Human-centred design: The tailwind to green marine transportation

A qualitative study on the advantages HCD has on the acceptance of green marine technology

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Abstract

Marine transportation in EU currently emits 18% of the total global marine CO_2 emissions which is approximately 140 million tonnes of CO_2. In response to this, new regulations aim to reduce carbon emissions by 40% by the year 2030, therefore, green innovations in marine technology are more important than ever. However, reducing carbon emissions requires people to accept these new technologies. In this paper, I explore the role of human-centred design in technology acceptance by using some methods in the design process. The design process included various methods such as user-, heuristic evaluations, expert reviews, role-playing, parallel prototyping, and prototyping. I studied, evaluated, and redesigned the interface of EcoPilot, that is a product which calculates, decreases, and optimizes fuel consumption in marine transportation. The design process of EcoPilot resulted in increased knowledge about the current user experience of marine technology aimed at reducing carbon emissions, as well as conclusions and reflections on how human-centred Design can improve the experience and promote the acceptance of new green technology.

Nyckelnord: HCD, Technological acceptance, green technology, feedback, visibility, Fitts's law

Sammanfattning

Sjötransporter i EU släpper för närvarande ut 18 % av de totala globala marina
CO_2-utsläppen, vilket är cirka 140 miljoner ton CO_2. Det har därför kommit nya
föreskrifter om att minska koldioxidutsläppen med 40 % fram till 2030. Därför
blir gröna innovationer inom marinteknik viktigare än någonsin. Att minska
koldioxidutsläppen kräver dock att människor accepterar det nya tekniken. I den
här artikeln utforskar jag rollen av människocentrerad design i teknikacceptans
genom att använda olika forskningsmetoder inom designprocessen.
Designprocessen inkluderade olika metoder som användartester, heuristiska
utvärderingar, expertutvärdering, rollspel, att skapa prototyper, och att skapa
prototyper parallellt. Jag studerade, utvärderade och designade om gränssnittet för
en produkt som heter EcoPilot, som beräknar, minskar och optimerar
bränsleförbrukningen inom grön marinteknik. Designprocessen av EcoPilot
resulterade i ökad kunskap om den nuvarande användarupplevelsen av
marinteknik som ämnar till att förminska CO_2, samt slutsatser och reflektioner
kring hur människocentrerad design kan förbättra upplevelsen och främja
acceptansen av ny grön teknik.

Nyckelord: HCD, Teknologisk acceptans, grön teknik, feedback, synlighet, Fitts
lagen

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Important terms

User interface/interface (UI): Parts of the technology that the user can perceive, read and interact with

User experience (UX): Involves studying how to create interfaces that consider users' abilities, activities, and context of use

Iteration: A process of repeating the design process where the designer evaluates, redesigns, and evaluates repeatedly to improve the user experience.

Intuitive: A design is intuitive when the user can use it without instructions. The user recognizes how to handle it and uses it efficiently.

Human Centred Design (HCD): Design that prioritizes humans over technology, putting them at the centre, and adapting technology accordingly.

Visibility: The degree to which the technology is apparent in communicating information and feedback about the system's status and the user's previous activities.

Feedback: Information that the user receives from an interface as a reaction to their interaction with the interface

Fitts's Law: A user experience design principle states that the bigger and closer a button is to the user, the faster it can be clicked. Fitts's law then means that buttons that are frequently used by the user should be bigger and more easily accessible.

Technological acceptance (from a visual model): When the user accepts new technology and eventually uses it

Introduction

"Perhaps the sea is one of the last working environments where the workers do not always have much of a choice in the equipment with which they have to work."
- Stella Mills (Mills 2005, p.72).

Mills writes about designing marine interfaces and emphasises the importance of involving the user and understanding their goals, especially when designing for marine interfaces where theories cannot be a replacement for involving the user as it is challenging to understand the users' goals when interacting with marine interfaces (Mills 2005, p.71-72). This paper aims to understand how the interface design can impact green technology acceptance and adoption. This section contains background information about the interface, the user, and the research objectives.

Background

"Ships emit considerable amounts of greenhouse gases, air pollutants, and underwater noise."
-EEA 2023

Although there has been progress in the EU since 2008, mainly due to the increased use of batteries, non-traditional fuels, and bioenergy, there is still a need for more action towards sustainability with the help of technology to decrease the CO2 emissions even more as ships in EU currently emit 18% of the total global marine co2 emissions which is approximately 140 million tonne of CO2 (EEA, 2023). Starting January 1, 2023, new regulations have been implemented by the International Maritime Organization. These regulations require ships to calculate their carbon intensity ratings ranging from A to E, with A being the best and C being the acceptable yearly rating. These new regulations aim to reduce CO2 emissions by 40% by 2030, compared to the levels recorded in 2008 (IMO, 2022).

Since 1997, when Qtagg was founded, Qtagg has worked with developing products in marine technology with algorithms that calculate and optimize the energy consumption of large ships, thus reducing fuel costs by 5–7% (Qtagg, n.d.). Ecopilot is one of Qtagg's products that calculates the rating of every route for a voyage and executes the users' priorities so that ships can arrive on time and save up to 7% fuel (Qtagg, n.d.). One of the ships where EcoPilot was installed saw a reduction in fuel consumption of around 2098 MT per year, which equates to approximately 6500 tons of CO2 emissions, equivalent to the amount emitted by 2000 cars in one year. If the Qtaggs system were installed in 60,000 more

ships, it could reduce emissions by equivalent to Sweden's annual CO2 emissions (Personal communication, April 18, 2023). Qtagg consults its users and has implemented changes, as well as has safety and error prevention in mind, where the user must take at least two steps to make changes except for emergency functions (Personal communication, April 21, 2023). After talking to Qtagg and drawing upon my three years of education in interaction design, I became curious about the role interaction design could play in enhancing the user experience of green marine technology. According to Haug (2016, p.662, 663), for a sustainable option to have a positive image, its quality and visual appeal must be equivalent to that of non-sustainable products. This can be achieved through involving the user and other stakeholders, as well as through possessing the right design capabilities and a genuine intention to contribute to a more sustainable world. Suppose the design of a sustainable product is unappealing and complex. In that case, users may associate the concept of sustainability with these negative qualities, indicating that good intentions are not enough on their own. However, cost, reliability, quality, and appearance are important factors for the user.

The target group

This section explains briefly the crew on a ship and specifies the target group in the research and design process.

The captain is responsible for leading the ship and ensuring the crew operates efficiently. The first officer who is also known as the chief mate, supervises bridge operations as the second-in-command. The second mate or second officer stands on the bridge, devising plans and monitoring various information such as weather and charts to ensure smooth voyages. Other significant roles include the engineering officer, chief engineer, second engineer, third engineer, and fourth engineer. They are tasked with maintaining the ship's engines, machinery, and technical aspects, ensuring that all equipment is operational, and monitoring engine data (nscc, n.d.).

This research focuses primarily on captains, first officers/chief mates, and second officers who use EcoPilot. As such, the target users for this project are those who fulfil the roles above on the ship. These users were interviewed to gather insights about their experiences using the studied interface to perform their duties.

The technology

Qtagg uses energy-efficient technology to minimize CO2 emissions during ship travel. One of their products, EcoPilot, features a trip-planning tool, the EcoPilot planning view. The user interface (see Figure 1) helps users plan various travel routes and identify more time- and energy-efficient ones. EcoPilot also has additional features that reduce ship voyages' speed and fuel consumption (Qtagg, n.d.) (Personal communication, April 18, 2023). To help users understand the EcoPilot interface, a 24-page user manual is provided that explains its various functions (Qtagg, 2023) EcoPilot interface can be controlled via clicking on the

touchscreen and sometimes a mouse as well, however some crew members may not have access to a mouse (Personal communication, April 29, 2023).
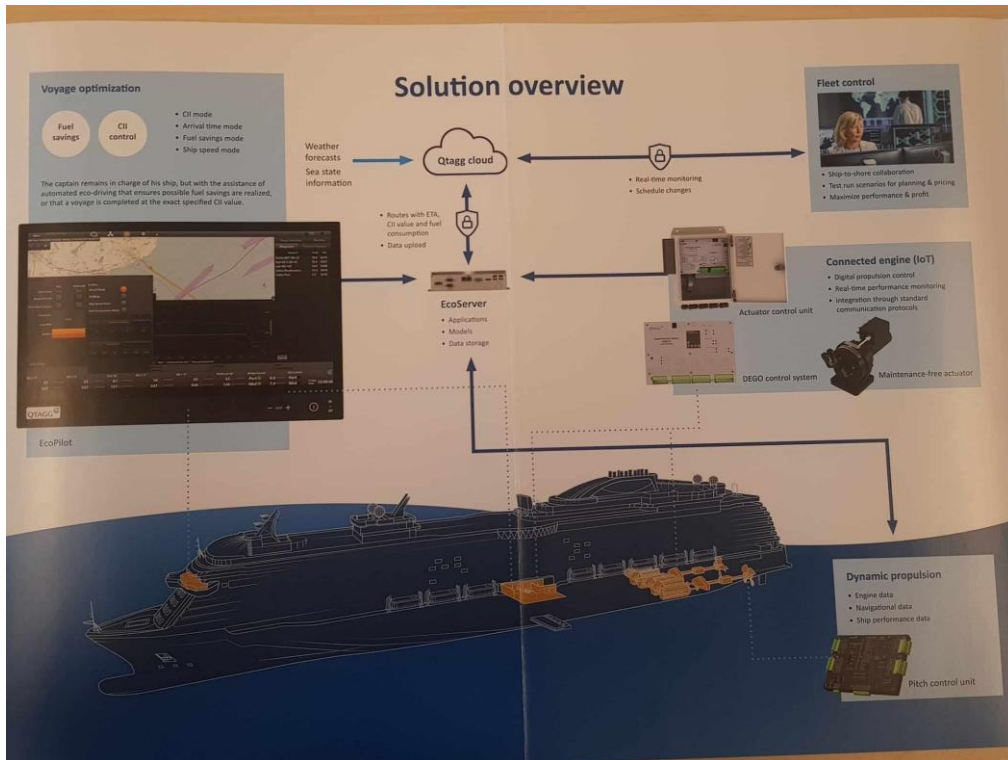
Figure 1 How the interface (the black rectangle in the far left of picture) fits in EcoPilot's digital system. (Qtagg, n.d.)

Purpose and Research question

The purpose is to research how the interface of marine technology, in this case EcoPilot, is experienced by the workers who use it daily, to find areas of improvement from a user experience and usability perspective (interaction), thus improving their experience, and to study how the HCD perspective relates or whether it can promote acceptance of green technologies.

My research questions are:
- How do captains, chief mates and second officers experience EcoPilot's interface while using it to perform their duties?
- How can Human-centred design help improve technological acceptance of green marine technology?

Literature and theory

Human Centred Design

While there is an appeal to technological development/innovations, Human Centred Design is about using the different technical resources and opportunities to meet the user's needs rather than prioritizing investing in technology (Benyon 2019, p. 13). Human Centred Design means prioritizing the human experience in the design process, including actions, needs, limitations, and feelings. It means effective communication between humans and technology where the design of technology adapts to the human (Norman 2014, p.9). The Human Centred Design increases the safety of the technology created and creates designs that users with different backgrounds and capabilities/limitations can use (Benyon 2019, p. 21-22). When interacting with technology, humans have different needs, such as a need to feel in control and a sense of competence; the user would easily accept new technology that meets those needs (Grundgeiger et al. 2021, p.827). The user may feel incompetent when utilizing new technologies, particularly when confronted with a problem; even though the problem may not be a human error but a communication error, the user tends to blame themselves (Norman 2014, p.65-66). For instance, humans are seen to be causing 75-95% of all accidents, and those accidents caused by "human errors" usually do not get investigated with curiosity (Norman 2014, p.162). Without a human-centred design perspective, humans will continue to face confusion, frustration, and, in worse cases, accidents when interacting with technology (Norman 2014, p. 8). To understand the user experience in-depth, Benyon writes about a framework named PACT, which stands for:

- **People:** Different users experience products differently due to their physical, mental, and social characteristics
- **Activities:** The purpose for which the design is used and whether it is used more frequently or less frequently, or if it is used alone or in collaboration with others.
- **Context:** The way we perceive new information and how we react to it is impacted by the physical, cultural, and social context the user is in (Benyon 2019. P.34-35).
- **Technology:** Design is used in an environment and is always affected by the social and physical surroundings where the design is being used. The time and place the product is used can help or limit the interaction between the user and the product. A particular context can make the interactions favourable while others will not, such as how a sunny environment would make a screen reflective, making its content hard to read (Benyon 2019. p.34-35). Using technology, the user can send information, where we can send commands to technology by clicking a button or speaking to it, such as when using Siri. Moreover, we can receive information visually through screens and audibly. Technology must communicate relevant information

and feedback that keeps the user informed about which activities are occurring (Benyon 2019, p.36-44).

Technological Acceptance

The Technology Acceptance Model is a model that explains how a product's perceived usefulness and perceived ease of use contribute to the user acceptance and adoption of a new technology (Lee & Wan 2010, p.40).
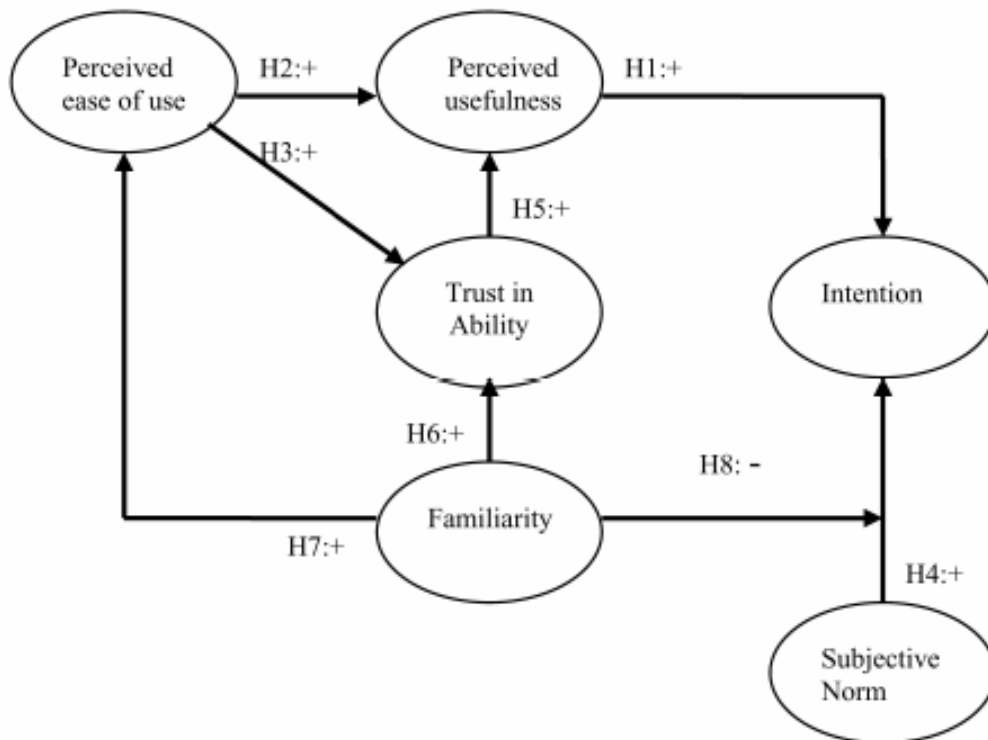
Figure 2 Technological Acceptance Model showing different factors that plays in Technological Acceptance and the relationships between them.

Lee and Wan's suggested model (see Figure 2) include the factors of familiarity and trust, in which Lee and Wan hypothesize that *"perceived ease of use is* positively related to perceived usefulness"; thus, "perceived ease of use is *positively related to trust in ability."*. Lee and Wan also suggest that *"familiarity is positively related to perceived ease of use"* (Lee & Wan, 2010, pp. 43-44). Familiarity means that the user has had previous experience with the technology and, therefore, can trust it more. To be familiar with technology means understanding its functions through positive experiences (Lee & Wan, 2010, p. 44). Many people feel uncertain when faced with the prospect of adopting unfamiliar technology, which can lead them to seek out the opinions of others, as they worry that the technology may not be trustworthy or up to their standards (Lee & Wan 2010, pp.43-44). Alternatively, becoming familiar with technology would reduce the need to rely on others' opinions and increase the likelihood of trusting it (Lee & Wan 2010, 44). Since the knowledge about an interface/product is transferable, the user does not necessarily need to be familiar and, therefore,

feel more familiar with new technologies if it is like other technologies or interfaces the user has interacted with before (Yablonski 2020. pp.1-2).

Human cognition

This section contains theories about how humans perceive, prioritize, and categorize visual information that they are faced with.

We perceive visual information in different ways, mainly bottom-up, which means that we receive the information through our eyes and then process it in the brain. Top-down refers to when the perceiver has a goal or something to look for (Ware 2008, pp. 8-9). Our goal affects our perception, since attention, for example, enables us to see a part of our environment and ignore the rest. However, that object should have a connected Edge/contour so that our neurons would perceive it as an object separate from the surroundings and thus focus on it (Ware 2008, p.48 & 52). Not only can we distinguish overlapping objects from each other easily if they differ in colour, texture, and direction of movement, but the more dissimilar objects are in feature, the easier they are to distinguish (Ware 2008, pp. 51-52). If an object has a cast shadow, it will also stick out from the group (Ware 2008, p.30). However, objects can be separated with the use of space as well; on the other hand, if two objects are considered to be close in proximity or have similar colours and common region/contour, they are more likely to be perceived as a group, if objects are aligned vertically or horizontally, they can also be perceived as a unit (Ware, 2008, p. 51). The relationship between the objects we see is also communicated visually. Hierarchy, order, and similarity are signified, as shown in the image below (see Figure 3). When we see horizontally aligned objects, we perceive a chronological relationship from left to right. When an object is larger or higher in space, we view it as more significant and see it first. Similarity or closeness between objects communicates a common thread between those objects (Ware, 2008, p.63).

Graphical Code		Semantics
Small shapes defined by closed contour, texture, color, shaded solid.		Object, idea, entity, node.
Spatially ordered graphical objects.		Related information or a sequence. In a sequence the left-to-right ordering convention borrows from the western convention for written language.
Graphical objects in proximity.		Similar concepts, related information.
Graphical objects having the same shape, color, or texture.		Similar concepts, related information.
Size of graphical object Height of graphical object.		Magnitude, quantity, importance.

The theories above about human cognition will be used to reflect, evaluate, and create an improved design. These theories will also be used in the discussion and conclusion of this paper to complement other theories, such as design principles and theories about technological acceptance, showing the bigger picture about Technological Acceptance from a Human Centred Design perspective when approaching the design of touch interfaces. Design quality and design principles

Design quality and design principles

As stated by Haug (2016. P.662-663) research on sustainable product design, high-quality design is crucial to meet consumers' expectations. This article lists various principles and theories that influence user experience and simplify the interface of green marine technology, thereby increasing its acceptance among users.

Hierarchy of needs in design

User satisfaction may be graded on a scale using values that correspond to the principles of Maslow's ladder of human needs. Users have differing needs that can be graded in this way, from the most basic to the highest level: *functionality, reliability, usability, proficiency, and creativity* (see Figure 4). Functionality, for example, can be met where the product or technology provides the basic function that is promised, followed by reliability, which means a robust performance of the product and its functions. After meeting both functionality and reliability, the product should also satisfy the need for usability, which means that the product is easy to use and minimises errors. Thereafter, the design that meets the functionality, reliability, and usability criteria can furthermore be proficient and creative, achieving a higher user satisfaction value on the scale. A product is deemed to have moderate value if it functions, is reliable, and is easy to use. A product of a proficient design means it is innovative and provides new functions. Creativity on this scale means that the product is of such high value that people use it to be creative is so easy to use that it's a reliable and robust and trustworthy tool that is used to create (Lidwell et al., 2010, p.124).
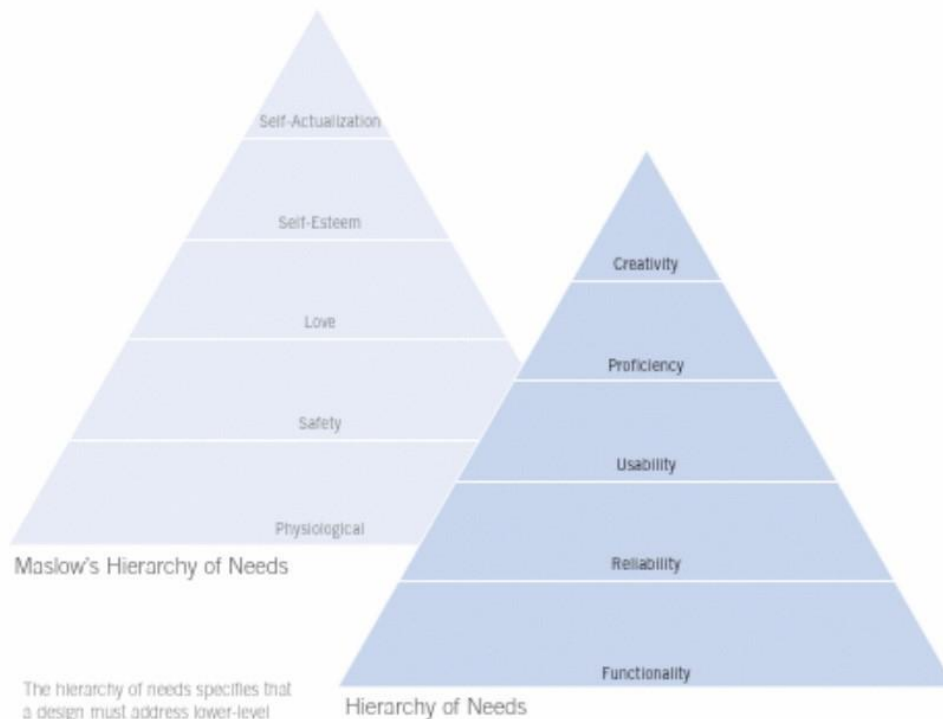
Figure 4 Hierarchy of needs in design (Lidwell et al., 2010, p.124)

Limitations of Short-Term Memory

Short-term memory or working memory is the memory where we remember information that helps us work so the brain retains its short-term. There is a theory that suggests humans can only retain five pieces of information in their short-term memory. When we receive new information, it replaces whatever was previously stored, causing us to forget the old information. This model helps understand the limitations of human working memory and can be applied to design (Norman, 2014, pp. 92-93 & 102).

Accessibility

An accessible design should be useable to individuals with varying abilities, backgrounds, and experiences. It should strive to reduce errors and be easily comprehended, regardless of the user's familiarity with the system or the presented information (Lidwell et al., 2010, p.16).

Legibility

For a text to be legible, it should be readable for the user with the proper colour contrast, spacing, typefaces, and size. Dark text on a light background is legible and more accessible for the viewer, as opposed to dark text on a dark background (Lidwell et al., 2010, p.148).

Fitts's Law

Fitts's Law states that the larger and closer a button is, the quicker it is for the user to access it. This principle applies to design, where buttons that require clicking should be placed closer and made bigger to make them easier to click. Conversely, buttons that should be avoided or have the potential to cause errors should be made smaller and more difficult to reach (Lidwell et al., 2010, p.98).

Aesthetics

The aesthetic usability effect shows that humans associate aesthetics with good quality and usability, which increases the probability of the design's acceptance and adoption. Aesthetics also help foster a positive relationship with the product and make the user more tolerant of design problems (Lidwell et al., 2010, p.20). Colour can also be a factor that adds to aesthetics, such as grouping objects on an interface or using complementary colours (Lidwell et al., 2010, p.48).

Alignment

Alignment means aligning different objects horizontally or vertically, which is also a factor that adds to aesthetics (Lidwell et al., 2010, p.24).

Consistency

Consistency is essential, as elements or functions should be consistent in looks and style to add to aesthetics and usability. Using specific colours and styles consistently communicates a particular message and affordance, which means interacting with the design is possible. Internal consistency in a system is aesthetically pleasing, and people associate it with being trustworthy (Lidwell et al., 2010, p.56).

10 general principles for interaction design

Nielsen's (2020) ten general principles for interaction design are a set of guidelines to assess design quality from a user experience perspective. These principles are:

- **Visibility of system status:** The interface communicates relevant information to the user, such as status and feedback on their previous interaction with the interface.
- **Match between system and real world:** It is familiar, and it feels intuitive, which means it follows the user's expectations of what they feel is true to how the interface should be interacted with.
- **User control and freedom:** The user can exit an interaction or an activity easily without negative results and, therefore, feels in control and confident.
- **Consistency and standards:** The words and interactions are consistent along the system interface or the product. The user expectation is based not only on the specific interface or product but is also built on

experiences with other interfaces or designs. This means that users usually expect the interface to behave in a manner consistent and familiar with their experience of this interface and with previous experiences of other interfaces or designs.

- **Error prevention:** means that the user is not only being informed about the error, but also the user is prevented from making an error in the first place.
- **Recognition rather than recall:** The user has limited memory, which means that it is easier for the user to recognize information that is accessible to them than having to recall that information from memory. This means technology should not require the user to remember exact information.
- **Flexibility and efficiency of use:** A design can be interacted with in more than one way, so it is flexible but is still effective in accomplishing the user's desired task.
- **Aesthetic and minimalist design:** Relevant information should be accessible, and irrelevant information can be hidden. Aesthetic means having a structured design that clearly presents and prioritizes relevant information/functions and minimizes distraction by non-relevant information.
- **Help user recognize, diagnose, and recover from errors:** Errors are communicated clearly, and the user is provided with the necessary information to solve them.
- **Help and documentation:** Help and documentation mean that when the user encounters difficulty, there is a function that would help the user find the correct information and documents to assist them in successfully using the interface.

The design quality and design principles will be used to evaluate the current interface and my design solution to define the design scope and have a guideline for creating a new design alternative. As well as comparing the quality of the interface to my design solution. This section will serve as a base for creating the new design solution. The user's hierarchy of needs will be used to discuss whether the new design solution helps elevate the design and meets the users' additional needs beyond basic needs, such as *functionality*, for example. Finally, the 10 general principles for interaction design will be used to compare the current design to my design suggestion and to track progress.

Methods

The design process can be a way to learn about different design theories. It can also develop and improve knowledge guidelines for the design process. Methods such as interviewing, brainstorming ideas, and testing them are a learning opportunity concerning design and the user experience (Martin & Hanington, 2012, p.146).

Arvola's design process (2020, pp.11-12) starts with the concept phase, where the designer collects information to build their vision. The concept phase is followed here by the adaption phase, where the designer creates a design suggestion, and lastly, the detailing phase, where the designer refines their design. Even though I began using Arvola's method, Aspelund's method was more detailed and went more in-depth (see Figure 5), including even the stages for communication and production which were expected to be a part of my design process. Therefore, Aspelund's design process will be used. The design process can be compared to establishing a relationship where ideas and practical applications meet (Aspelund, 2006, p. 3). It begins with excitement and creativity, which is the *inspiration* stage. However, as the designer progresses, they must ground their ideas in research and facts. This is known as the *identification* stage, where the core of the design is defined, and the idea becomes less abstract. After the identification phase, the designer enters the *conceptualization* phase. During this phase, the designer focuses on specific ideas and eliminates others. As a result, the idea becomes more focused and limited. The *exploration/refinement* phase follows the conceptualization phase, where the designer sets boundaries for the idea and determines what is possible and what is not. This phase builds a structure for the idea. With an interest and curiosity in the idea cultivated during the inspiration phase, the designer faces challenges to make their idea tangible but is motivated to bring it to life. The *definition/modeling* phase is when the designer creates a prototype or design to bring the idea to the world. The following phases of the design process are *communication* and *production,* since it is a part of the designer's job to communicate the design to others and motivate them to produce it (Aspelund, 2006, pp. 3-4).
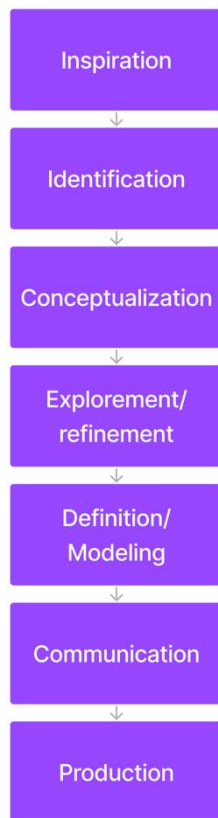
Figure 5 A model to visualize Aspelund's design process.

These stages are used below as a headline in the title method.

Inspiration

Personal interview

The most effective method to explore users' experience of the EcoPilot's interface was via interview because the users I could contact worked on the sea outside of Sweden. Moreover, the process of user-testing in real time on a boat could be distracting and even a safety risk, whether online or face-to-face. Instead of in-field user testing, I started with interviews because, according to Martin & Hanington (2012, p.102), interviews can be valuable for gaining insight into a user's attitude, perspective, and experience. Descombe (2018, p.270) states that personal interviews are more straightforward to conduct, record, and document than group interviews. Although I could not conduct face-to-face interviews, Descombe (2018, p.277) notes that this may be an advantage in some cases because interviewees are less likely to be influenced by the interviewer's presence and may provide more honest and accurate responses. The user providing honest information is essential for maintaining the validity of the research. Personal interviews decrease the likelihood that the user would conform to the group

pressure or want to avoid mentioning negative experiences with the interface, assuming that it would reflect negatively on their competence.

I contacted three users familiar with the interface and conducted semi-structured interviews to explore the user experience further. The interviewees were two first officers and a chief mate, whom Qtagg helped me contact. According to Descombe (2018, p.57-58), in exploratory research, exploratory sampling is used, especially in qualitative research, where the researcher is open to learning more and finding research questions along the way and does not have a pre-decided research focus. Before interviewing, I sent the interviewee a consent form via email through Google Forms (see Appendix 1). I asked them to contribute and if they consented to being video or audio recorded. Which they did agree to.

Scenarios

A scenario is a story about the user's using the product for a specific task. Scenarios help create a Human Centred Design by strengthening empathy with the users instead of focusing on the technicalities for the functions of the product because scenarios make the team more aware of design activity from the user's perspective and context (Martin & Hanington, 2012, p.152).

Role-playing

Role-playing is a method that can be used to develop more insights into the user experience. Based on what activities the user utilizes the technology for through interviews, for instance, it is possible to role-play as the user develops more empathy for the user and learns about the interface and what can be improved (Martin & Hanington 2012, 148).

Different scenarios inspired by the interviews were tested, and I was able to write notes after role-playing as the user while using the then-current prototype of the interface that I had access to. A user familiar with working on the sea when it comes to being in boats and being familiar with the task EcoPilot is used for was also asked to screen-record themselves, fulfilling those scenarios. The video was then shared with me to observe and study. In both role-plays, the touchscreen was used instead of a mouse, since many users do not interact with the interface with a mouse.

For role-playing, the used scenarios were:
- Setting the speed of the ship to a specific number (for example, 18 knots)
- You need to double-check the time and date of the planned voyage.
- Planning a voyage step by step

Identification

Heuristic analysis

Heuristic evaluation means informal evaluation of a prototype or a design from different criteria, and it can be conducted before doing usability testing and applied later. Heuristic evaluation helps define certain problems or challenges in the design. You can help start a discussion both in the early stages and after usability tests. The researcher would have an easier time finding and relating to the users' perspective when observing the user while completing tasks after the heuristic evaluation and analysis (Martin & Hanington 2012 p. 98). Heuristics usually take the form of a list of criteria that should be considered and assessed, similar to a "check-list".

- Visibility of system status
- Match between system and real world
- User control and freedom
- Consistency and standards
- Error prevention
- Recognition rather than recall
- Flexibility and efficiency of use
- Aesthetic and minimalist design
- Help user recognize, diagnose and recover from error
- Help and documentation

The method heuristic analysis will be used to evaluate both the current and the redesign of the interface. To evaluate the interface, I used The System Usability Scale. Where every principle in the interface will be evaluated in the scale from 1 to 5 where 5 means that the principle is applied perfectly in the interface, while 1 indicates that the principle is not applied. The ideal score was calculated by multiplying 5, which is the maximum score for a principle, by 10, which is the number of heuristics used. To study the scaling method, I studied Lewis's (2018) article on the SUS (system usability scale) scale.

Affinity diagram

Affinity diagramming is a data sorting method; it means that after learning about the different users and their context through interviews or observations, the researcher can put the different information data or observations on sticky notes, then move the sticky notes where one group the sticky notes with similar theme/problem so that patterns and themes emerge relevant to the design and the users' experience (Martin & Hanington, 2012, p.12). I used Figma as a digital tool to create an affinity diagram. I had sticky notes on there and grouped the different gathered data from the user.

Persona

After conducting an affinity diagram to sort the found data, creating a persona would define the design scope and make the user more relatable instead of viewing data from different sources. A persona is a useful tool that helps to communicate the user's identity and how they interact with technology (Benyon

2019, p.132). A persona must be based on facts collected about the target user to help create empathy for the user (Arvola 2020, p.79) and should always avoid stereotypical ideas or preconceptions about the user.

User Journey Mapping

User journey mapping is about visualizing the user experience step by step. It gives an insight into how the user uses the technology and what specific interaction can be explored further or redesigned and improved. User Journey Maps are followed by showing where contact with the user occurs, employing both personas and scenarios along a timeline of interaction with the product (Martin & Hanington 2012 p.196).

Conceptualization

Parallel prototyping

Parallel prototyping refers to creating more than one prototype to receive feedback. Parallel prototyping works for exploring different designs as well as materializing the designs since more alternatives being presented (see Figure 13) or communicated to the team would help reduce the pressure on one design but also supports creativity and constructive criticism (Martin & Hanington 2012 p.122).

Exploration/refinement

In this phase, I refined and delimited my research into a few points.

In this study I prioritized feedback, visibility, and button size. Although learning about user perception and cognitive loads was relevant, learning about the activities that can be performed on the product was time-demanding and not feasible. The focus became mainly on feedback, visibility, and Fitts's Law during the testing phase and documentation.

The design focuses on:
- Feedback/visibility
- Small buttons
- Too much information

At this stage, based on the result of the interviews, my hypothesis was that to solve the user's issues, it was necessary to improve feedback and visibility. Initially, pop-up alarms were considered to provide feedback, but since it was mentioned in the interviews that alarms could be distracting, it was concluded that they were not the solution. Instead, a chat-like system was considered to communicate information to users. I called this idea the "status section." It would display the most recent and relevant information at the bottom, while the older Information would move to the top. To improve visibility, I considered using

colours and decided to add more colours to the engine when it is turned on and reduce the colour when it is turned off to increase contrast.

User testing

Usability testing involves evaluating the ease of use of a design to identify areas of difficulty for users. This is typically done using the think-aloud protocol, where the test subject is asked to complete a task while being observed or recorded and asked to vocalize their thought process. Usability testing can be performed at various stages of design development. The Think Aloud Protocol involves having the user verbalize their thoughts, actions, and emotions while performing a task using scenarios (Martin & Hanington 2012 p.194). This approach provides designers with greater insight into which interactions elicit negative or positive emotions from the user. It can be used to evaluate and test design in the early stages, as well as for products that have already been designed and launched (Martin & Hanington 2012 p.180). As part of my usability testing, I recruited four participants who had prior experience with sea-related activities. These participants, who varied in age, were asked to test the prototype and complete certain tasks while explaining their thought process and emotions, including any feelings of uncertainty that arose during the testing process (see Figure 6).
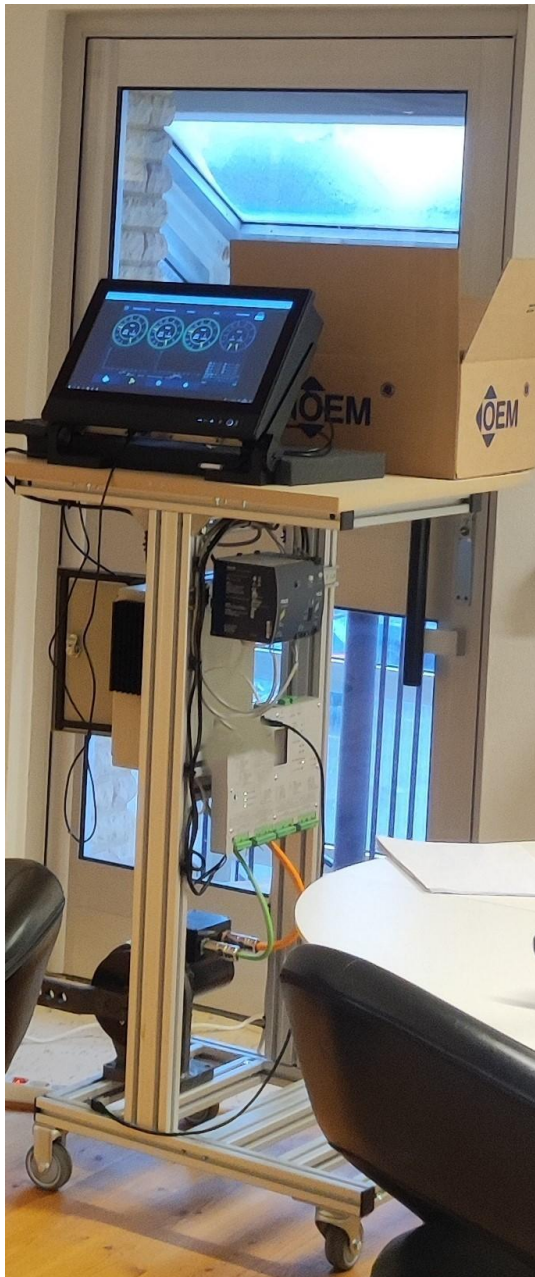
Figure 6 An image took in the user-testing on the touchscreen and a table that made it easy to shake creating a context like the scenario where the boat might be shaking while the user is using the interface.

Definition/Modeling

Prototyping is a method of exploring ideas and testing them in various design stages. It is also used to communicate the final idea before production (Martin & Hanington, 2012, p. 138). In my project, I used prototyping to showcase my idea to experts for review. To gather feedback, I created an interactive prototype of the system. Later, the prototype can be handed off to developers to create the new interface.

Communication

Expert Review

Expert review as a method was used in both iterations. Parallel to the user test and after the final prototype. In contrast to heuristic evaluation, expert review does not involve following a specific set of guidelines. Instead, the expert relies on their experience and knowledge to inspect and design the interface. I received expert reviews from five members of Qtagg team, who possess expertise in Electrical Engineering, software development, sales and Business Management.

Production

EcoPilot is an existing product, and my results will be used to improve the interface. This production is currently a work in progress.

Method critique

To improve the validity of this research, it would have been beneficial to conduct user testing specifically on the target audience. To answer the second research question with more confidence, a survey could have been given to users at the end of the test to determine their likelihood of adopting the technology. Additionally, if the final prototype was tested on four new users, the research would be more reliable. The study would also have been more valid if tested on the appropriate target audience in the right context, such as on a boat. However, this was not possible during the research period. Also, the unavailability of contacts with people who understood the task that the users would conduct made it impossible to conduct additional user testing. Finally, for the heuristic test, I used the SUS (System Usability Scale) scoring system from 1 to 5 where 5 is perfect. In retrospect, it would have been more appropriate to use the more commonly used 4-point severity scale.

Results

Interview results

In the interviews, I gained insight into the users, such as how they use the interface. For example, none of the interviewees give EcoPilot complete control; they only use a few functions. According to personal contact with Qtagg (2023), they want the user to trust and give control to EcoPilot, which means planning a voyage and sitting down, having a cup of coffee, letting EcoPilot lead the ship (see Figure 7), and stepping in when needed. One of the interviewees thinks that giving EcoPilot control seems like a good idea; it is an algorithm that will learn and improve with time. However, his master [sic] (captain) is more comfortable using only a few functions.

The interviewees named some struggles with the interface, mainly the small screen with tiny buttons, having to use a touch pen to avoid misclicking, and needing more information or feedback. The interviewees mentioned a need to stay alert and keep check on the different technologies. While talking in detail, indicating the technology's lack of feedback and visibility.

> *"If he didn't notice it meant he wasn't keeping sharp watch, you know! and as officers that's not possible for us we're sitting there we're like all the time looking and controlling although there's a lot of technology and EcoPilot and autopilot you have to have a sharp eye on everything and watch it"*
> - Interviewee 1 (Personal communication, April 11, 2023)

Figure 7 An image of Stena Line cruise, a similar vessel type to the ones where the interviewee works and utilize EcoPilot (Stena Line, n.d.)

Scenario results

Scenarios were created based on tasks mentioned in the interviews. Those tasks/interactions were chosen because they were considered worthy of further exploration or improvement. The scenarios that were built were:
1. You are planning/booking a voyage.
2. You need to double-check the time and date of the planned voyage.
3. You need to set the speed of the ship to a specific number and the boat is shaking.
4. You want to mute the alarms that you are receiving.

5. You would like to see which engines are active while sitting 3 meters away from the interface.

Results from role-playing

Notes from the role-playing were:
When planning a voyage, there were some distractions. For instance, the map (see Figure 8) was there when the user didn't need to see the routes yet. Furthermore, when trying to recall the previous activity, being the planned voyage, the user feels uncertain and unsafe even if it happened minutes ago. When changing different parameters, it was frustrating to click on the screen since the buttons were small.
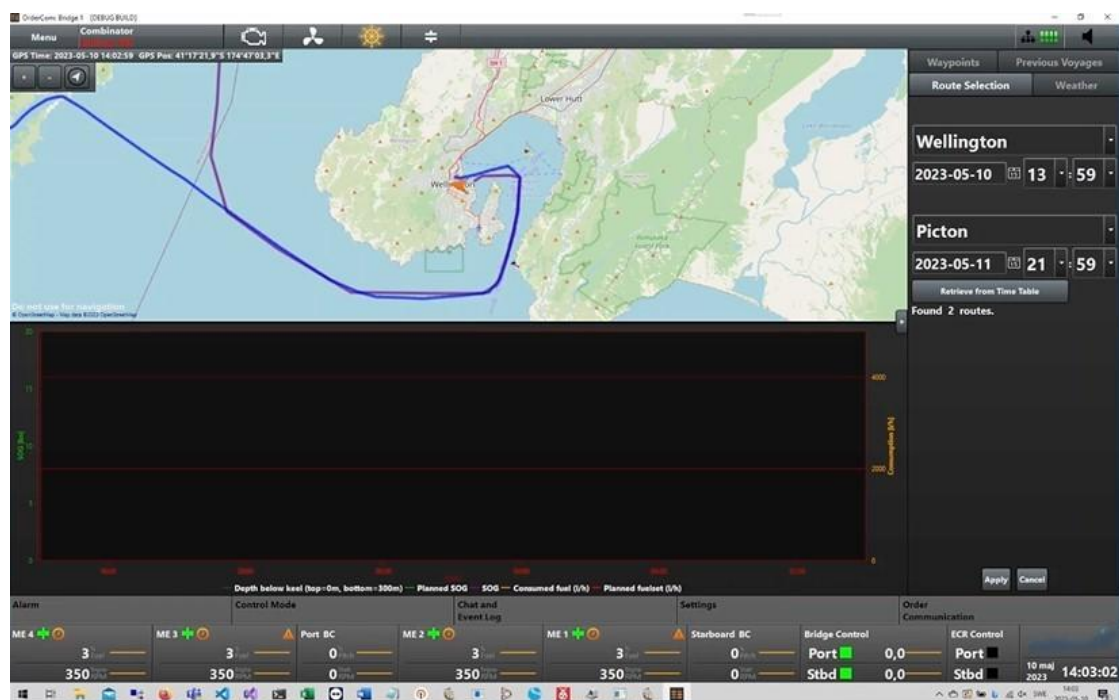
Figure 8 A screenshot of the current interface where the user plans a voyage from Wellington to Picton on the right.

First heuristic test results

Here are presented in table form the results of the heuristic evaluation (see Figure 9) aimed to evaluate the current interface from the 10 general principles for interaction design.

Usability Analysis	Explanation	Score

Visibility of system status	- The arrow shows that the route has started and where the vessel is - It's possible to see the status of different engines. - After clicking apply it's not clear whether changes have been made	3
Match between system & the real world	- Users with background in operating ships would understand abbreviations like ETA (estimated time of arrival), but would unexperienced user understand that? - The icons used for engine status view, fuel efficiency, propulsion status view, and EcoPilot planning view are clear. - -The placement of the menus isn't logical and intuitive.	2
User control and freedom	- You can easily make changes and click apply. - You can exit EcoPilot, and be in control of the ship	4
Consistency and standards	- The use of colour is inconsistent for the menu. Both black and white text is used for similar functions instead of consistent style.	2
Error prevention	- a risk of missclicking since the buttons are close to each other's. - Lack of feedback - -It's easy to undo actions - It's good that you must click apply to apply changes, so it's harder to make an error.	2
Recognition rather than recall	- The status of different engines is always visible. - The user is expected to rely on memory because of the lack of visibility and feedback.	2
Flexability and efficiency of use	- There are different view modes for different users. - There's usually one way to access a function and the interface doesn't offer a lot of flexibility. - Night mode and day mode are good.	2
Aesthetic and minimalist design	- Some relevant information isn't accessible. - Some irrelevant information is accessible. - Chat function is available, although the user doesn't use it. - Lack of contrast and hierarchy	1
Help users recognise, diagnose and recover from errors	- When an error happens, the user is sometimes left to guess why it happened	1
Help and documentation	- There's no help and documentation function on the interface.	1

Sum of all usability analysis scores		20

Figure 9 A table showing the results of the first heuristic test

The first heuristic test received a grade of 20 out of 50, as the sum of all principles' scores in the table is 20, while the ideal score is 50.

Affinity diagramming

I have attached a screenshot of the affinity diagram (see Figure 10) that includes data collected from user interviews. This helped us to narrow down the scope of the study and identify the most significant factors that contribute to improving the user experience. Using this information, we aim to create an interface that meets the diverse needs and expectations of the user, resulting in a user-friendly green marine technology interface that is readily accepted by the user.

Figure 10 A screenshot of the affinity diagram that was created on Figma

The result of Affinity diagramming showed different themes such as:
- Visibility: mentioning lack of feedback and insight about the system/ the voyages status
- Fitts's law
- cognitive overload
- Other
- More information is needed: more functions or information were requested from a user.
- Positive comments.

The biggest clusters were visibility and Fitts's law (in exclusion to positive comments). As mentioned before, the lack of feedback, and information about the system's status and the buttons being too small was a recurring concern of the user.

Persona result

After conducting multiple interviews and researching online, a persona was created (see Figure 11) to better understand the lives of ship crew members, including captains, first officers/chief mates, and second officers. In one online video, a chief officer mentioned his enjoyment of meeting new people and the significance of shipping for the economy. He also emphasized the value of his work. While the pay is good, being away from loved ones can be challenging (Dare Devil, 2022). A blog post where a captain was interviewed provided additional insights, highlighting that promotions can be significant events in the career of a maritime professional (ROL Cruise, n.d.). Another video mentioned that first officers and chief mates often become future captains (JhayAy Vispo, 2021). Many individuals opt for a career in the maritime industry to satisfy their desire to explore the world, engage in sailing and diving activities, and delve into travel literature, history, and biographies (NOA teacher at sea blog, 2016). On the other hand, some people feel an innate inclination towards the sea. However, it is worth noting that being away from family is often cited as a disadvantage of working in this industry (Charman, 2021).
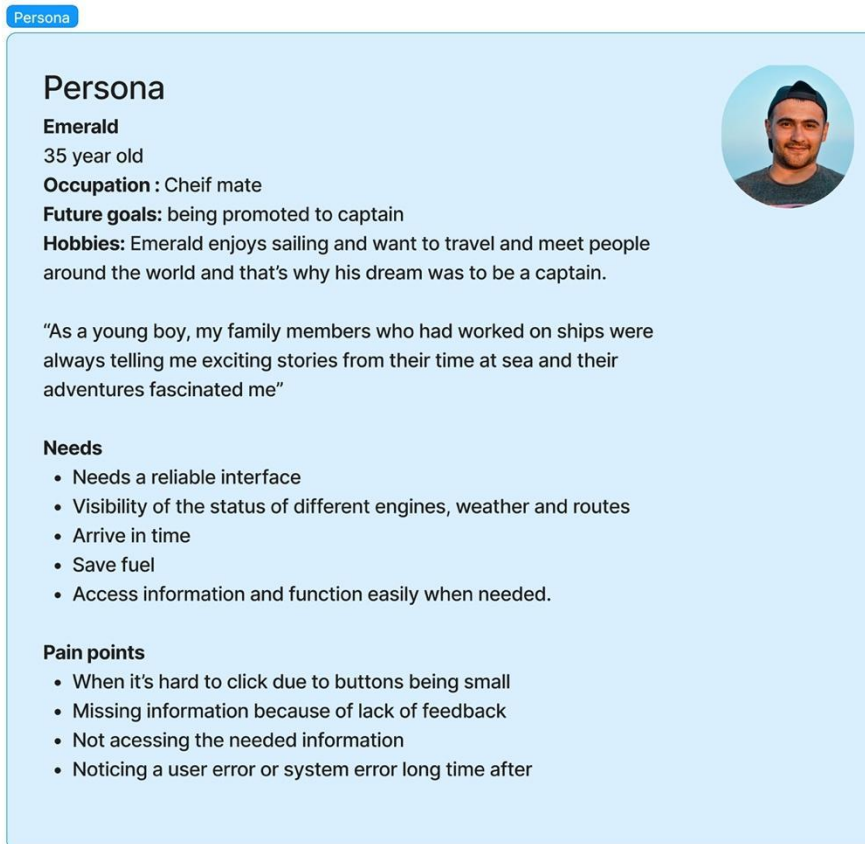
Figure 11 Image of the persona

User journey map results

After conducting an interview's mock activity and scenarios, a user journey map was created (see Figure 12) to communicate and clarify the user's journey. The user journey revealed potential opportunities for improvement, such as adding in-time feedback and improving the interface's intuitiveness. These improvements will make the user feel more competent and safer while using the technology, which will ultimately increase their trust in it.

ACTION	reading the manual	testing the interface	Making an error at work	Checking and monitoring data extra carefully
TASK LIST	**Tasks** A. Recieving information for the first time about the product C.reading the manual	**Tasks** A. planning a voyage B. Reading different weather and engine data	**Tasks** A. He noticed that he missed something B. notice that he booked a voyage on the wrong date.	**Tasks** A. checks data carefully B.advices 2:nd officers to do the same
FEELING ADJECTIVE	**curious** want to be good at his job.	**excited and anticipating** because of panel pc. user feels like it's an ipad and is fascinated by the technology.	**angry and dissapointed** user feel like they failed, and feels frustrated	**stressed and worried** the user is now worried about the future of their job and stressed about potentially missed information
IMPROVEMENT OPPORTUNITIES	**Area to improve** if the interface is simpler the user have the apportunity to learn by doing without using a manual.	**Area to improve**	**Area to improve** in time feedback would reassure the user and offer them the needed information	**Area to improve** The user would feel safer with the help of interface that has in-time feedback as well as if the interface is intuitive and makes the user feel competent and more re-assured about their future career-goals

Figure 12 User journey map starting from reading the manual to learning about the interface to associating the interface with stress and unsafety.

Parallel prototyping results
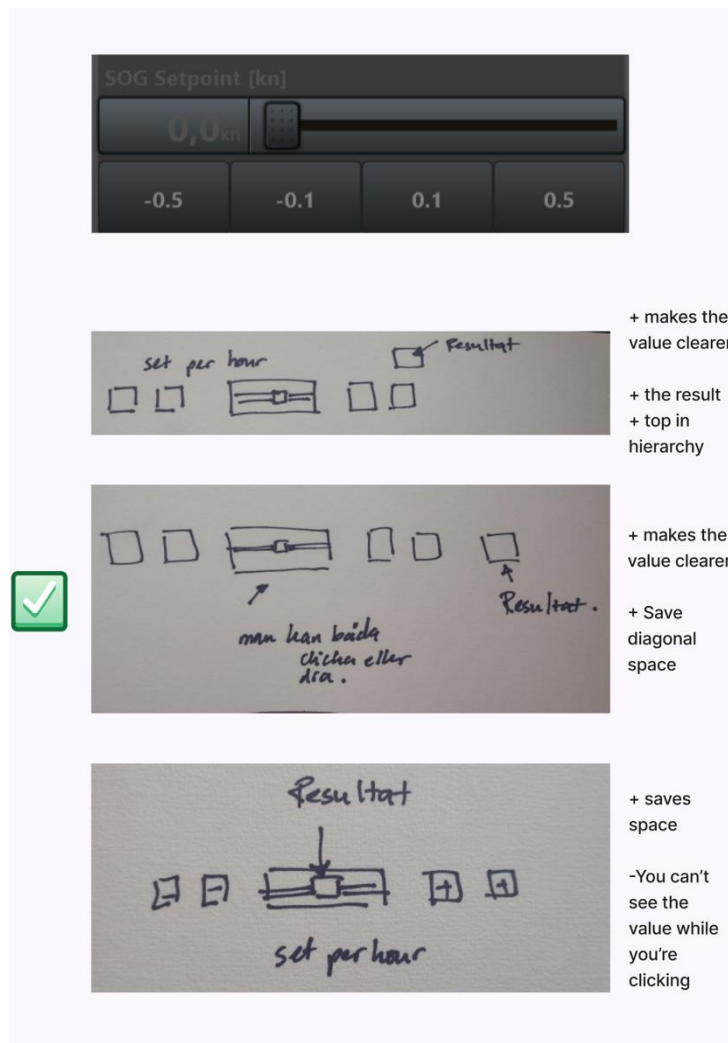
Figure 13 Three different alternatives to control mode were created and presented for feedback.

Results of the first iteration

The research showed the different areas of improvement, namely the size of the button and the interface's visibility, and with support of Miller's (2005, p.73) article where she mentioned that dark blue helps the screen of marine interfaces be visible in the day despite the sun. Miller also advises using more than only text; symbols, for instance, can be used if the user understands them. These suggestions were experimented with, used, and tested for the first iteration (see Figure 14).
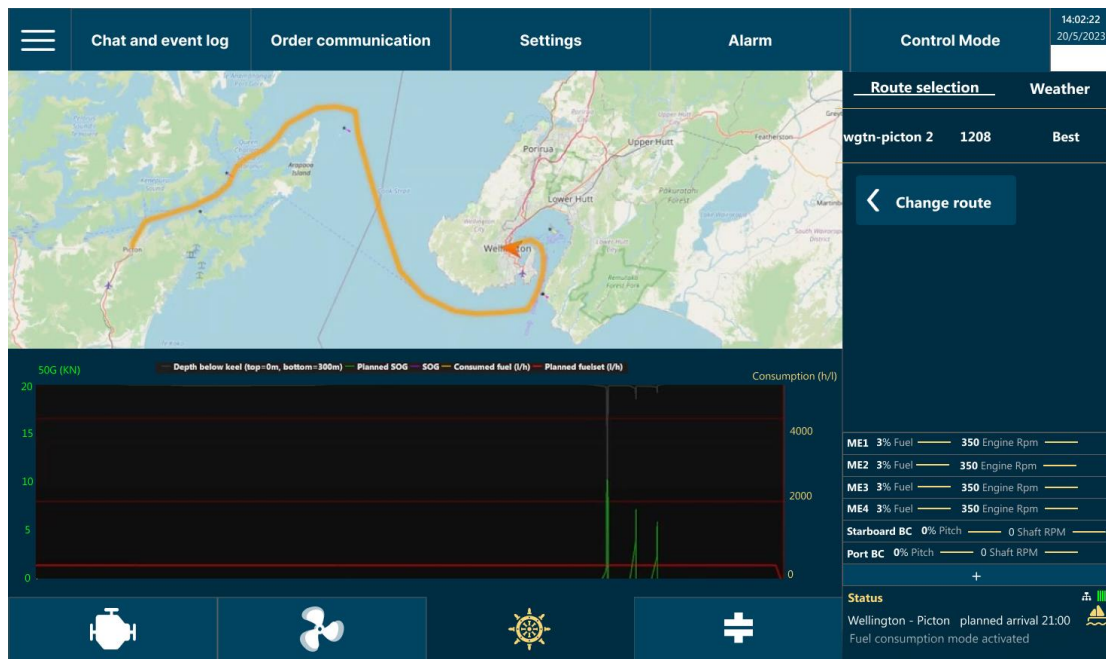
Figure 14 A picture of the first iteration created on the software Figma

User testing results

Fitts's law: Applying Fitts's law has resulted in the participants clicking quickly and not expressing difficulty or stress despite the table shaking.

Visibility: The participants could find the function showing their previous activity. The users could also see which engines are active while sitting two meters away from the touchscreen.

Familiarity: One of four participants expressed discomfort with the changes, especially with the colours; however, he was still able to complete the five different tasks. For the four participants, muting the alarm and navigating through the interface was easy for the participants.

Results from expert review

The feedback from the expert review was that the final prototype is visually appealing and more user-friendly with the addition of the status function. It is also more feasible than the previous iteration, as it is designed to be more familiar to the user. The prototype includes an additional green ring around the engine to indicate that it's turned on (see Figure 15), which is a positive to make it clear for the user. Feedback through text was also considered positive, as it provides the user with more information and feedback. Overall, this prototype has received positive feedback and as a step in the right direction.

Figure 15 Using lighter orange/yellow gradient instead or dark orange to light orange gradient to raise the contrast. Also adding a green ring, choosing a lighter shade of green that has more contrast against the grey background

Heuristic analysis to the final design

The table below (see Figure 16) displays the results of the heuristic evaluation conducted on the final prototype. The first evaluation was done to enhance the current design, while this one aimed to determine whether applying various design principles and theories could improve the interface's quality and make it more appealing to users.

Usability Analysis	Explanation	Score
Visibility of system status	- Status section shows the status of the system. - More colour added visibility for the engines	5
Match between system & the real world	- Users with background in operating ships would understand abbreviations like ETA (estimated time of arrival), but would unexperienced user understand that? - The icons used for engine status view, fuel efficiency, propulsion status view, and EcoPilot planning view are considered clear.	4
User control and freedom	- You can easily make changes and click apply. - You can exit EcoPilot, and be in control of the ship	4
Consistency and standards	- The language and the style of the interface is consistent	5

Error prevention	-	- Buttons are larger, decreasing the risk of misclicking	5
	-	More feedback	
	-	It's easy to undo actions.	
	-	It's good that you must click apply to apply changes, so it's harder to make an error.	
Recognition rather than recall	-	The information is structured on the interface in a way that's easy to remember.	4
Flexability and efficiency of use	-	There are different view modes for different users.	4
	-	There's more than one way to click off a menu, through clicking on the button again or through clicking outside the menu components.	
	-	There are more ways to mute the alarm which are more intuitive and visible.	
	-	Night mode and day mode are good.	
Aesthetic and minimalist design	-	There's alot of information, although most of it the user needs.	4
	-	It would be interesting to study whether there are functions that can be put in the backgrounds.	
Help users recognise, diagnose and recover from errors	-	Status function can allow the user to know information including their past activities and background functions.	4
Help and documentation	-	There's no help and documentation function on the interface.	1
Sum of all usability analysis scores			40

Figure 16 A table of the heuristic test that was conducted on the final design.

The result of this heuristic evaluation is 40 (see Figure 16). So, compared to the first heuristic evaluation, which had a total score of 20, my design process increased the design quality by doubling the total score.

Final prototype

Before

After

Figure 17 Before and after image of the engine view in EcoPilot where the final prototype shows more colour in the active engines. Furthermore, an added cast shadow from the engine icon on the right makes the clicked button stick out indicating that it's the engine mode that is active.

Before
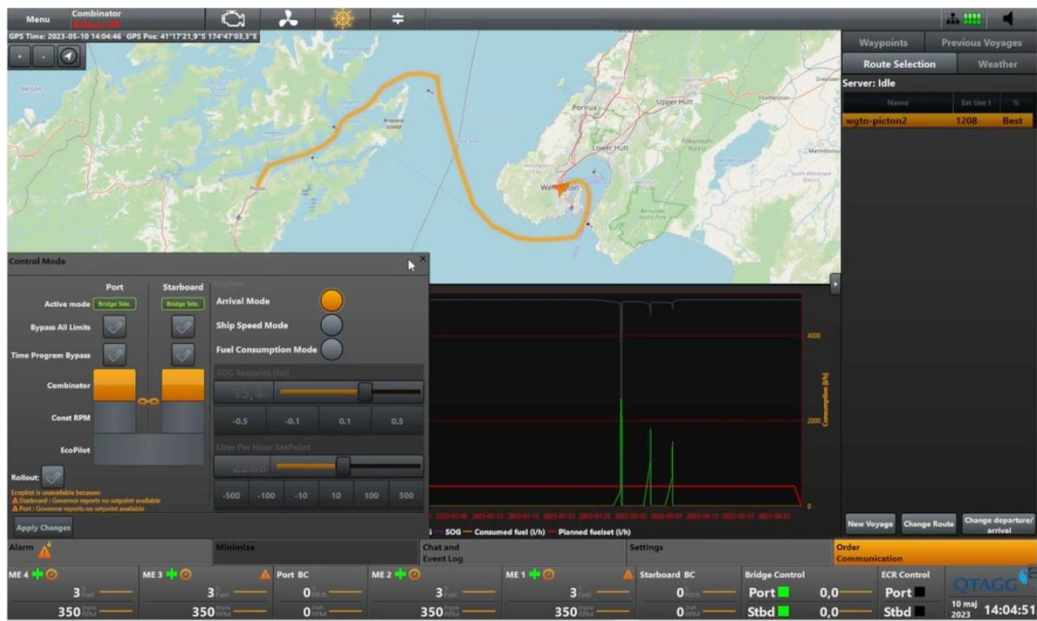
After
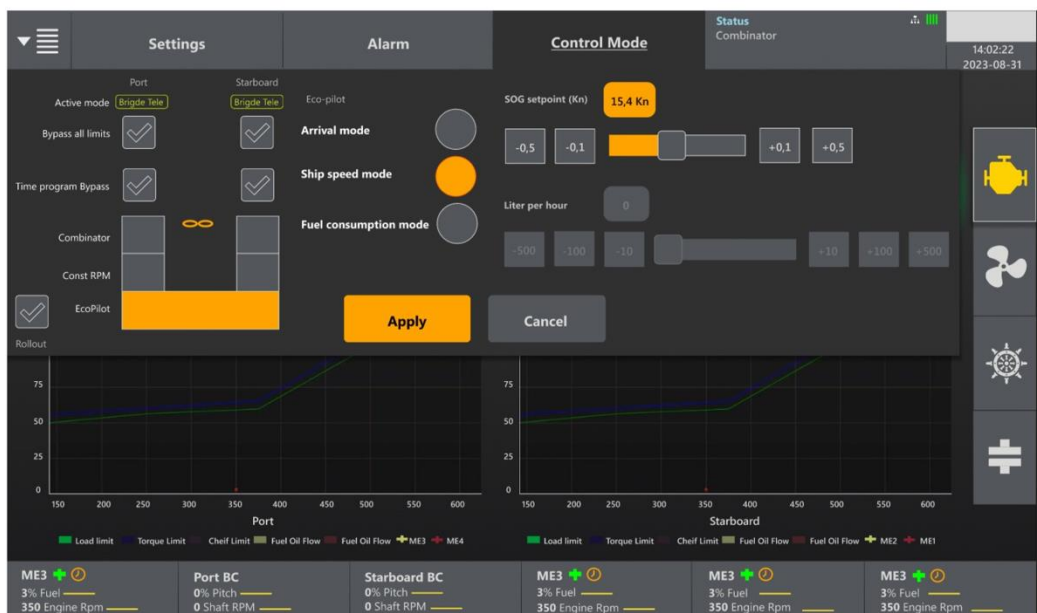
Figure 18 Before and after images of EcoPilot's control mode function where the buttons are larger in the prototype, and a brighter orange and green was used to create more contrast. The elements have consistent spacings, alignment and closeness, making them all different parts of "control mode".

Before
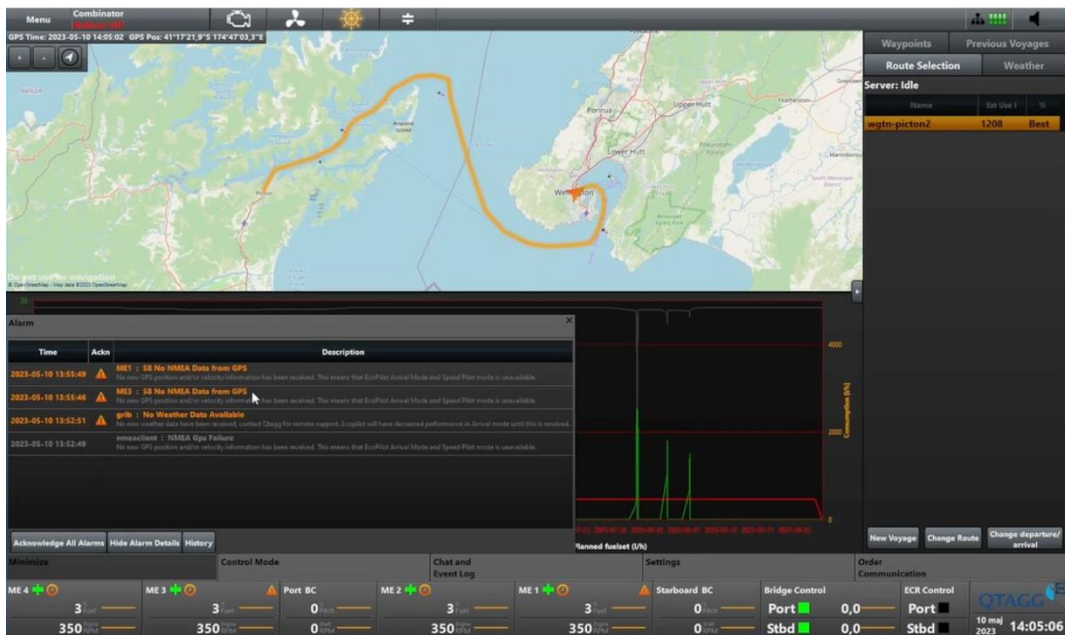
After

Figure 19 Before and after images of EcoPilot where the final prototype makes muting the alarm more accessible with three ways to turn off an alarm (through clicking on the text or on acknowledge, or clicking on the checkmark)
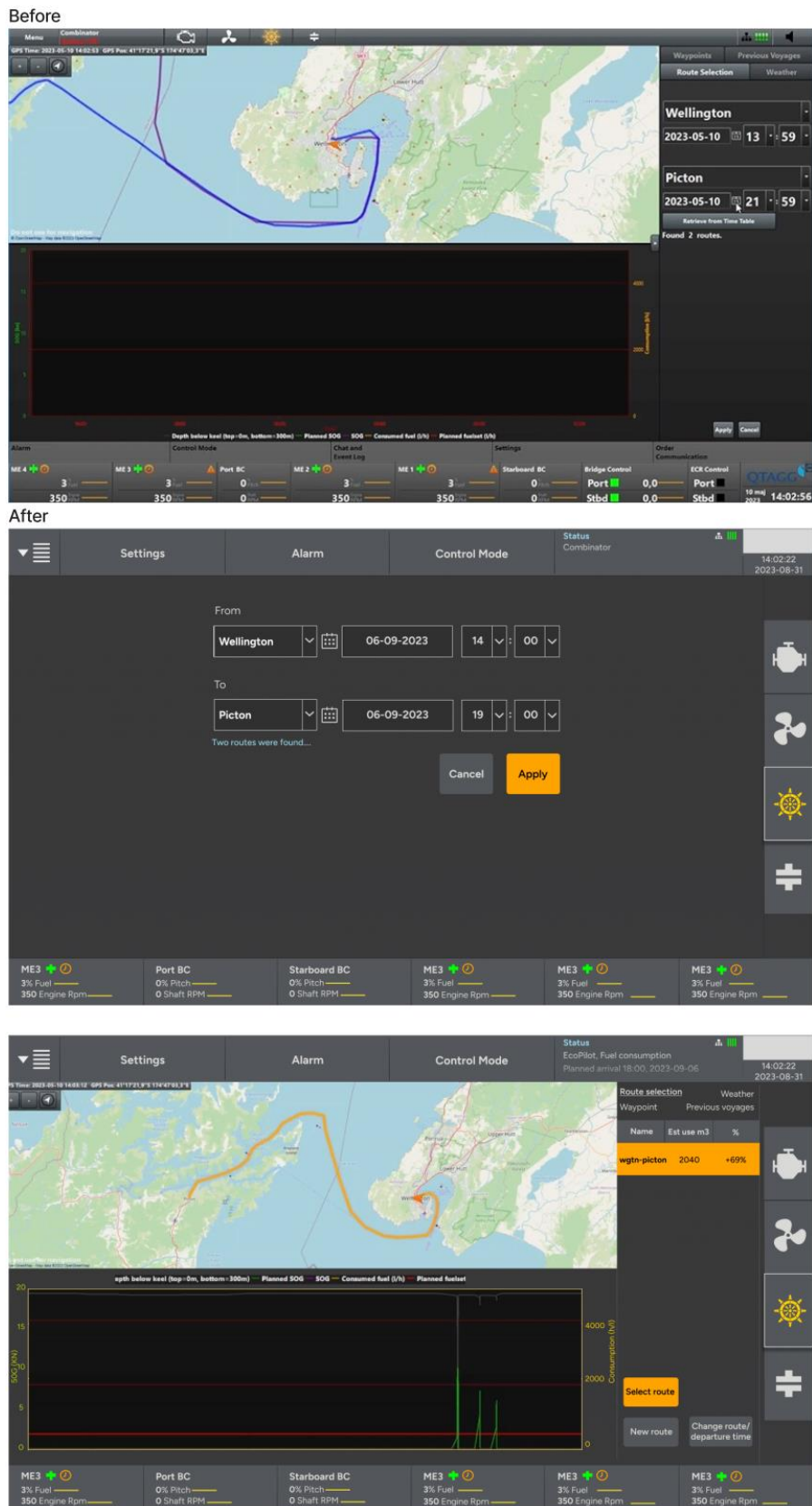
Figure 20 Before and After images of EcoPilot's planning view where the prototype doesn't include the map when it's not needed to allow for more space and add minimalism into the interface. The final prototype has more in time feedback (note the text "Two more routes were found..." and the "status" section)

Before
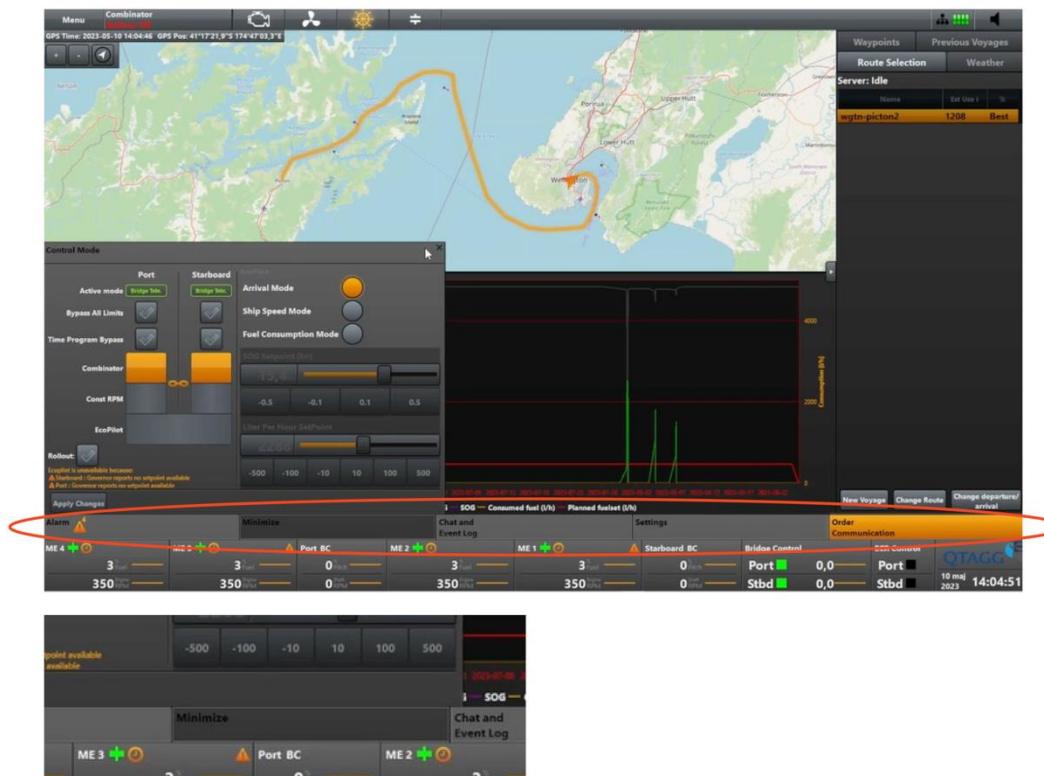
After
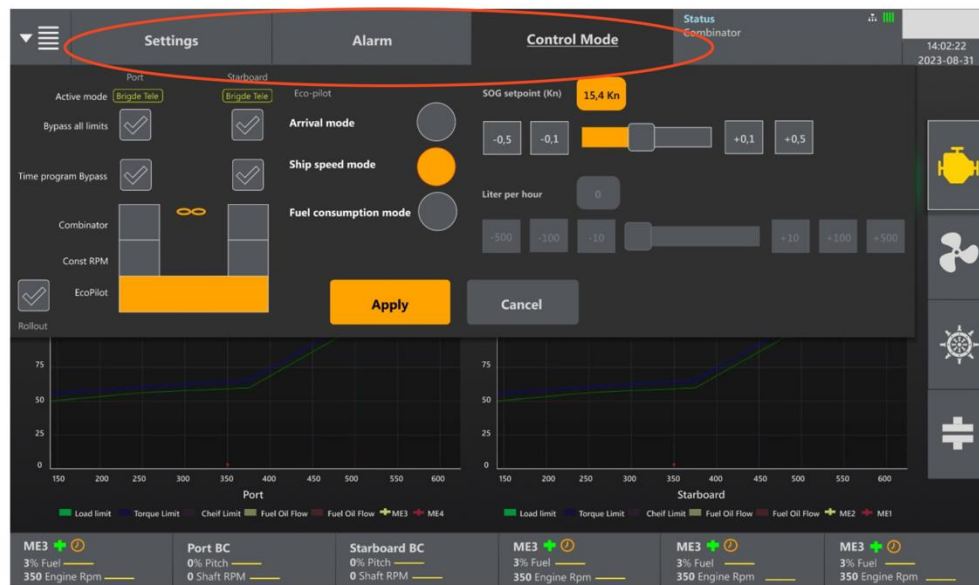
Figure 21 Menu before and after where in the picture below the menu is more intuitive and more legible with bigger font and more colour contrast

Discussion and conclusion

This research aims to study the human-centred perspective and its application to sustainable options, such as green marine technology, to make them more appealing to users. The goal is to contribute to studies that help drive green technology forward, especially in the light of new regulations to reduce CO_2 emissions. It is necessary to support such green innovation to achieve the EU's sustainability goals, which call for a 40% reduction in CO_2 emissions by 2030 compared to 2013. Currently, marine vessels in the EU are responsible for 18% of CO_2 emissions caused by marine transportation. According to Haug (2016, pp. 662-663), sustainable products are meant to be equal in quality to non-sustainable options, considering convenience and visual appeal. In the theories and literature section of this bachelor thesis, I explore the different factors that can affect the user experience, including how humans perceive and process visual information, our different needs, and design theories such as Fitts's law and visibility. To study how humans adopt new technology, I examine the Technology Acceptance Model by Lee and Wan (2010, PP.43–44), who assert that for users to accept a new product, it must be familiar, trustworthy, easy to use, and perceived as beneficial.

After conducting interviews, evaluations, and role-playing, it was discovered that the captains, chief mates, and second officers had mixed experiences with the original interface. Although they initially expressed that they found it user-friendly, upon further questioning, they identified some issues, such as the lack of visual feedback, small button sizes, and errors while performing tasks. Interestingly, the target group tends to blame themselves for such mistakes and ends up over checking due to their distrust towards the technology, which stems from their previous experience.

During my design process for the EcoPilot system I created a Figma prototype with interactions to test, discuss and evaluate my design ideas. The prototype enabled me to communicate and test the planning of a voyage, clicking on bigger buttons, as well as showcase my visual and aesthetic choices.

The results of this process included feedback from experts, heuristic evaluation, and user tests. Through these activities, I was able to conclude that my design process resulted in an increased knowledge about HCD role in technology acceptance and a progression in EcoPilot's interface in these areas:

- **Aesthetic and minimalism**: I used more colours and better contrast than the original black and grey. White on grey seemed to have better contrast and a better aesthetic style. I also added alignment to create a more aesthetically pleasing design, aligning sections with text to make it more logical. The design of the view bar was supposed to emulate familiar patterns in design for the user, such as the Instagram view bar or Apple dock bar. The menu bar with text on the top was also inspired by a familiar

pattern in website design, with many text-based menus and settings usually on the top of the interface.

- **Familiarity**: In the testing phase in the exploration stage, the users were able to recognize the new design without the need for an instruction manual. However, during this phase, the design was straying away from the original design, which experts believed could be problematic. Some users may not have associated the new colours with the product, leading them to feel uncertain about the changes. After defining the colour profile for EcoPilot and implementing it (see appendix 14), the final prototype received positive feedback. The changes were deemed appropriate, visually appealing, and user-friendly.

- **Hierarchy & contrast:** During the exploration phase, I received feedback regarding the hierarchy of the interface. Since I was unaware of the user's priorities and what information they were looking for, I prioritized other parts, such as the view menu. However, during the modelling phase, there was an opportunity for me to rectify this issue. The product owner considered removing a part of the interface that the user rarely used. Removing those functions made the interface more minimalistic, giving me the space to restructure the elements on the interface without compromising the accessibility of some necessary elements for the user. In the last iteration, to enhance hierarchy, I made the text for the menu larger and highlighted the alarms in the interface (see Figure 19). The placing of the menu was also meant to highlight the increased hierarchy in those parts. With the new interface restructuring, the users still recognized the design as familiar, and their success in conducting different scenarios proves the effectiveness of the changes made.

- **Human cognition:** Space has also been considered and used to group and separate objects. The text in the menu (see Appendix 14) is larger, and the size of each rectangle is the same, making it more apparent that the menu component is a part of the group. The objects are also aligned, making it more apparent that they are grouped. The menu and view bar are distinguished by changes in direction first. When conducting the user test, all the users could see the alarm since it was big and higher on the page hierarchy making it easier for them to see it.

- **Alignment:** Alignment makes visuals interpreted as visually appealing (Lidwell et al., 2010, p.24). when an interface is visually appealing, the user will interpret it as user-friendly, so the user is more likely to develop trust for it (Lidwell et al., 2010, p.20). Alignment contributes to more than aesthetics. It also creates a structure where it is apparent which objects are a part of a group (Ware, 2008, p. 51). The user could adjust to the new design where the menu is now moved (see Appendix 11).

- **Legibility:** for the text to be legible and to make the text more consistent, I chose a colour with better contrast with the background (see Figure 21). As already mentioned, consistency is not only aesthetically pleasing; it

also communicates trustworthiness and perceived usability (Lidwell et al., 2010, p.56).

- **Limitations of Short-Term Memory:** The status section makes it so that it's more forgiving not relying on the user's memory as cited before *"we're sitting there we're like all the time looking and controlling although there's a lot of technology and EcoPilot and Autopilot you have to have a sharp eye on everything and watch it"* the user has much information to monitor and watch which makes it necessary to provide visibility and feedback.

- **Visibility and feedback:** with the help of user testing and later expert reviews, it was proved that the user could see if the engine was active when adding extra colours (see Figure 17) even when standing 3 meters away from the screen. Furthermore, the status section (see Figure 20) updated the user and gave feedback to make the user feel safer.

- **Fitts's law:** when the current design was iterated with consideration to Fitts's law (see Figure 18) the user was capable to use to click on the touchscreen using their fingers with more accuracy.

- **Users' hierarchy of needs:** The new design was functional, more reliable, and usable since it is more intuitive for the user. The prototype is proficient since it is reliable and functional. EcoPilot's current functions are unique, and the product's uniqueness has been made more evident with the help of the new UX design choices. The design is also higher in creativity, where the user would find the product as a trustworthy tool that is a part of their day.

During the first heuristic evaluation, the original interface's design flaws became apparent, with small buttons that were easy to miss, inconsistent design, and no feedback when errors occurred. Based on my heuristic evaluation, the initial design scored 20 out of 50, which can be considered below average. However, the redesigned version, which incorporated research on the user's needs, received a score of 40 points out of 50, indicating a higher than average score. This indicates that the redesign, which included user journeys, user testing, and expert reviews, effectively doubled the overall quality of the design by increasing it by an additional 20 points. As Haug (2016) writes about ethical design, ethical designs should be simple to use and attractive for the user to compete with nonethical design. As written earlier, Lee and Wan's (2010) Technology Acceptance theories state that "perceived ease of use" is positively related to both "perceived usefulness" and "trust in ability." Additionally, "familiarity is positively related to perceived ease of use." Therefore, if a product is perceived as easy to use, it is considered valuable and trustworthy, which leads to Technology Acceptance and adoption. Familiarity with the visual features also contributes to its ease of use (Lee & Wan, 2010, pp.42-44). However, whether a design is perceived as easy to use depends on other factors. For example, who the users are and what they use the product for. When looking at the interface of green marine technology, it was evident that the terms *visibility*, *feedback,* and Fitts's law were crucial to improve

the interface. Fallibilities in those areas were evoking negative emotions in the user. The user or people around the user did not trust the technology completely; as mentioned in Lee & Wan's (2010) article, trust was an essential pillar to making people accept technology; however, creating trust is a challenging task. An interface that the user trusts is an interface that fulfils their needs, is visually appealing and is easy to use to make him/her feel competent. To speak about that, it's vital to mention design theories such as Familiarity, Alignment, consistency, and Human cognition. Finally, a design that puts the human at the centre has many benefits since it makes it closer to understanding the user, thereby creating a design where we can establish trust with the user so that they can accept new technologies. It is especially crucial when the technology benefits the environment, such as green marine technologies that have the capability of reducing CO_2 emissions to marine transportations.

Further research

The objective of this research was to assess the current user experience of EcoPilot and suggest ways to enhance the acceptance of technology, mainly touchscreen interfaces, through Human Centred Design. Additionally, it would be valuable to explore the usage of different modalities, such as touchscreens compared to traditional buttons. Also, evaluating design ideas on a boat or a vessel, or in an environment that simulates the conditions of a boat, including the platform's shaking, would also be advantageous. Moreover, the height of the table at which the touchscreen is placed should be analysed as well as other factors could be studied such as cognitive loads and distractions on captains and officers. Looking back and reflecting on the PACT framework (*people*, *activity*, *context* and *technology*) it's possible that *people* have been the focus of this study whilst activity, context and technologies could have been studied more. I learned for instance how weather as a *context* affects the user, as well as different activities the user uses EcoPilot for, but it could have been interesting to observe the user and learn more about the environment of their work, and possibly how other different technologies can be used and added to communicate with the user, to give an instance auditory interaction between the user and the technology.

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Appendix

Appendix 1 – Digital consent form

Consent form

Hello, my name is Rana, I study interaction design and i'm doing research for my bachelor thesis in information design.

This is a consent form for an online interview in research for a bachelor thesis in information design. It's an online interview with the goal of researching the user's experience with the product eco-pilot.

This interview is voluntary, which means that you're free to withdraw the data that's been collected from this interview, or to stop the interview for whatever reason.

If you agreed for the interview to be recorded, the file will be deleted after the research is done and will only be used to transcribe the interview.

If you would like a copy of this form or want to withdraw your participation, please contact me at raz19001@student.mdu.se

I understand that I can pause or withdraw my participation in this research for any reason without any consequences

○ Yes

○ No

I understand that the information that i share in this interview will be used for a bachelor thesis in information design

○ yes

○ No

I give consent for this interview to be recorded

○ Yes

○ No

Please type your name

Short answer text

Appendix 2 - Interview Questions (semi structured)

My name is Rana Alostaz, and I am working on my bachelor's thesis in interaction design. I will be studying the interface and user experience of EcoPilot. The interface refers to everything that you see on the touchscreen.

- Could you please tell me about your role and how you use EcoPilot
- How long have you been using EcoPilot?
- Can you share your first experience with EcoPilot, and any difficulties you faced during that time?
- How has your experience changed since then?
- Does weather affect your experience with EcoPilot?

Appendix 3 – Interviewee 1

I **would like to know a bit more your role and what do you work with Stena Vision**

I'm the second officer on board in Stena vision. we will be soon in route from Rossler Ireland to (recording inaudible) in France, so we will be switching the route soon. But I hope I can help you with your questions.

How long have you been using EcoPilot? since I'm the officer here at Stena vision for six months, so six months

Would go through the first time you use EcoPilot and describe the context and how the process look like and if you had any first impressions so my first impressions so I will pick up on it as an unnecessary was actually easy the pilot so I move quick to find it since my career started actually but yeah I was the one on my ship that liked EcoPilot, because not everybody like it, they might like some utilities but not the one where it does everything for you the most the most common the best thing of the pilots so you can give it the parameters and it decides what it's going to do. You don't have to supervise it and it learns and relearns, it's adaption algorithm I think with Qtagg, but not everyone wants to give the opportunity for this algorithm to make mistakes and to learn and make it better what they really enjoy using that one

Mostly we are using the fuel consumption fuel consumption over here, so we don't have to change the problem we just to just pressing plus or minus to give more kilograms per hour that's how we reduce or increase the speed of the vessel but it's like it's that simple it's really pure Simplicity and I love it I love using it

Why do you think other people that work with you and your colleagues don't like using it as much?

When I look at it, it's mostly older officers, they like the routine, they like the things that they know what it what is that it's simple and Technologies you know you know like it's some sometimes your parents or grandfather when you're showing him something that smartphone that he's like I don't trust that, yeah. here I think it's somehow similar

Are there any noticeable difficulties you had with EcoPilot when you first started using it, since the day I started this, and we were using it all the time if not the fullest. I don't remember the name, it's the one where you don't have to change the speed or kilograms, yeah. We were using that but not everyone liked it, so we switched to using only the fuel consumption in the last months actually it was in charge. I really like using this is full experience when it changes the speed it has this weather routine for it gets the information about the weather, so it consumes less fuel and be cost effective, so it's very good, it's a very good tool

Yeah would you say there's Improvement in the experience when you now use it after 6 months like I mean yes and I've seen this vehicle but I think have more

time to get the custom to that and like I said we would need to give this place to make an errors so we could we adjust because for example look at this one issue with coming to and just before we have like ETA on one way point. No matter what we clicked there, if we set the time, it always went three hours ahead, so it was quite strange maybe that was the case in why we switched to the not full experience of EcoPilot, but no other problems.

So, the algorithm was still learning at that stage, and it made some mistakes?

Yes, I think it should make mistakes, because if it gets the ETA and all the parameters it just comes on the minute. I think it needs more time. I think the more try it gets the better it will be, so it would be best if she could just give it a couple of tries, make some errors and it gets better.

Is it you that makes the error or the product? Actually, in that case that was the product. for example, it's 7:00 p.m. at this way point and we were there at 7:05

were there any cases where you probably or someone else maybe made a mistake or they clicked on the wrong thing yeah couple of times sometimes you know if something is too simple like for example in fuel consumption it's plus and minus. u see the number and u click more kilograms per hour no just clicking will you get used to that because sometimes you look at this and oh, I clicked 10 instead of 100 so you see that you're speeding suddenly, but it's not a problem because after 3 minutes you see that you made an error for someone was giving the ETA for four hour arrival and we have the same day arrival for example we depart at 9 o'clock and we are in Sweden at 19:30 and somebody miss-clicked and clicked the day after, and the vessel instead of going 18 or 17 knots it started going four knots cause it had almost two days to go, so if someone didn't control that we would actually go couple of minutes or couple tens of minutes on that velocity and then we had to go faster to make it up. and that would take more fuel so it wouldn't be effective, but that was more user error, than design

How did the officer fix that when it happened? He just realized he made a mistake. He went "oh, we're going 4 knots, why" and because it was automatic, he just checked oh we set the wrong date, so he had to fix it and it was fixed and the vessel was starting to go to the proper velocity. And everything Goods watch

How long would you say it took at the like he realized the mistake?

Ten minutes, probably because he was saying this to me like an anecdote, it was nothing big. It's nothing big you know. If he didn't notice, it meant he wasn't keeping a sharp watch, you know! And as officers, that's not possible for us, we're sitting there we're like all the time looking and controlling, although there's a lot of technology and EcoPilot and autopilot you have to have a sharp eye on everything and watch it

Do you have any other examples? Is it okay I'm trying to think of something examples regarding the user interface? it's just mostly because it's a touchscreen you can just miss-click or you think you click that, but you didn't. just normal smartphone problem I would say

Where is it common to miss-click?

probably in some menus that are like sense you know like five different two new spaces.

Sometimes the vessel is rolling and everything is moving around so you can miss-click, but it's nothing it's not major problems I'd say because everyone is controlling with their doing, I mean I hope everyone is.

Is it fixable? Is it easy to change if you make a mistake?

The unclicking is so simple,

I never clicked and thought "omg, how will I change it how do I change it, how can I go back"

just click to go back, it is very user friendly and beginner friendly.

My friend when I started here showed me EcoPilot and I could just click and learn. as I clicked, I learned by me and in a couple of days I was perfectly fine with that. Nothing could surprise me about EcoPilot.

Do you use a mouse?

We use touchscreens here. No, we have one on the port side but the closer one to officer seat I would say is the touch yeah

Are all the screens the same size, I mean I don't know if you see that it's good but okay two screens over here okay which are smaller and closer to the place where I sit normally, and there's a bigger mouse, but we use that rarely.

Is there a reason why you use or not you and your colleagues use fuel consumption in the most?

the reason why we use that it's cause it's like very easy to control and you can give like very minor changes for example when you using the manual trouble you just move from I don't know thanks here if sometimes you want to be somewhere on the minute you can just ask for example 30 kg just three clicks on 10 and you can go I don't know points to notes faster so it's very good for like mine or minor changes which can help with not using the engines that much cause you're not giving big change in the propulsion system you're not going super-fast super slow super-fast you're just giving the minor changes. I think it's very good for fuel consumption.

In my understanding Fuel consumption EcoPilot doesn't take that much control, is that correct?

in the first months we gave the authority to EcoPilot. It was always 3 or 5 minutes ahead of time and it had its problems.

Is this problem solved now? like I said before, if we gave it more voyages on the same route with the same settings, I think it would learn actually, but the master

decided we're not using it was only using fuel consumption and we're now only using fuel consumption mode.

Is there something that you would like to add?

I think the interface is very simple for example I'm took my girlfriend to the bridge she was like she was very surprised you can you know like operate the propulsion of the vessel with something that looks almost like iPad or something you just have a plus and minus and it's super simple, and it's very good.

Regarding the interface, it's a small screen and there's a lot of buttons on the screen. That might be something to consider. I think it's like especially with these touch panels, it may sounds funny but when you have like a storm or something like that, it's not that easy to click sometimes it's not easy to stand on the bridge, because it's like waving you and you're moving around, and if you're trying to point your finger at something sometimes it's really not that very easy, if you're trying to survive and everything is falling and you need to go faster to go overweight quicker, but these are minor problems I would say

Appendix 4 – Interviewee 2

What is your role?

I' m a chief mate in Athena seaway

How old are you?

37

How long have you been using EcoPilot?

I don't remember think it was installed 2 years ago, so 2 years. you can check with qtagg but I think 2 years

Can you tell me a little bit about what do you use it EcoPilot for?

mostly we use arrival mode, sometimes speed mode almost 95% of the time we are using arrival mode, but we almost never use fuel consumption mode

Would you describe the first time you used EcoPilot ?

the first time I used it there was some system error, but those got solved and then it was okay to use EcoPilot.

Beside these error that were resolved, how would you describe your experience?

We decreased fuel consumption I don't know how much percent, and the ship speed increased. Before the ship wasn't too fast now the ship increased by one or two knots that it was before EcoPilot

What do you think of the interface, it means everything you see on the screen and everything you can click on.

The screen is okay, we are having not a problem but it's not very good when we when we are creating a route on I don't know what you call it but on an additional computer. it's not clear we haven't a clear map, el. sea chart we haven't a route, and we not know where the exact depth of the sea that should be improved.

So more information would be good?

If you're looking at the el. Sea charts we have alot of information like depth of the sea like traffic ...(seems)here only general chart but what we need is to know when creating a route, the exact position where we should increase or decrease the speed. If the el.sea chart would be a button in the EcoPilot that would be much easier for us to use.

Did you come across any difficulties when learning how to use EcoPilot?

I think no, we have the instructions and the manual now I'm only using the main functions like control mode, engine parameters and propeller parameters.

Everything I think is clear to me

What do you think of control mode and the buttons?

The buttons, I think everything is okay

You haven't experienced problems with that.

I don't remember any problems. You can write an email to us i can ask my colleagues too. This moment I don't remember. I don't have an issue with the buttons or graphics, we can write an email to you.

Does the weather affect how you use EcoPilot?

We use it as usual on arrival mode, and sometimes if the weather is very heavy, stormy weather we switch to ship speed mode. If we were delaying, we have to use full speed when switching to ship speed mode.

Can you describe how do you switch mode?

How you switch mode? You just click control mode and click speed mode and apply changes.

So, everything works fine for you there?

I think several times the system automatically switched from arrival mode to fuel consumption mode, and we noticed it later, it was yeah it was several times

So, the system switched from one mode to another, and you did not get any information about that on the screen, correct?

No, we did not get information and after few hours we noticed that the system automatically switched into consumption mode. If we have serious problems, we always email Qtagg and they solve the problems.

Did you email them about this? Or was it not an issue?

I think we didn't because we now know it could happen so we always checking and change what mode is used. It happened several times but it's not so often, so we don't remember.

We had problems when the system was installed, but after half a year the biggest problems were solved. Now everything is more or less okay. But we still have a problem with the chart, when we are creating a route it's not clear, where or how the exact position and we don't see. You should write an email, and i can forward that email.

Thanks for your time and if you come across anything else, you can email me.

Follow up email

Hi,
Talking about route creating it's difficult to set exact position where we want to reduce or increase speed because there is no el. chart with information what we have on ECDIS. It's not clear what depth is in exact position.
Navigation routes and speed limits makes impact to each other if the routes are nearby each other. It's again the same reason why el. sea chart would be very important to improve the system. If el. chart would be installed, then we could set exact speed in exact area and no impact would be despite that route in opposite directions passing very close to each other.

Regarding other issues I didn't mention that sometimes we have a problem to begin new route for example route is created, and we just want to load it, but sometimes program just stuck, and we can't do anything. Maybe it's possible that EcoPilot downloading weather forecast or other reason. After some time, programs begin to work. It would be ok if we knew why it happen, for example alarm could pop out and inform us that something is in progress or what is wrong.

Hello, (Name)!
I'm going through your interview and i want to ask you if you use the mouse when using EcoPilot or do you only use the touchscreen.
Thanks in advance.
Greetings
Rana Alostaz

Hi,
We use touchscreen only.

Appendix 5 – Interviewee 3

How old are you?
I'm 40.
I **would like to know a bit more your role and what do you work with Stena Vision**
I am presently a chief mate for 5 years. My experience was as an officer on the watch for like 4 years It was with Stena also, so I have been with Stena for 9 years, almost 10 years. Before my experience as an officer in the watch in 2008 to short count it's about 15 years as an officer.
I'm away from my family in (audible).
What goals do you have at Stena vision when using EcoPilot?
With EcoPilot, I remember when I was on the watch now, I'm familiarized with it but I don't use it as much often as I did before. Anyway, I remember some things, so I will help you with your questions but to be honest not every question would be for me easy to answer.
Our goal is to achieve the proper fuel efficiency. Unfortunately, our route between Gdynia Karlskrona because our voyage between Polen and Sweden is 173 miles. So it's not huge distance. I think this program we have much fuel efficiency on long cruise. As you know there are many buttons like EcoPilot mode, Fuel consumption mode and speed mode. Those three modes. Yeah, so for us, it's most important to be on time. So, we're using the EcoPilot.
What mode did you say
we're using destination time. We're not using fuel efficiency because in my opinion it would be better for the tankers or the type of vessels which they are taking the fuels from the tank, not like engine tanks but the tank for carrying the fuel like the gas tankers. Regarding the speed is not so much efficient. We tried it but it's not good for the engines So the most efficient buttons which we are using is arrival mode, ETA., and when using EcoPilot I understand it's only 173 miles, but when you're using it every time it's giving you a total distance per year. So, if you have a long-term strategy regarding the fuel consumption, it makes sense. For short voyages like us what it affects is the weather and the depth, these two inputs. But regarding EcoPilot were using estimated time of arrival.
Do you mean arrival mode?
Yes, arrival mode.
What is the first impression of EcoPilot and if you remember the first time you used it?
The interface is very logical and friendly to the user It's logically divided and it's easy to use from my side and my colleague's sides. For many years Qtagg were with us and were rectifying our suggestions; what can be better, what can be improved. One thing that we suggested, and they did, was to put colours for when the engine is activated. So, we have four engines and every engine have their parameters regarding the fuel consumption regarding the load, the pitch and when we're switching on additional engines, we have a short indication as a color the green ones that appears, and that's good we can improve that and give much more color Inside that Circle if you know the interface
So, if you have four engines, so you have four circles with the parameters. Our suggestion is to give full green inside the circle to fulfil the circle because. During the daytime it's hard to recognize from 3 m when we're sitting off the panel If the engines are working or not. That's good; that can be improved.

So, it's feedback that shows you that the engine is working?

Yes, cuz sometimes I need to work much forward to the screen. Then I can find out which engines and how many engines I have right now in use, so it would be much more comfortable for us to fulfil the circle inside the engine, so we can see from the sitting place We can see easily with the engines are running.

They are the four ones, right?

Of course, we can see the, but the numbers are coming of course, I can see that. But it would be much easier for me to have much more colour to have an indication from a huge distance, let's say.

You have mentioned weather, would you say the weather affects your experience of EcoPilot? The weather affects us a lot in EcoPilot and It's tricky because our route (inaudible) Takes around 12 hours, but the forecast is updating every 6 hours. So, sometimes we need to act accordingly to present situation Because the forecast is the forecast, but the present situation is something different. So, sometimes you need to exit EcoPilot and play with the engines according to the situation.

How do you switch from EcoPilot?

There are two ways of switching off EcoPilot. One way is pressing the combination mode on the screen. So, you need to stand and walk to the screen, let's say 3 meters on our vessel, and then you can switch off There's the one where you press the button on the screen. The second way is that we reduce the telegraph. So, we dropped the telegraph at least one. And the telegraph has different positions from 0 to 10 (inaudible). If the handle of the telegraph has been set on seven, and EcoPilot was in use; If you drop the telegraph from seven to six, then we automatically switch off EcoPilot for the combination mode. so it's very quick. So, what can be improved, and this is a good idea for us and for the safety, of course, to give an additional option to changing from EcoPilot to combination mode is, not only by dropping the handle of the telegraph but also by increasing. So, if we give the algorithm with plus and minus one, it would be perfect. Now it's only set to minus one. It would be perfect then they set plus and minus one because it means every movement of the telegraph Up or down, it will change from EcoPilot to combination. Because sometimes if it's emergency, we need to drop down the telegraph to switch off and change to combination and then increase again

So to exit a EcoPilot you pull it down, and then to go faster you have to put it up again ?

Exactly, yes. So we don't need to go down and up again.

If you talk about the screen again, there's a button called bypass or limit That's also used when it's a dangerous situation.

We never use this button because it's for in case of emergency, hope we never use it.

And regarding the screen I think there should be a function called buzzer off. Because every alarm that comes on the screen affect our manoeuvring, and not all alarms are much important Like from Eco-server and (audio inaudible) And then we need to switch off, switch off again and again and then we focus only on the switching of the alarms. And we have many alarms in the manoeuvring. So, we need a function that's buzzer off, and it's only enough with the visual then we can see that the alarm is flashing or whatever.

What alarms are most important for you that you wouldn't want to miss?
I think the loss for Eco-server for us is not much important in the manoeuvring.
Maybe it would be useful for you to if it's if you can choose what kind of alarms you want to receive and what you don't want to receive
 it would be possible to categorize alarms but it's very difficult. For me, it's enough when I have a buzzer off and buzzer on, because during the manoeuvring, we're not focusing on the EcoPilot . EcoPilot we're only using in the (audio inaudible) for the indication how many engines we have etc., so regarding those alarms, they disturb us.
When you schedule a voyage on arriving mode, did you come across any mistake that you made or that's someone else made Or did it always work well from the beginning
From the beginning, when we used arrival mode. We need to set the last Waypoint the time yeah So from our experience, we're dropping down two or three minutes to be on the same time. For example if ETA: the estimated time for arrival is 18:40, we will not be sending 18:40. We will be sending 18:38 or 18:37 to be on time. So, sometimes there would be some differences.
So it happens some sort of delay Is it from a EcoPilot is it something else
Yes, the problem can be regarding this Waypoint in this route which implemented from the Qtagg It's taken from (audio inaudible) navigational chart. I think the (audio inaudible) have different formula for counting the distance between two-way points, and EcoPilot have a different formula.
Do you see well and do you click on the right things when you're using arrival mode?
Yes this is well done! Hmm… Just give me a second! No, I would keep it like it is now.
When you schedule a voyage, and you click on apply do you always feel like you're sure of what happened and what you did
You know, it's hard to say because I'm not sitting in front of the EcoPilot
If it's a stormy day for example and you're using EcoPilot did you have an experience where it's hard to click on the screen
No we're writing by hand on stormy weather and if if we want to use the like the finger, we have a special let's say, a pen with Special gum to have correct accuracy.
What kind of pen is it?
I don't know what to call it, but sometimes you have a pen with a special gum on the top.
Yes, I understand what you mean. Do you always use it?
Yes, we usually use it because everyone has a different finger, and if one guy is, like, eating something. Of course, we approached the equipment with clean hands, but, in fast reactions, sometimes, we are pressing.
Who came up with using pens for this
Officers

Follow-up emails:

Hello, (name)
Thank you so much again for your insights yesterday. I have a question.
-I was wondering when you mentioned pen if you were talking about touch pens

Hi Rana,
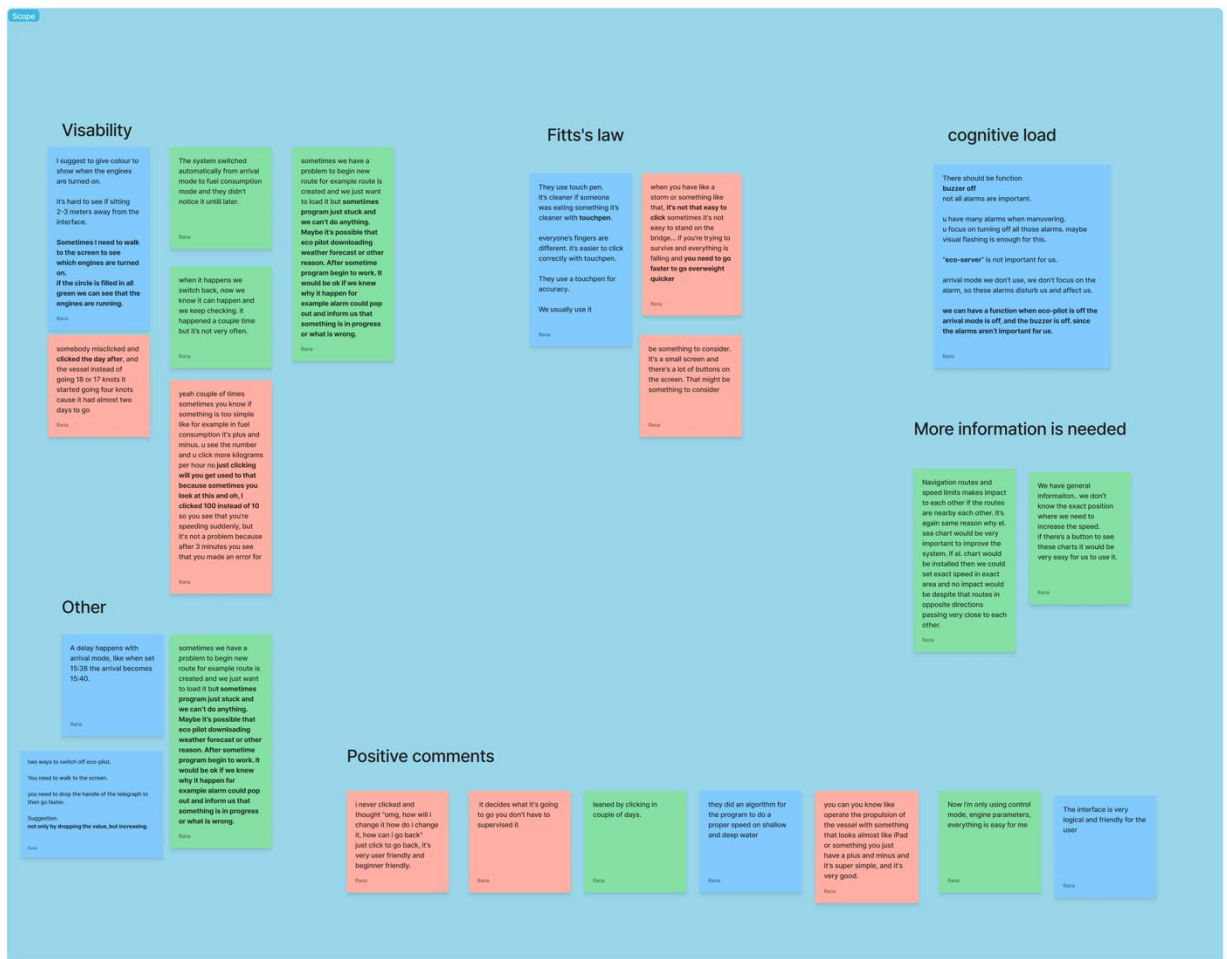Yes, correct touch pen

Hello, (name)!
I'm going through your interview, and I'm curious if you use the mouse when using EcoPilot or if you only use the touchscreen.
Thanks in advance.
Greetings,
Rana Alostaz

Hi again!
We use touchscreen mostly.
(name)

Appendix 6 Affinity diagram

Scope

Visability

I suggest to give colour to show when the engines are turned on.

it's hard to see if sitting 2-3 meters away from the interface.

Sometimes I need to walk to the screen to see which engines are turned on.

if the circle is filled in all green we can see that the engines are running.

Rena

The system switched automatically from arrival mode to fuel consumption mode and they didn't notice it untill later.

Rena

when it happens we switch back, now we know it can happen and we keep checking. it happened a couple time but it's not very often.

Rena

sometimes we have a problem to begin new route for example route is created and we just want to load it but **sometimes program just stuck and we can't do anything. Maybe it's possible that eco pilot downloading weather forecast or other reason. After sometime program begin to work. It would be ok if we knew why it happen for example alarm could pop out and inform us that something is in progress or what is wrong.**

Rena

somebody misclicked and **clicked the day after,** and the vessel instead of going 18 or 17 knots it started going four knots cause it had almost two days to go

Rena

yeah couple of times sometimes you know if something is too simple like for example in fuel consumption it's plus and minus. u see the number and u click more kilograms per hour no **just clicking will you get used to that because sometimes you look at this and oh, I clicked 100 instead of 10** so you see that you're speeding suddenly, but it's not a problem because after 3 minutes you see that you made an error for

Rena

Other

A delay happens with arrival mode, like when set 15:38 the arrival becomes 15:40.

Rena

two ways to switch off eco-pilot.

You need to walk to the screen.

you need to drop the handle of the telegraph to then go faster.

Suggestion.
not only by dropping the value, but increasing.

sometimes we have a problem to begin new route for example route is created and we just want to load it but **sometimes program just stuck and we can't do anything. Maybe it's possible that eco pilot downloading weather forecast or other reason. After sometime program begin to work. It would be ok if we knew why it happen for example alarm could pop out and inform us that something is in progress or what is wrong.**

Rena

Fitts's law

They use touch pen. It's cleaner if someone was eating something it's cleaner with **touchpen.**

everyone's fingers are different. It's easier to click correctly with touchpen.

They use a touchpen for accuracy.

We usually use it

Rena

when you have like a storm or something like that, **it's not that easy to click** sometimes it's not easy to stand on the bridge... if you're trying to survive and everything is falling and **you need to go faster to go overweight quicker**

Rena

be something to consider. It's a small screen and there's a lot of buttons on the screen. That might be something to consider

Rena

Positive comments

I never clicked and thought "omg, how will i change it how do i change it, how can i go back" just click to go back, it's very user friendly and beginner friendly.

Rena

it decides what it's going to go you don't have to supervised it

Rena

leaned by clicking in couple of days.

Rena

they did an algorithm for the program to do a proper speed on shallow and deep water

Rena

you can you know like operate the propulsion of the vessel with something that looks almost like iPad or something you just have a plus and minus and it's super simple, and it's very good.

Rena

Now I'm only using control mode, engine parameters, everything is easy for me

Rena

The interface is very logical and friendly for the user

Rena

cognitive load

There should be function **buzzer off** not all alarms are important.

u have many alarms when manuvering. u focus on turning off all those alarms. maybe visual flashing is enough for this.

"eco-server" is not important for us.

arrival mode we don't use, we don't focus on the alarm, so these alarms disturb us and affect us.

we can have a function when eco-pilot is off the arrival mode is off, and the buzzer is off. since the alarms aren't important for us.

Rena

More information is needed

Navigation routes and speed limits makes impact to each other if the routes are nearby each other. It's again same reason why el. see chart would be very important to improve the system. If el. chart would be installed then we could set exact speed in exact area and no impact would be despite that routes in opposite directions passing very close to each other.

Rena

We have general informaiton.. we don't know the exact position where we need to increase the speed. if there's a button to see these charts it would be very easy for us to use it.

Rena

Appendix 7 – Persona

Persona

Emerald

35 year old

Occupation : Cheif mate

Future goals: being promoted to captain

Hobbies: Emerald enjoys sailing and want to travel and meet people around the world and that's why his dream was to be a captain.

"As a young boy, my family members who had worked on ships were always telling me exciting stories from their time at sea and their adventures fascinated me"

Needs
- Needs a reliable interface
- Visibility of the status of different engines, weather and routes
- Arrive in time
- Save fuel
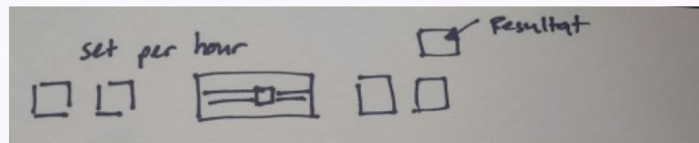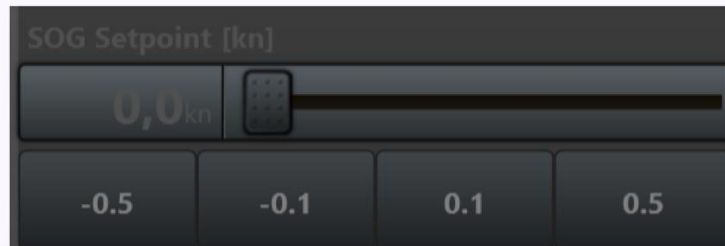- Access information and function easily when needed.

Pain points
- When it's hard to click due to buttons being small
- Missing information because of lack of feedback
- Not acessing the needed information
- Noticing a user error or system error long time after
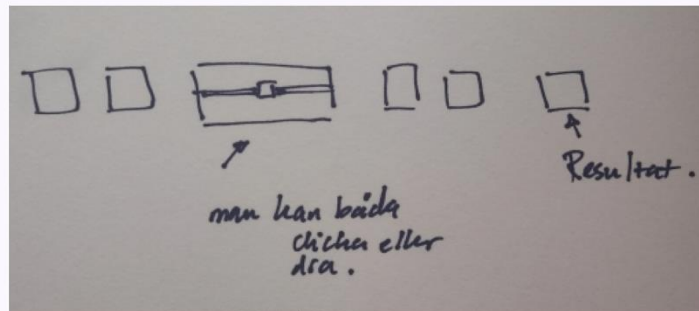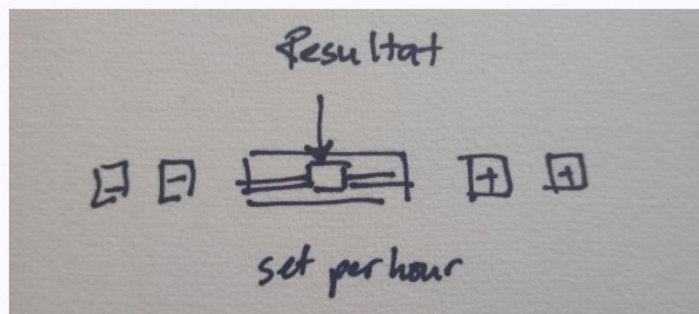
Appendix 8 – User journey map

	reading the manual	testing the interface	Making an error at work	Checking and monitoring data extra carefully
ACTION				
TASK LIST	**Tasks** A. Recieving information for the first time about the product C. reading the manual	**Tasks** A. planning a voyage B. Reading different weather and engine data	**Tasks** A. He noticed that he missed something B. notice that he booked a voyage on the wrong date.	**Tasks** A. checks data carefully B.advices 2nd officers to do the same
FEELING ADJECTIVE	**curious** want to be good at his job.	**excited and anticipating** because of panel pc. user feels like it's an ipad and is fascinated by the technology.	**angry and dissapointed** user feel like they failed, and feels frustrated	**stressed and worried** the user is now worried about the future of their job and stressed about potentially missed information
IMPROVEMENT OPPORTUNITIES	**Area to improve** if the interface is simpler the user have the opportunity to learn by doing without using a manual.	**Area to improve**	**Area to improve** in time feedback would reassure the user and offer them the needed information	**Area to improve** The user would feel safer with the help of interface that has in-time feedback as well as if the interface is intuitive and makes the user feel competent and more re-assured about their future career-goals

Appendix 9- Parallel prototyping

SOG Setpoint [kn]

0,0 kn

| -0.5 | -0.1 | 0.1 | 0.5 |

set per hour   Resultat

+ makes the value clearer

+ the result
+ top in hierarchy

man kan båda
chicha eller
dra.

Resultat.

+ makes the value clearer
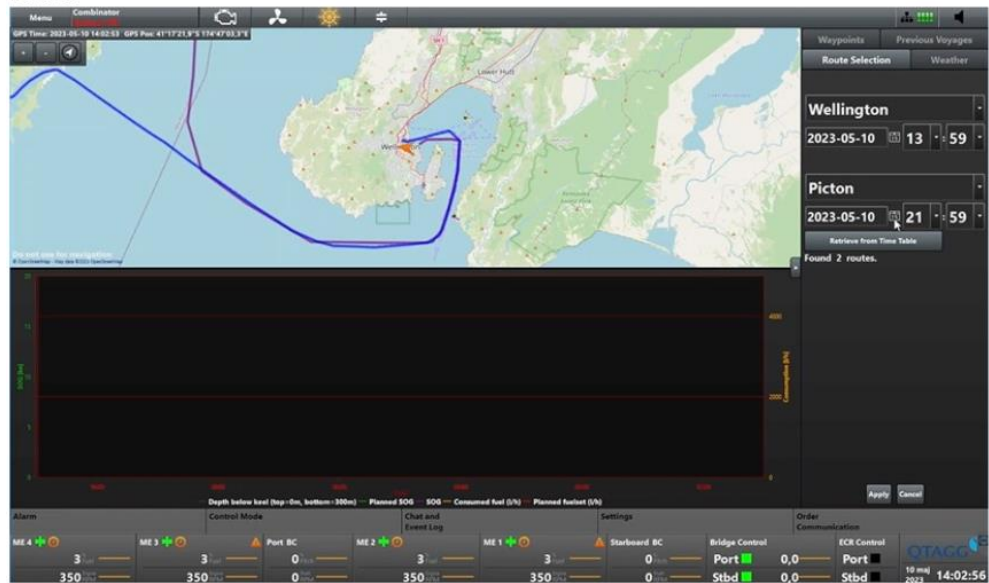
+ Save diagonal space

Resultat

set per hour

+ saves space

-You can't see the value while you're clicking

Appendix 10 – Planning view before and after
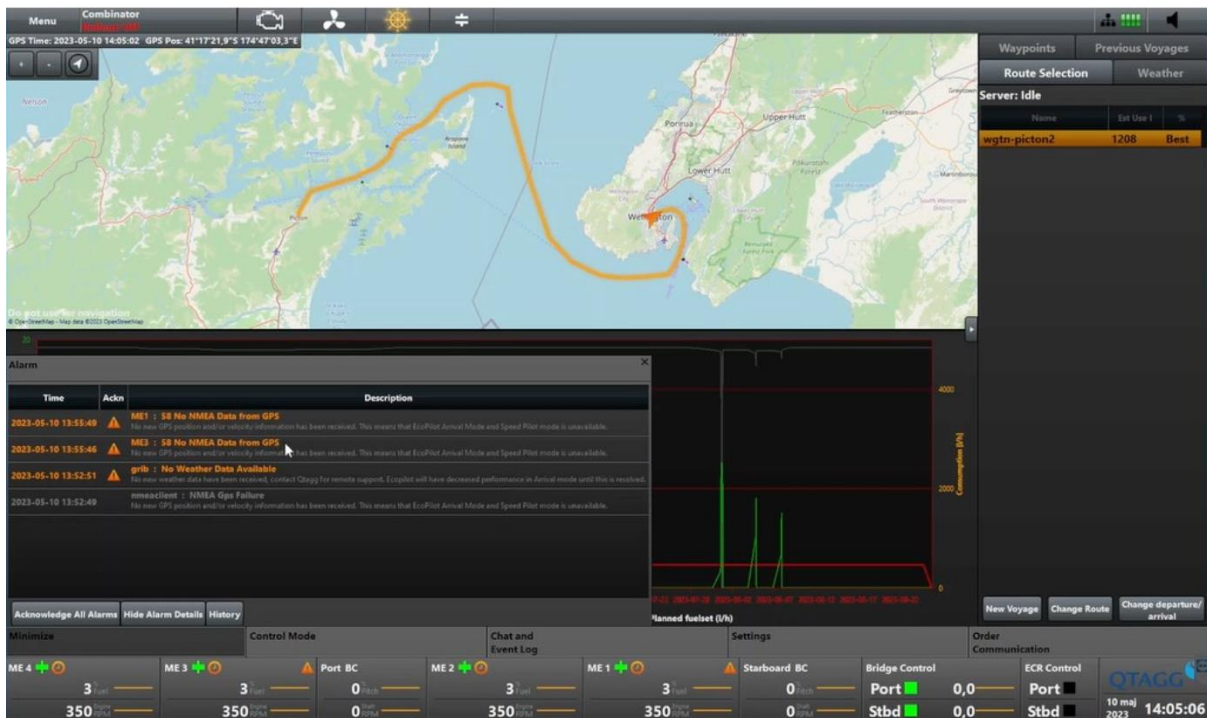
Before

After

58
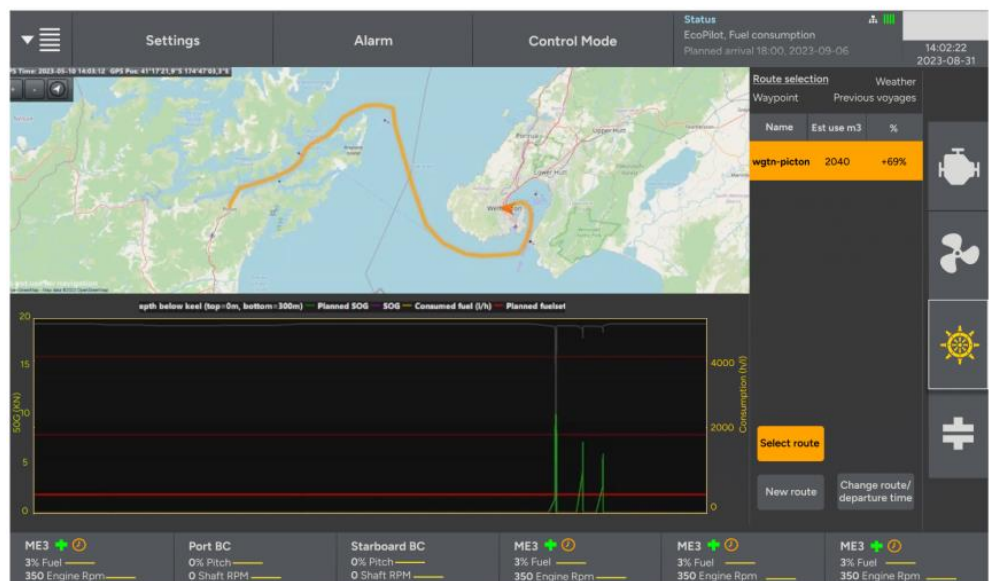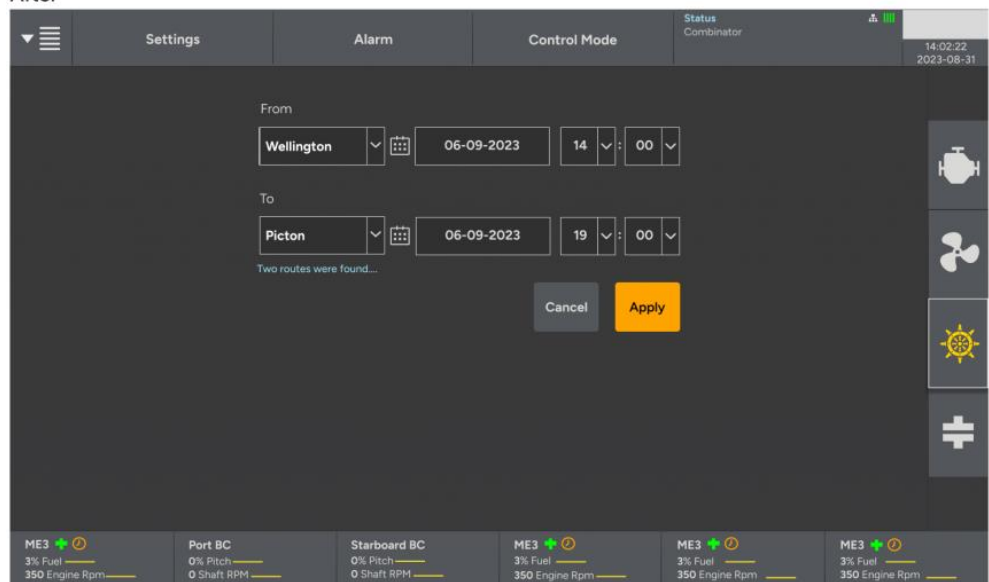
Appendix 11 – Engine status view

Before

After

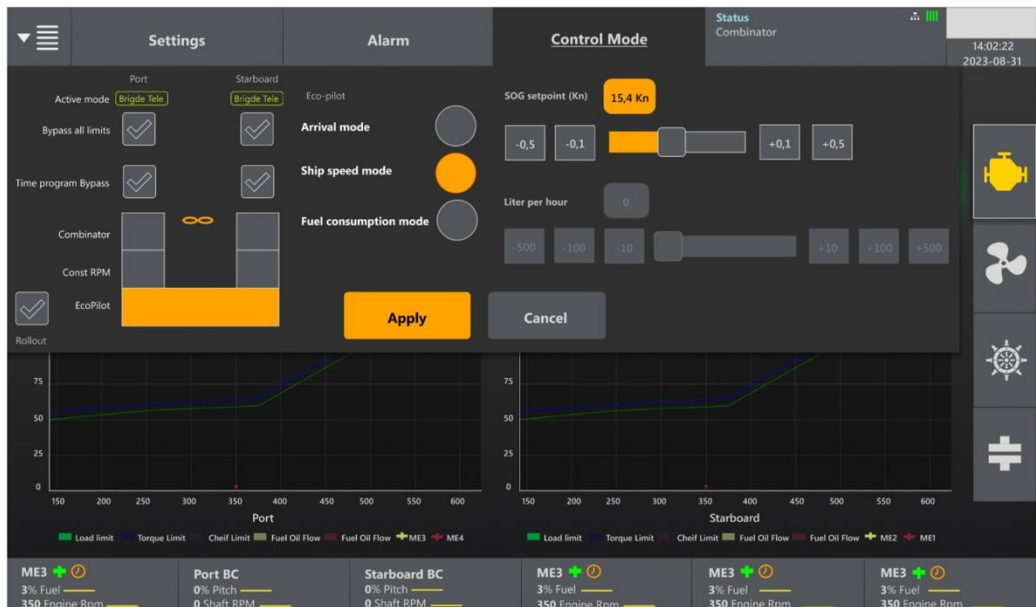# Appendix 12 – Before and after: Alarms

Before

After

Appendix 13 – Before and after: Control Mode

Before
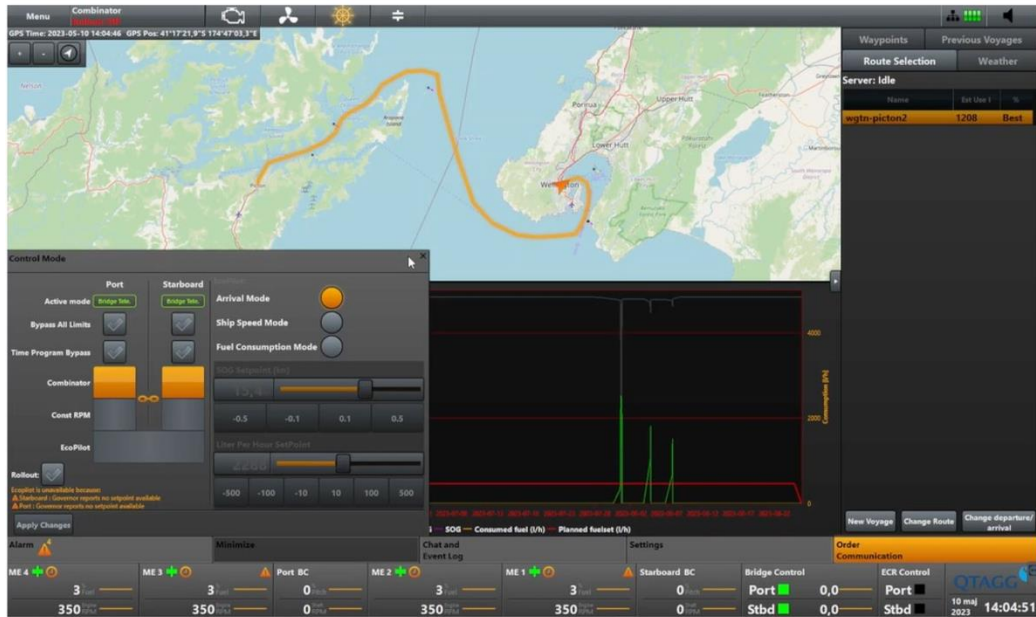
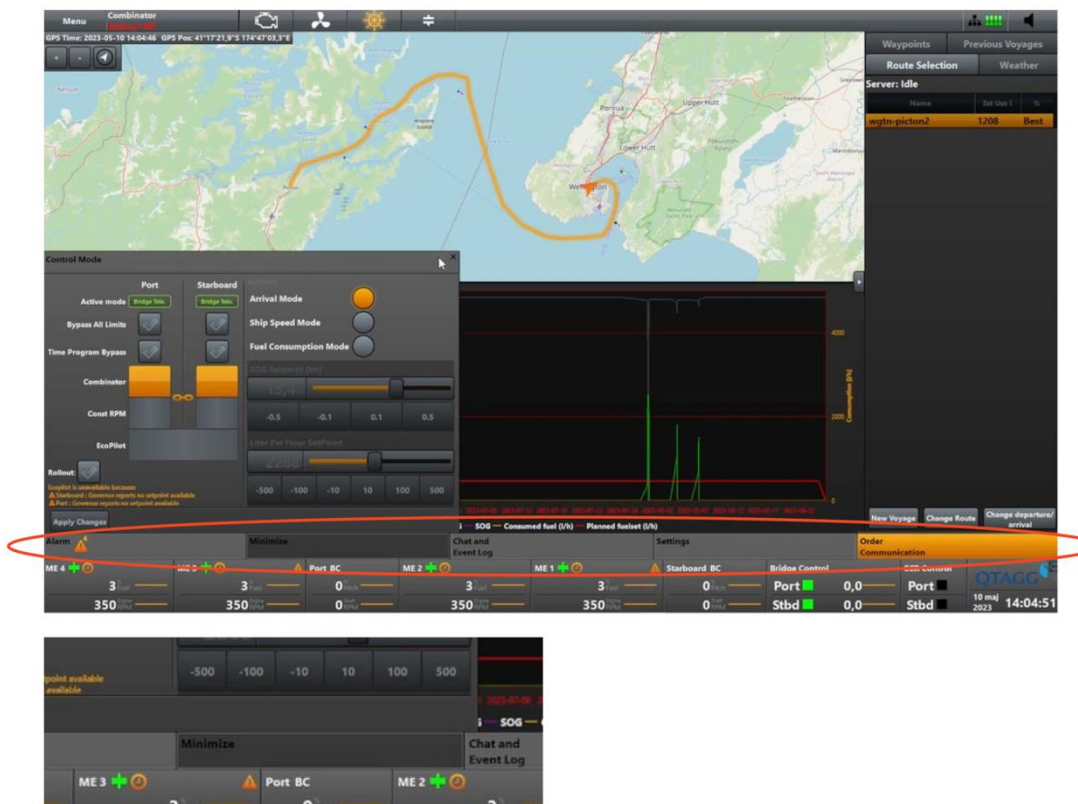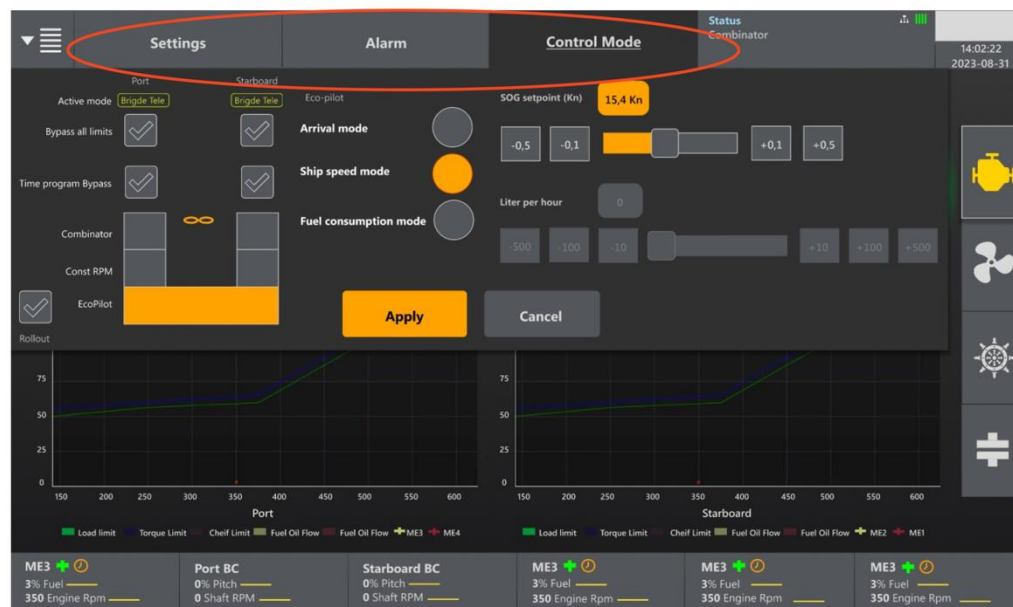## After

Appendix 14 – Before and after: menu

Before

After

Appendix 14 – EcoPilot colour profile

Colour palett from Qtagg

Gradient background used in current interface

Qtagg Logo Blue

Qtagg symbol Blue

Red

Orange1

Orange2

Yellow

Green1

Green2

Blue1

Blue2

Black

Gray1

Gray2

Gray3

Gray4

Gray5

Appendix 15 – First iteration