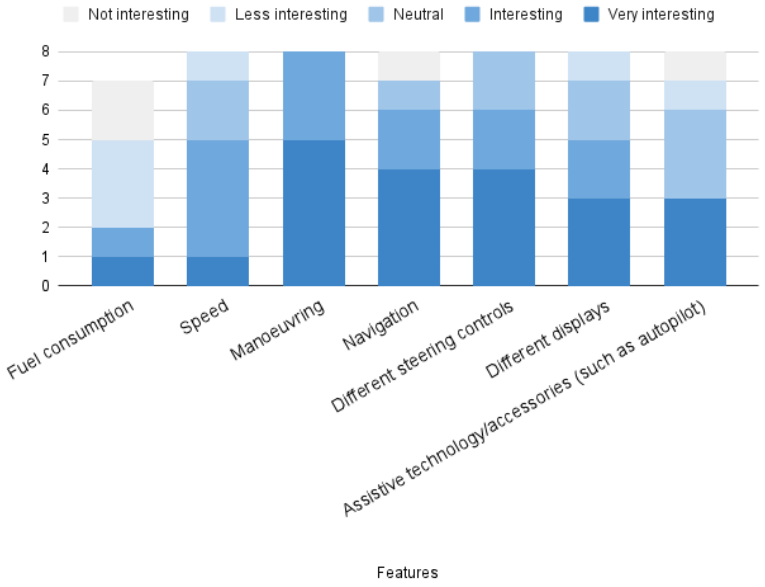


Figure E.8: Features in the simulator to evaluate boat components according to respondents who are "Considering or have considered buying a motorboat/yacht"

"What is your opinion on the possibility of using a simulator to test different boat components and customize your own boat before buying a fully equipped boat?"
The opinion on the possibility of using a simulator to customize the boat before buying it was significantly positive, see Figure E.9

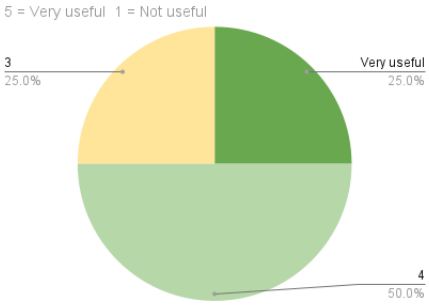


Figure E.9: Opinion on using a simulator to test components before buying according to respondents who are "Considering or have considered buying a motorboat/yacht"

E.3 No interest in buying a motorboat/yacht

The number of participants was 15 people in this category. The majority of respondents were men between the ages of 25-40. In this category, the participants had scattered experience levels, see Figure E.10. Most of the respondents were interested in renting a boat sometimes, 60%, 20% were not interested in renting a boat

sometimes and 20% were not sure.

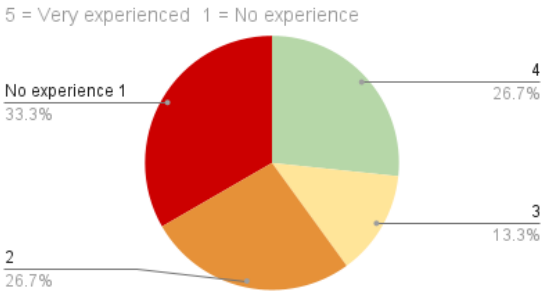


Figure E.10: Experience level on the respondents who have "No interest in buying a motorboat/yacht"

Features and training scenarios would like to see in the simulator to test? The most relevant features to test according to the respondents were docking, leaving the dock and handling strong winds, see Figure E.11.

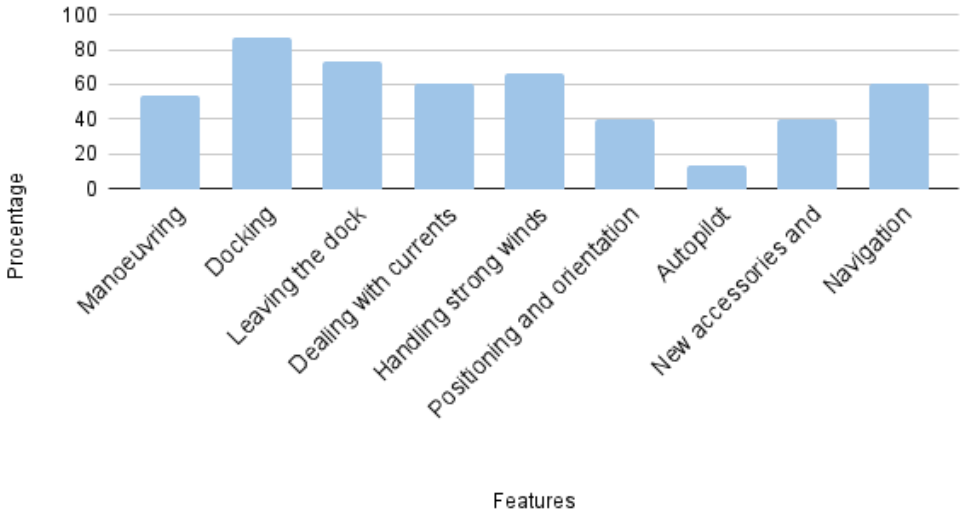


Figure E.11: Features to test in the simulator according to respondents who have "No interest in buying a motorboat/yacht"

What is your opinion about the usefulness of the described simulator? [Testing components]
Of the respondents, 20% thought it was very useful, 46,67% useful, 20 % neutral, 6,67% less useful and 6,67% not useful.

What is your opinion about the usefulness of the described simulator? [Practice on boat driving]
Of the respondents, 20% thought it was very useful, 46,67% useful, 20 % neutral,

13,33% less useful and 0% not useful.

What specific moments or situations do you feel unsure about or think are the most difficult about driving a boat
The most concerning moments and situations for the participants were docking, strong winds and navigation, see Figure E.12.

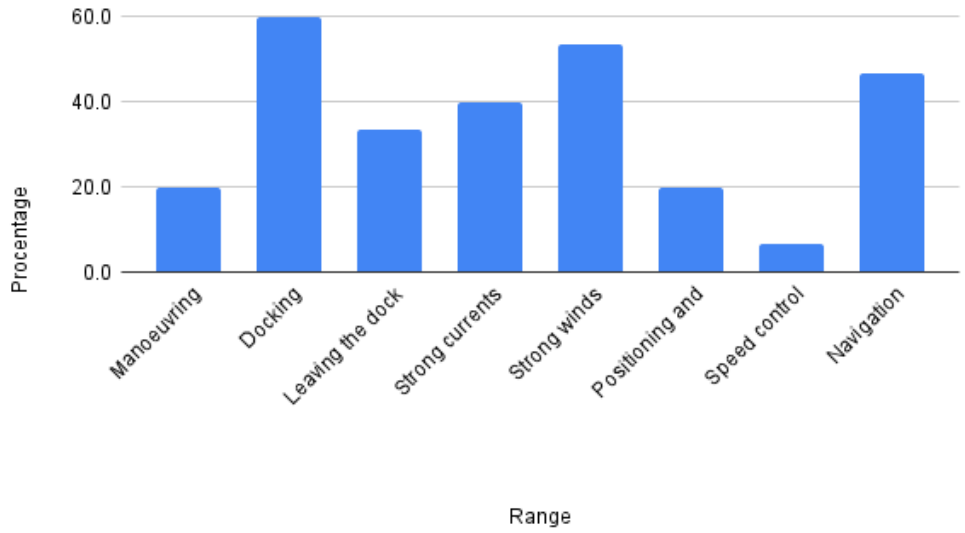


Figure E.12: Most concerning situations according to respondents who have "No interest in buying a motorboat/yacht"

What is preventing you from buying a boat?
The main reason for not buying a boat according to the respondents in this group was the price, lack of time and insufficient boating experience, see Figure E.13.

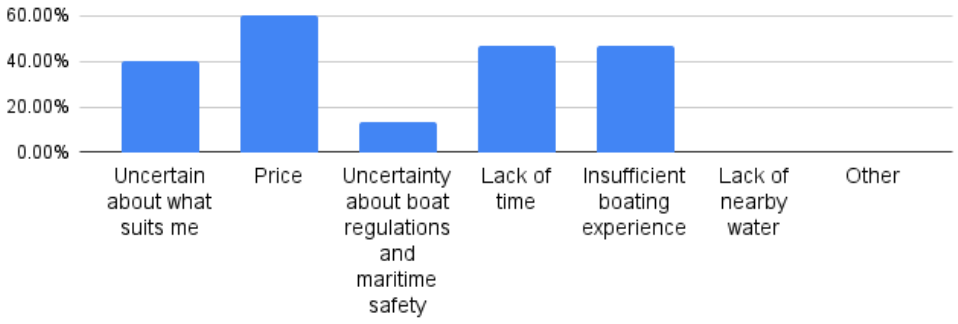


Figure E.13: Reasons not to purchase a boat according to respondents who have "No interest in buying a motorboat/yacht"

What is your opinion on the possibility of using a simulator to test different boat options and features before actually renting or buying a boat?

Of the respondents, 20% thought it was very useful, 46,7% useful, 26,7 % neutral, 6,7% less useful and 0% not useful.

F Customer needs to Criteria

	Requirement specification		
	Verison: 1.0		
Source Q=Questionnaire I=Interview	**Input**	**Need**	**Criterion**
	Challenges with driving boats:		
Q	Many people feel insecure while boating.	Become less insecure while boating	Be able to practice boating
I	Do not want to lend out the boat to people with uncertain boating experience.	Become comfortable when lending out your boat	Be able to test drive someone elses boat
I	Do not want to lend out the boat because they are protective of it		
I	Do not want to lend out the boat because they are not sure the other person can drive their specific boat.		
I	Do not want to lend out the boat because it is an expensive product.		
I	Do not feel comfortable when someone else is driving your boat.		
I	Boating is very different from other vehicles.	Become familiar with boat basics in a safe environment	Learn boat basics
I	There is a delay when steering or trying to stop the boat which is shocking and difficult when driving for the first time.		
I	First time boating getting a feeling of the throttle can be difficult		
I	A phycical safe environment to test drive the boat would be useful, like inflatable docks		
Q	Winds makes boating difficult.	Become more comfortable driving in different wind strengths	Adjustable wind strength
Q	Strong winds makes the docking difficult.		
Q, I	Navigating is sometimes difficult.	Become more comfortable navigating	Include a sea chart Pratice navigation
Q	Currents makes boating difficult.	Become more comforable driving in strong currents	Adjustable current strengths
Q	People think strong currents are difficult when boating.		
Q	Docking is a difficult situation when boating.	Become more comforable with situations in different harbours	Test drive different scenarios
I	Y-bars are difficult to dock in.		
I	Avoids new harbors because of insecurities when docking.		
I	One of the most critical moments are docking, practice is key.		Test drive in different environments
Q	People think docking is difficult when boating.		
I	One of the most critical moments are leaving the dock, practice is key.		
Q	People think navigating is difficult when boating.	Become more comfortable navgiating in different areas while enjoying the environment	Practice naviation with disctractions
I	High focus on the map is required to prevent accidents, but it is not always easy.		
I	Navigation is not always easy, you can misinterpret where you are.		
I	Preparations before visiting new places involve looking at the GPS to get familiar with the environment.		
I	The bigger the boat, the scarier it is to drive it.	Become more comfortable driving bigger boats	Include big boats
I	Some people avoid driving bigger boats because insecurities.		
I	Less vision over the boat the bigger it gets.		
I	Harder to maneuver bigger boats.		
Q	People think orientation is difficult when boating.	Become more comfortable of the positioning and surroundings of the boat	Practice positioning from different views
I	Beeing able to see a surround view of the boat would be helpful for bigger boats to see its position.		
I	Front and back sensors would be the most useful.		
I	There is a lot of things to consider at the same time while boating, easy to miss something as a beginner	Become aware and comfortable with situational awareness	Situational awareness training
I	Ropes can get stuck in the propellar while boating which causes damage.		
I	Sometimes you get a swell in the boat which can cause damage or disturbance.		
I	Navigating in the dark is very difficult.		
I	Manoevring in slow speeds is difficult and differ from boat to boat.	Practive driving in slow speeds	Enable different speeds

	Technical requirements and user experience:		
I	The simulator should not be expensive to use	A affordable and enjoyable home simulator with an attractive interface and pleasing aesthetics	Affordable
I	Good aesthetics and a nice interface for the simulator to be fun.		
I	The simulator could be used for fun.		Exclusive aesthetics
I	Simultor can be used from home.		Enjoyable
I	The simulator could be used for educational purposes.	Need for an educational practice tool to get a better feeling for boating	Have an educational practice mode
Q	Simulator can be used for practicing.		
I	Simulator would be helpful for people with little experience to get a feeling for boats.		Realistic feeling for boating
I	Equally important to use the simulator for practicing as test components.	Tool for exploring and get a feeling for different products and asseccories	Include existing products and their behaviours
I	Home simulator can be used to get a rough feeling and overview of the products.		
I	Want to test different assistive tools and components to get a feeling for how they work.		Component walkthrough
I	Do not want the simulator to be restricted to only Volvo Penta's products.		
I	Boating is more about the envrionment and experience rather then the driving	A simulator that is as realistic as possible with physical steering components	
I	A more realistic simulator with physical components can be placed at a reachable location.		Realistic environment
I	A more realistic simulator with physical components at a reachable location would compensate for a less realistic home simulator.		Realistic boat
I	Wants to be able to drive the boat as realistic as possible without features your own boat do not have.		Realistic movements
I	Want the simulator to be as realistic as possible.		Realistic waves
I	Simultor view from inside the boat as in real life.		Physical components
I	Accurate waves would make the simulator more realistic		
Q	Show navigation in the simulator with correct sea chart.		Accurate sea chart
Q	Show display in the simulator.		
I	Be able to select view.	Drive the boat from different views	Enable different views
I	Drive the boat with the view from inside the bridge.		
	Effective training in the simulator:		
I	User can understand how to drive by muscle memory.	Practice driving in real-life scenarios as you would in actual situations	Real life scenarios
I	Practice driving is usually done by aiming towards and around a buoy.		
I	All practice is good, even if some situations do not feel difficult.		Logical workflow
Q	It would be very useful to use the simulator for practice driving.		
I	Trying new ways of driving in the simulator to find more beneficial ways of driving in certain situations.	Test new way of boating and push limits	User can customize environment
I	Simulator can be used to try things you normally avoid with your boat because of insecurities.		
I	Want to test the display before receiving the boat to get familiar with it.	Get familiar with the display and its functions	Display walkthrough
I	Would want to test IPS system.	Experience difference with driving with IPS and non-IPS equipped boats	Allow different compoentents
I	Want to test difference between straight-shaft boats and IPS system with bow thrusters.		Include IPS system
Q	Test maneuvering.	Become more comfortable with maneuvring the boat	Steering practice
Q	Manoeuvring is the most important to be able to do in the simulator.		
Q	People want to be able to see the speed in the simulator.	Want to see the speed of the boat in the simulator	Show speed
I	Would want a teaching mode in the simulator to learn what to do	Teaching mode with directions on how to handle different situations	Enable instructions in situaions
I	Wants instructions or tips of what to do in different situations		
Q	Test docking.	(Same as earlier)	
Q	Test leaving the dock.		
Q	Test different currents.	(Same as earlier)	
I	Want to see how the boat drifts in different strengths of current.		

Q	Test different wind strengths.	(Same as ealier)	
	Adaptation of boat size and configuration:		
I	Want to choose the engine, steering type, thrusters, and hull for the simulator boat.	Be able to test different boat compositions to get a feeling for the components	
Q	It would be very useful to test different components for the boat in the simulator		Allow configurations
Q	Be able to test difference between different steering controls.		Offer different engines
Q	Simulator can be used for testing different accessories.		Offer different steering tools
Q	Simulator as a tool for testing different boat configurations.		Offer different propulsion systems
I	The simulator should have many different boat options.		
I	Test different boat configurations to feel difference in boat behaviors.	Be able to test different boat compositions to a feeling for the different behaviours	Offer different shapes of hulls
I	The shape of the hull affects how the boat behaves.		Offer different boat sizes
I	The weight of the boat affects the maneuverability.		Offer different boat weights with accurate center of gravifty
I	Simultor as a tool to find the right boat	Configure a customized boat to suit personal preferences or purchases	Automatic configuration of purchased product
I	Want to configurate the boat to the same as the customer bought to get a feeling for it.		
Q	Be able to configure and test a boat to see what suits the buyer, to get a customized boat		
I	People want to test drive a boat in the simulator as similar to their own as possible.		
	Purchasing boats and limitations		
I	People usually buy their first boat secondhand	Get more comfortable with buying the boat you want and know what features you prefer in an early stage	Show where the products can be purchased
I	When owned different secondhand boat, you know what features you want and buys that from a dealer		
I	When comfortable with the first boat, you usually upgrade to a bigger boat		
I	When buying boats the price often limits the amout of add-ons and functions	Less expensive to own a boat	Communicate the value of the proucts
Q	A barrier for buying a boat is the price.		
I	Price is a limiting factor when buying a boat.		
Q	A barrier for buying a boat is lack of time.	Purchasing boats should require less time and energy	Allow for virtual testing
I	Not many test drive their boat before buying it because of time limitations and energy.		Allow easy purchase
Q	When purchasing a boat a understanding of how the interior and exterior spacing looks like	Get a feeling of how the layout of different boats look	Focused views of the boats layout
Q	Not sure if boating is of interest	Become more comfortable and curios driving boats as a non boat owner	Easy accessible
Q	People do not want to buy a boat because of insufficient boating experience		Increase interest for boatlife
I	A boat simulator could be used as a learning tool for rental companies.		Enable verification of boat skills

G Concept Evaluation

	Weighting factor Importance of existence for each persona 1 = Low weight 5 = High weight			Estimated criteria fullfillment 1 = Low 5 = High	Weighting factor Importance of existence for each persona x Estimated criteria fullfillment			Quality 1=Poor 2=Fair 3=Good 4=Excellent 5=Outstanding			
Verison: 1.0								Demand	Wish	User tests	
Sorted criteria	**The un-experienced boat driver**	**The experienced boat owner**	**The boat buyer**	**Concept 2:**	**SUM C2 Persona 1:**	**SUM C2 Persona 2:**	**SUM C2 Persona 3:**	**Acceptence level**	**Target level**	**Actual level**	**Comparision**
Boat Practice and Testing:											
Be able to practice boating	5	4	3	4	20	16	12	Good	Excellent	Poor	-
Be able to test drive someone else's boat	1	3	2	4	4	12	8	Fair	Good	Fair	0
Learn boat basics	5	2	1	2	10	4	2	Fair	Good	-	None
Enable instructions in situations	5	3	2	3	15	9	6	Fair	Good	Fair	0
Test drive different scenarios	5	4	4	4	20	16	16	≥ 3	≥ 5	3	0
Test drive in different environments	5	3	3	4	20	12	12	≥ 2	≥ 3	2	0
Practice navigation with distractions	3	4	1	3	9	12	3	Poor	≥ 2	-	None
Practice positioning from different views	5	4	3	4	20	16	12	≥ 2	≥ 4	-	None
Display walkthrough	5	3	5	4	20	12	20	Good	Excellent	-	None
Manoevring practice	5	4	4	4	20	16	16	Good	Excellent	Poor	-
Component walkthrough	3	3	5	4	12	12	20	≥ 4	All	5	+
Situational awareness training	5	4	2	4	20	16	8	Poor	Good	-	None
Practice navigation	5	4	2	4	20	16	8	Good	Excellent	-	None
					0	0	0				
Customization and Options:					0	0	0				
Adjustable wind strength	5	5	5	5	25	25	25	≥ 2	Continuous	Continuous	Target
Adjustable current strengths	5	5	5	5	25	25	25	≥ 2	Continuous	Continuous	Target
Allow configurations	3	4	5	4	12	16	20	Good	Excellent	Good	0
Offer different engines	2	4	5	3	6	12	15	≥ 2	All	2	0
Offer different steering tools	5	5	5	4	20	20	20	≥ 2	All	2	0
Offer different propulsion systems	3	4	5	4	12	16	20	≥ 2	All	2	0
Offer different shapes of hulls	4	4	4	3	12	12	12	≥ 2	≥ 3	1	-
Offer different boat sizes	5	5	5	3	15	15	15	≥ 2	≥ 4	3	+
Offer different boat weights with accurate center of gravity	3	4	4	4	12	16	16	Poor	Good	Poor	0
Automatic configuration of purchased product	1	3	5	2	2	6	10	Good	Excellent	-	None
User can customize the environment	3	4	2	3	9	12	6	Fair	Good	Good	+
Allow different components	3	3	5	4	12	12	20	≥ 4	All	7	+
Include existing products and their behaviours	5	5	5	4	20	20	20	Good	Excellent	Fair	-
Include IPS system	3	4	5	4	12	16	20	Good	Excellent	Good	0
Enable different views	5	5	5	4	20	20	20	≥ 2	All	1	-
Enable different speeds	5	5	5	5	25	25	25	0 ≤ Knots ≤ 35	Continuous	Continuous	Target
					0	0	0				
User Experience and Engagement:					0	0	0				
Exclusive aesthetics	3	4	5	4	12	16	20	Excellent	Outstaning	Good	-
Enjoyable	4	4	4	4	16	16	16	Excellent	Outstaning	Excellent	0
Have an educational practice mode	5	4	4	3	15	12	12	Fair	Excellent	Fair	0
Realistic feeling for boating	5	5	4	5	25	25	20	Excellent	Excellent	Poor	-
Realistic environment	4	4	4	4	16	16	16	Excellent	Excellent	Excellent	Target
Realistic boat	4	4	4	4	16	16	16	Excellent	Excellent	Good	-
Realistic waves	4	4	3	4	16	16	12	Excellent	Excellent	Excellent	Target

Realistic movements	5	4	4	5	25	20	20	Excellent	Excellent	Good	-
Physical components	3	4	4	4	12	16	16	None	Yes	None	0
Accurate sea chart	1	4	2	4	4	16	8	Poor	Fair	-	None
Logical workflow	5	5	5	5	25	25	25	Fair	Excellent	Excellent	Target
Show speed	4	4	5	5	20	20	25	Poor	Excellent	Good	+
Include a sea chart	4	4	1	4	16	16	4	Fair	Good	-	None
Sales and Marketing:											
Show where the products can be purchased	2	3	5	4	8	12	20	Poor	Good	Good	Target
Communicate the value of the products	3	4	5	4	12	16	20	Good	Excellent	Good	0
Increase interest for boat life	3	3	1	3	9	9	3	Poor	Fair	Poor	0
Enable verification of boat skills	4	4	2	3	12	12	6	Fair	Good	Poor	-
Allow for virtual testing	5	5	5	5	25	25	25	Good	Outstanding	Good	0
Allow easy purchase	2	4	5	4	8	16	20	Good	Excellent	Fair	-
Focused views of the boat's layout	2	3	5	3	6	9	15	Fair	Excellent	-	None
Easily accessible	5	5	5	5	25	25	25	Excellent	Outstanding	Excellent	0
Affordable	5	5	5	5	25	25	25	Excellent	Outstanding	Outstanding	Target
SUM Weight factors x Estimated fullfillment					**797**	**816**	**801**			**None**	10
Total performance per concept							**2414**			**-**	11
										0	17
										+	5
										Target	8
									#criteria		**51**
									% Over Acceptance Level		**58,82%**
									% Target level		**15,69%**
									% Over Acceptance Level of implemented solutions		**73,17%**
									% Not implemented		**19,61%**

H Idea bank

Idea Bank			
Interviews & Questionnaire	**Project meetings**	**Customer Journey fair**	**Brainstorming session**
Use levels and for example 4/5 possible stars for how well you made it, to make the simulator fun	Send a joystick to customers who have bought a boat allowing them to practice until their boat arrives. Alternatively, it could be their own joystick	Be able to select your display, such as on efrom Garmin, if collaborate with them. Thi sway, users can test their display and be ready when they receive it, avoiding the need to read a boring manual for both navigation and the display's functionality	At the beginning of the simulator, you can configure your boat by selecting options such as the engine, choosing from three different hulls, selecting the length, steering system, etc,so you have your own customized boat.
Include things in the simulator users are hesitant to do in reallife such as dock in a tricky space	Include "Volvo Penta island" features		
Enable practicing to navigate in the dark	Let competitors lease space in the simulator to display products too		
Practice catastrophic scenaroios, engine failure etc and safety procedures	Send a 3D printed mini version joystick recycled plastic from fishing nets to customers/users	The simulator can be used to gather data to learn more about the user	Levels to gameify and make the user wanting to continue
Use the simulator to test a layout of a boat **befoer** purchasing	Create your own profile, join an online world, pick up friends with your boat.	Use the simulator to find likeminded people almost like an dating app	Dock in different types of environment; y-bars, natural harbour etc
Create a world to play in and maybe meet other owners, which could open up eyes for the "boating-lifestyle"	Collaborate with competitors so they can rent the simulator to feature their products. This would mean more work for Penta, but also more income with a steady revenue stream	The simulator can enable over the air updates to upgrade the customers/users boat	Have a simulator at OEMs and Dealers which is more equiped with for example steering wheel and joystick etc.
Lease the simulator to rental Companies who can use it to verify knowledge before customer renting.	When you purchase a boat + equipment, you will receive an email with 'Test your boat here + link, to assist with onboarding. The boat will then be fully configured	The simulator can be used in multiple steps in the journey, not only while **waiting** for the engine or other Products. Prepurchase: Test what is of preference. Owning: Tips on how to maintain equipment and knowledge/skills during lowseason etc. Aftermarket; Over the air updates.	Inclued typical teaching moments used in real life, such as drive against a buoy to practice aiming or other similar
Be able to test drive boats equipped with features my own boat does not have			
Use as a teaching tool to learn how to drive a boat in a safe environment	Get interior design companies to buy a spot if possible to showcase their products in the boatsimulator		
	3D scan harbours for users to exercise in and become more familiar with		
	Internal use of simulator - section where you can test compatibility and wiring diagrams to ensure all parts work together (Today boatbuilders have too many parameters and industries to take into account when building)	Provide the once who have bought a joystick with one to try at home	Use virtual computers to enable users to log in and test the simulator with high resolution and fast capacity
		Include geofencing for enhancing realism	
	Compete with others who uses the simulator; "How many nights did you overnight in your boat this seson", "How far did you drive your boat", "How many harbours did you visit"		

I Pugh matrices

Solutions	**Tips option** Harbour Docking Select option to show tips or instructions	**Show tips** Harbour Docking Tips on how to handle the vessel	**Levels** Harbour Docking Different levels for boat skills with introduction for each level what the user should do	**Step by step** Harbour Docking Step by step tutorial option with instructions while driving	**Real-time instructions** Harbour Docking Real-time instructions and feedback based on the user's actions and the simulated environment	**Pattern** Harbour Docking Drive after a pattern	**Free play** Harbour Docking Free play
Amount of support		+	-	+	+	+	-
Joyfulness		-	+	+	0	-	0
Intuitiveness		+	+	+	+	+	-
Development time		0	-	-	-	+	+
Degree of learning posibility		+	+	+	+	-	-
Learning correctness		+	-	+	+	+	-
Engagement level		0	+	+	+	-	-
Realism immersion		-	0	0	-	-	+
Assessing user progress		0	+	0	+	+	-
Adaptability		-	-	0	0	-	-
Amount of instructions		0	0	+	+	-	-
Variety		-	+	0	+	0	0
Scaleability		0	+	0	+	-	-
Learning time		0	+	+	+	+	-
Situational awareness ability		0	+	+	+	-	-
Maneuvering learnability		0	-	+	+	0	-
	Amount of: -	4	5	1	2	8	12
	Amount of: 0	8	2	5	2	2	2
	Amount of: +	4	9	10	12	6	2
	Sum	0	4	9	10	-2	-10

Figure I.14: The first Pugh matrix iteration with the solution "Tips option" as reference

Solutions	**Real-time instructions** Harbour Docking Real-time instructions and feedback based on the user's actions and the simulated environment	**Show tips** Harbour Docking Tips on how to handle the vessel	**Levels** Harbour Docking Different levels for boat skills with introduction for each level what the user should do	**Step by step** Harbour Docking Step by step tutorial option with instructions while driving	**Tips option** Harbour Docking Select option to show tips or instructions	**Pattern** Harbour Docking Drive after a pattern	**Free play** Harbour Docking Free play
Amount of support		-	-	-	-	-	-
Joyfulness		-	+	+	0	-	+
Intuitiveness (enkelatt förstå vad göra)		-	-	-	-	0	-
Development time		+	+	+	+	+	+
Degree of learning posibility		-	+	-	-	-	-
Learning correctness		-	-	-	-	-	-
Engagement level		-	+	+	-	-	-
Realism immersion		-	0	0	+	-	+
Assessing user progress		-	+	0	-	-	-
Adaptability (kan kund gör ngt?)		-	-	0	0	-	-
Amount of instructions		-	-	-	-	-	-
Variety		-	+	0	-	-	-
Scaleability		+	+	-	-	-	-
Learning time		-	+	-	-	-	-
Situational awareness ability		-	-	-	-	-	-
Maneuvering learnability		-	-	-	-	-	-
	Amount of: -	14	7	9	12	14	13
	Amount of: 0	0	1	4	2	1	0
	Amount of: +	2	8	3	2	1	3
		-12	1	-6	-10	-13	-10

Figure I.15: The second Pugh matrix iteration with the solution "Real-time Instructions" as reference

Solutions	**Levels** Harbour Docking Different levels for boat skills with introduction for each level what the user should do	**Real-time instructions** Harbour Docking Real-time instructions and feedback based on the user's actions and the simulated environment	**Step by step** Harbour Docking Step by step tutorial option with instructions while driving	**Tips option** Harbour Docking Select option to show tips or instructions	**Pattern** Harbour Docking Drive after a pattern
Amount of support		+	+	+	+
Joyfulness		-	-	-	-
Intuitiveness (enkelatt förstå vad göra)		+	+	-	+
Development time		-	-	+	+
Degree of learning posibility		-	+	-	-
Learning correctness		+	+	-	+
Engagement level		-	-	-	-
Realism immersion		0	-	+	-
Assessing user progress		-	-	-	0
Adaptability (kan kund gör ngt?)		+	+	+	0
Amount of instructions		+	+	+	-
Variety		-	-	-	-
Scaleability		-	-	-	-
Learning time		-	+	-	-
Situational awareness ability		+	-	0	-
Maneuvering learnability		+	0	0	+
	Amount of: -	8	8	9	9
	Amount of: 0	1	1	2	2
	Amount of: +	7	7	5	5
		-1	-1	-4	-4

Figure I.16: The third Pugh matrix iteration with the solution "Levels" as reference

J Unity building blocks

Unity building blocks					
Interaction between boat and water	Boat drift in water	Bouyance			
Menue	Buttons (Start, next, info etc)	Configuration	Different modes	Turn off the game	
Joystick	Movements: Tilt, snap on interaction	Buttons (On/Off, Assisted docking, DPS	Forward force and turning propeller and boat	Input from mouse or key	Assisted Docking (countract force, 3 tap one meter each, show corridor)
Lever	Movement: Rotation	Buttons (On/Off, singel lever)	Forward force	Input from: mouse or key	
Steering wheel	Movement: Rotation	On when lever is on	Turning propeller and boat	Input from: mouse or key	
Wind and Waves	Adjustable	Direction	Force		
Thruster	Force	Shift side			
View	Camera:	Camera rotation			
Environment	Dock	Tree	Cliff	Sky	Penta island

K Test and Unity feedback

K.1 Man, 59, with boating experience, raised near the harbour and owned a boat his whole life until recently:

The participant understood all buttons in the configuration step except IPS and regular while choosing the propulsion even though the participant knew about forward drive and regular drive. When continuing into the practice docking scene within the "Train my boat skills" option the participant noted that even though the steering wheel was chosen the joystick was also placed in the scene. Continuing to explore the options the participant did not understand how to interact to power and steer the boat thus a walkthrough was necessary.
Furthermore, the participant understood the winds and waves well in the next scene to test Assisted Docking within the "Test Equipment" option. The participant looked mostly at what was happening to the boat while dragging the lever of intensity and direction, thus did not pay much attention to the arrows to indicate wind and wave direction. While exploring the forces the participant did not immediately try the assisted docking even though it was explained when entering the scene of exploring assisted docking, thus guidance to press the button was suggested and the participant saw the difference. This led to further questions regarding price and technical questions about how this works in reality, confirming that the simulator can generate interest for the product.

K.2 A 31-year-old man with no prior boating experience tested the simulator:

The participant understood all the buttons in the simulator's configuration except for "Shape" and "More Info". When "Shape" was explained, it was suggested to change the term to "Hull Shape". The button "More Info" in the configuration scene was perceived as too broad, making it difficult to understand its purpose.

In the practice docking scene within the "Train my boat skills" option, the participant initially missed the arrow indicating the direction to drive towards. A suggestion was made to change the arrow colour, as it was overlooked due to many impressions. The instructions given before entering the scene were forgotten.

Additionally, the participant requested clearer indications to understand if any of the levers were in forward or backward drive mode. The control sensitivity was also found to be too intense, resulting in unrealistic boat movements during certain turns.

During the "Test Equipment" phase, the participant found it unclear what was expected. It was suggested that the "Assisted Docking" feature should include some form of explanation or a picture of the joystick before entering the game.
The participant concluded the experience of testing with a suggestion that it would be good to have some sound of the engine, waves and surroundings etc to elevate

the experience.

K.3 A 56-year-old woman with no prior boating experience tested the simulator

Overall, the participant found the simulator's interface very appealing and most features easy to understand. The boat customization options were straightforward, though additional information on what configurations suit specific needs would benefit users unfamiliar with boating. For instance, guidance on whether to select a D6 or D8 engine for larger boats would be helpful. She appreciated the technical details provided about the engines and suggested including similar information for the differences between regular and IPS propulsion systems, which she did not understand.

Upon entering practice mode, the participant did not read the instructions but intuitively pressed the "On/Off" button to start. While the joystick was easy to understand, it was overly sensitive, making it difficult to steer. The lever was more challenging to use due to unfamiliarity, indicating a need for a brief explanation of its operation. During the Assisted Docking test, there were no guidance instructions, and the participant attempted to access information via the UI button, which was not implemented. This highlighted the need for more information at that stage. Additionally, she preferred an alternative view when testing this feature but still understood the product's concept.

K.4 Participant from in-depth interview - Student who owns a boat

The first noted issue was that the simulator does not work on a Mac. A Windows computer was therefore instead used for further testing. While the participant understood the configuration step well including the buttons, there were difficulties in understanding how to interact with the levers and steering when entering the "Train my boat skills" and practice docking scene. This was even though a small explanation text was added to the different tools before this test, based on earlier test persons' input. It was suggested that the instructions for steering should perhaps be centred or highlighted more.

During exploration, the participant understood the wind and waves buttons and purpose and suggested having the two different arrows which were initially there to ask for feedback on what was the most suitable. But the answer was rather to keep both which distinguishes wind and waves apart. Otherwise, it was recommended to check for any standard symbols for each. The participant observed that the wind and waves changed very rapidly and that the dock appeared to jump in the water, creating unrealistic movements for the environment. Additionally, the steering wheel was perceived as too slow in comparison to how the boat moves and rotates, and the lever should not rotate 360°. It was also noted a bug when restarting the level which was that the boat did not reset.

Furthermore, the participant understood the home button, information button etc in the play scenes in the top right corner well. When asking the participant about the view when playing, it came up that it was preferred to choose the view when trying to dock, explaining that it helps to determine if the boat is well positioned, such as checking the docking from an overhead view after trying to do it from the helm view inside the boat. When asked if it was the same for all scenes, both “Train my boat skills” and “Train my boat skills” the participant thought it would be useful for both. the last input was to let the boat continue to drift slightly after releasing the controls to mimic real movements in the water.

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