D1.8 Final Usability Report

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1 Introduction

Over the past sixty years, designers and manufacturers have been increasingly engaging end-users of their products and designing these products on the basis of users' expected tasks, existing problems, and needs (Sanders & Stappers, 2008). Human Centred Design (HCD) is an example of a design approach that resulted from and influenced this approach which then subsequently influenced industrial and interaction design in the 1990's (Koskinen, Zimmerman, Binder, Redström, & Wensveen, 2011). HCD remains one of the three main movements that govern the realm of design and the one to consider the human as the primary component (Giacomin, 2014). The International Organization for Standardization (ISO) and the International Ergonomics Association (IEA) have designated HCD as the endorsed approach for the integration of human factors and ergonomics (HF/E) and usability principles, knowledge, and techniques in design practice. HCD is described as a multidisciplinary design approach based on an iterative design and evaluation process, and on the contribution of key stakeholders such as the end-users to improve the understanding of user and task requirements (ISO, 2010; Maguire, 2001; Mao, Vredenburg, Smith, & Carey, 2005). By implementing this approach, products, systems and services should be made more "*usable and useful by focusing on the users, their needs and requirements*" (ISO, 2010), consequently optimizing "*human well-being and overall system performance*" (IEA, 2016). Achieving this in the maritime transport services is necessary, since the shipping industry is related to approximately 90% of the world trade today, hence being at the forefront of global economy (ICS, 2015) and having a decisive impact on international sustainable development. The proliferation of automation resources and decrease in crew numbers also represents a need for more training and skill development, better human-technology interaction and function allocation, and more HF/E integration in ship design and operations (Grech, Horberry, & Koester, 2008; Praetorius et al., 2015).

The integration of HF/E in design processes remains generally limited in ¨engineering¨ domain (Norros, 2014; Vicente, 2006) and product, facilities and systems continue to be designed with little consideration for the humans who interact with them (Edwards & Jensen, 2014). Although "*the fields of human factors/ergonomics and design have a common aim – to develop products and systems that successfully meet the needs of their users*" (Langford & McDonagh, 2003, p.1), researchers have systematically identified that this view is not easily implemented and maintained in the engineering world due to challenges in making scientific human factors methods design-driven (Norros, 2014) and to adjusting them to industrial use (Andersson, Bligård, Osvalder, Rissanen, & Tripathi, 2011; Norros, 2014). In the maritime domain, design work has been mainly executed by engineers who tend to focus on technical aspects of design more than on the end-users (Lurås, 2016; Petersen, 2012), which has made it difficult conveying an HCD and usability mind-set (Petersen, 2012) and hence the practice of human-centred and participatory approaches. The lifespan of modern ships, which is usually between

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twenty-five and thirty years (although it can reach fifty or more), and the rapid technological advancements also diminish the opportunities for HF/E interventions and standardization (Grech et al., 2008). Thus, onboard work environments and equipment remain insufficiently capable of supporting the users (Lurås, 2016). Although there has been extensive focus on safety and major improvements to maritime occupational health and safety, maritime casualties continue to occur (CyClaDes, 2015a; Earthy & Sherwood Jones, 2010; Kataria, Praetorius, Schröder-Hinrichs, & Baldauf, 2015; Lurås, 2016) and occupational mortality and morbidity rates for seafarers remain among the highest of all occupations in western society (Roberts, 2008; Roberts & Marlow, 2005). Although concrete statistics that support the conclusions that the root causes of maritime casualties are related to human factors issues are limited, 'human error' is still reported the most prominent reason (Lurås, 2016; Lützhöft, Grech, & Porathe, 2011), implicated in between 75-96% of the accidents (Hanzu-Pazara, Barsan, Arsenie, Chiotoroiu, & Raicu, 2008; Veysey, 2013). Concurrently, approximately one third of all marine accidents have also been associated with poor design (Grech et al., 2008), which further draws attention to the need for HF/E integration in the sector.

1.1 Work Package Scope

As part of the EfficienSea2 program, human factors implementation into various work packages was proposed, primarily WP6.3 and 6.4. Human factors intervention consisted of two parts:

a. Delivery of tutorials on aspects of human factors principles and integration
b. The assessment of the ArcticWeb and BalticWeb with respect to their usability and contribution to efficient work practice during simulator trials at Chalmers.

This work created 5 documents which are attached as Appendices to this report and consists of:

I. Human Factors and e-Navigation Solutions (Appendix 1)
II. Ensuring the proper methodology is used for identifying and solving user needs (Appendix 2)
III. BalticWeb Usability Report (Appendix 3)
IV. BalticWeb UI improvements of the VTS/SRS interface following results from the simulator study (Appendix 4)
V. ArcticWeb design & interaction review (Appendix 5)

1.2 Human Factors and Ergonomics

Ergonomics, from the Greek *ergo* (work) and *nomos* (natural laws), can be defined as the applied science of work, and its foundations date back to Ancient Greece or even the Stone Age with the making of tools. However, the name itself was only introduced in 1857 by the Polish scientist Wojciech B. Jastrzębowski (Jastrzębowski, 1857, reprinted in 2006) and later

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coined by the British chemist and psychologist Kennet Frank Hywel Murrell in his military studies during and post-World War II (Chartered Institute of Ergonomics & Human Factors, 2016).

Ergonomics started to be associated with the study of human physical attributes in industrial contexts for the design of workstations and work processes in Europe during the 1950s. It was in North America that the terms *human factors* and *human factors engineering* originated and these applied the same methods as ergonomics but not necessarily to work settings (e.g., military settings or technology for personal use) (Helander, 1997; Koskinen et al., 2011). Human factors, human factors engineering and engineering psychology developed from the study of systems performance in military settings (Helander, 1997). Human factors was understood in its wider spectrum of physical, cognitive, psychological and social properties of humans in relation to a sociotechnical system (Chartered Institute of Ergonomics & Human Factors, 2016; Koskinen et al., 2011).

The European Productivity Agency (EPA) established a Human Factors Section in 1955, which led to an international association of work scientists in 1957, which, in turn, formalized the IEA. The initial focus of this association was on the wellbeing and productivity of the workers from a biological standpoint, but this soon expanded towards a focus on cognition and on non-vocational activities due to the advancement of technology (Helander, 1997). Despite the initial differentiation, ergonomics and human factors are today treated equally and have merged into the same discipline. The IEA provides the following definition:

> *"Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance."*
>
> IEA (2016)

HF/E as an applied scientific discipline adopts a multidisciplinary and sociotechnical systems perspective, considering the various elements of a work system and their interactions. This involves the study of human capabilities, limitations and needs, taking into consideration the physical, cognitive, social, organizational, contextual and environmental aspects of work, in order to fit the task and tools to the human. The domains of specialization within HF/E that represent human competencies are:

- Physical ergonomics refers to anthropometrical, anatomical, physiological and biomechanical characteristics of the human body related to human activity. This can consist of work-related musculoskeletal disorders, working postures, manual handling, repetitive movements, workplace layout, product design, safety and health, noise, lighting, motion, vibrations, temperature and hazardous materials. These aspects can

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not only affect physical well-being and mental health, but also influence overall human performance (IEA, 2016).

- Cognitive ergonomics is related to mental processes such as perception, interpretation of information, and motor response. This branch of ergonomics involves competencies such as the design of activities, systems and technology that can fit the human mind and cognitive abilities; mental workload and performance; stress; and decision-making support (IEA, 2016).
- Organizational ergonomics focuses on the organizational context and the optimization of sociotechnical systems, including the organizational structures, policies, cultures and processes for communication and decision-making on who holds which skills and knowledge, who has done and will do what, as well as other features of the human capital and intellectual property. On this level, the focus can range from communication to human resource management, knowledge management, teamwork, arrangement of work schedules, participatory ergonomics/design, cooperative work, organizational culture, and quality management (IEA, 2016).

1.3 A Sociotechnical Systems Approach

Reductionism has been a common heuristic in the way humans problematize things, but not always considered the best approach if we wish to design technology fit for people, especially in complex sociotechnical systems like the maritime industry (Lützhöft et al., 2011). Putting too much reliance into the capabilities of human beings or into the functions of technology alone has resulted in detrimental effects. Taking a holistic approach can capture not only the attributes of the different elements but also of their relationships and emergent properties (Lurås, 2016; Vicente, 2006), which are not physically palpable but have an immense influence over the functioning of the system.

Sociotechnical systems are systems of a complex nature within which there are socio-political and technological elements and wherein these elements interact and should be oriented towards a common goal. *Systems thinking* is promoted as the path to address the division between humanistic and mechanistic sciences and the subsequent technology-driven design trend that fails to answer the needs of the people who are meant to use it (Vicente, 2006). The issue of having unseemly fitted designs to the reality of work tasks occurs when there is an equally unseemly design mind-set. The more humans evolve, the more we use machines to complement naturalistic thinking. Nonetheless, we still study them separately as two elements of a system that may interact but that share nothing else in common. Contrarily, it has been suggested that machines should be treated as an intrinsic part of our society, making the social and the technical inseparable:

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"I have sought to show technicians that they cannot even conceive of a technological object without taking into account the mass of human beings with all their passions and politics and pitiful calculations, and that by becoming good sociologists and good humanists they can become better engineers and better-informed decisionmakers. An object that is merely technological is a utopia (…) Finally, I have sought to show researchers in the social sciences that sociology is not the science of human beings alone – that it can welcome crowds of nonhumans with open arms (…)"

Latour (1996, p.viii)

Indeed, studying technology and humans separately seems counterproductive when technology does not exist without humans nor do humans live isolated from technology. According to Vicente (2006), knowledge about people can be organized into different levels: the physical, the psychological, the team, the organizational and the political. The *physical* level corresponds to the physical capabilities and limitations shared by the majority of the intended users of a particular design, regarding body shape, physiology, strength, and movement. The *psychological* refers to the cognitive characteristics, such as short- and long-term memory capacity, logic and expectations, as well as our cognitive limitations. Taking into account that certain products are to serve a *team* of two or more people working together towards common goals, communication, coordination, efficiency and effectiveness are aspects that must be thought of when designing, as well as the limitations of working in teams. Teams are usually working within an *organization*, whose leadership, information flow, reward system, organizational behaviour and blame culture can impact performance. Staffing and work schedules are included in this level. The *political* is the top level that comprises every design. Designers must consider the socio-political and cultural status of things in order to create designs that can survive and prosper in the marketplace (Vicente, 2006).

Similarly, an alternative sociotechnical systems model, "The Septigon Model", has been found to be consistent with the organizations in the maritime domain (Grech et al., 2008). This model considers the physical, metaphysical and technological elements of a system as a single unit, the interactions among them and how they influence system performance for the achievement of a common goal. These elements comprise the individual, the technology, the practice, the group, the physical and organizational environments, and society and culture. The *individual* refers to the human element in the system and its physical, sensory and psychological limitations. *Group* refers to communication, team management and regulatory activity aspects. *Technology* is associated with machines (hardware and software), tools, manuals and signs. *Practice* refers to informal rules and customs, unlike *organizational environment*, which is related to formal rules, official procedures, instructions, norms, policies, and organizational culture. The *physical environment* regards weather, visibility conditions, temperature, lighting,

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noise, vibration, motion, space and display. Finally, *society* represents the socio-political, economic and cultural environment that surrounds the organization, in its broad spectrum.

The systemic way of viewing problems and their solutions opposes the more reductionist outlook that, despite yielding abundant knowledge, has led to the harmful separation of the engineering and the humanistic sciences, which does not allow for an understanding of the bigger picture (Forsman, 2015; Vicente, 2006) and is likely less useful for preventing system errors (Grech et al., 2008).

1.4 Participatory Approaches to Design

Besides the holistic perspective, user participation is an intrinsic trait of the HF/E discipline (Langford, Wilson, & Haines, 2003), as much of the HF/E practice has unavoidably been participative to some extent (Haines, Wilson, Vink, & Koningsveld, 2002). Research on the concept of user participation dates back to the 1970s, when in Scandinavia the Collective Resource Approach was founded to heighten the value of industrial production by involving workers in the design and development of new work systems (Gill, 1996; Kraft & Bansler, 1992; Sanders & Stappers, 2008), and in the democratization of computer automation (Steen, 2011). Other European programmes like the German humanization of work (Kissler & Sattel, 1982) and the British Lucas Plan of socially useful production and technology (Smith, 2014) were also important players in the shift to participatory approaches (Gill, 1996). In the early 1980s, discussion around the concept of user participation shot up in the HF/E community (Langford et al., 2003).

User participation can be disguised under different names: participatory design (Barcellini, Prost, & Cerf, 2015; Langford et al., 2003), participatory ergonomics (Haines et al., 2002; Vink, Koningsveld, & Molenbroek, 2006), HCD (or UCD)[1] (ISO, 2010; Langford et al., 2003), or co-design (Sanders & Stappers, 2008). Even though they might differ in their origins and nature, they hold principles in common (Steen, 2011) and engage people in the planning and controlling of the design of their own work and leisure activities and tools.

Participatory approaches to design establish a collaborative framework within an HF/E intervention process that organizes relevant users and stakeholder groups affected by the change. The idea is that discussions amongst stakeholders who do not necessarily have skills or expertise in design or HF/E can stimulate the identification and codification of pertinent tacit knowledge related to the process. These could include, but are not limited to, identifying aspects of their workplace, systems or tools that can be improved, developing solutions for problems according to their knowledge and experience, and supporting the development of

[1] Human Centred Design (HCD) and User Centred Design (UCD) are terms used interchangeably today. For this thesis, however, the adopted term is HCD so as to regard for users as well as for other stakeholders affected by design practice (ISO, 2010), as well as for broadening and humanizing the concept of user (Steen, 2011). The term UCD will, thus, be used solely in the historical sense of the design movement.

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such solutions (Glina, Cardoso, Isosaki, & Rocha, 2011). Involving users in design can improve the transmission of relevant information and knowledge within and between organizations. In fact, the more complex the problem-solving, the more the actors in the network should engage in the knowledge transfer process to fulfil the capacities required (generative, disseminative, absorptive, and adaptive/responsive) to successfully solve the problem (Parent, Roy, & St Jacques, 2007). Involving users can enhance the meaningfulness of work (Glina et al., 2011); optimize performance; attenuate work-related health issues (Glina et al., 2011; Österman, Berlin, & Bligård, 2011); increase learning within the organization, comfort and productivity (Vink et al., 2006; Österman et al., 2011); improve design ideas and solutions, and facilitate implementation (Haines et al., 2002).

User involvement can take different forms in terms of direct or indirect (via representatives) participation; where in the design process the users are involved; among other dimensions of participation (Haines et al., 2002; Langford et al., 2003). Users can also be involved in a passive fashion by being given directed tasks or asked to comment on design concepts developed by others. The current participatory design and HCD wave, though, calls for active user involvement at the early design stages, meaning that users can, collectively with designers and other stakeholder groups, influence design ideation and conceptualization (Sanders & Stappers, 2008). Active user involvement can increase the acceptance and commitment of the users to the new product as they understand that the design is being suited to them rather than enforced (Maguire, 2001), and produce a sense of control and ownership, on the assumption that the users later experience the things they helped develop or improve upon (Bligård, Österman, & Berlin, 2014; Glina et al., 2011; Österman et al., 2011).

The use of participatory approaches by practitioners, however, is still limited (Olsson, 2004). Empirical usability evaluations in which users interact with the product under development by being asked to perform certain tasks, for example, are reported to imply higher costs and time-span than analytical usability evaluations (e.g., heuristic) which don't require users as test subjects (Bligård & Osvalder, 2013). The latter are more commonly used and do not allow space for active user participation (Olsson, 2004). The inertia of practicing participatory approaches can also be explained by the lack of a clear definition of the concept and process of participation, especially since different participatory approaches exist and differ somewhat in their definitions and/or contents. Properly defining a user population or fulfilling the needs of all different types of users of one sole system may also represent a challenge for designers (Olsson, 2004). Participatory approaches can also cause uncertainty due to communication gaps and lack of consensus between stakeholders (Mallam, 2014). Studies have indicated that designers and engineers may experience some difficulty in assimilating input from users into their design process. Users may not be able to adapt their needs and communication patterns towards what designers need to know and can manipulate (Bligård et al., 2014). This requires the use of a common language and support from the management team (Mallam, 2014), as

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well as the inclusion of multidisciplinary skills on the design team and the maximization of direct interaction between designers and end-users (ISO, 2010). Gathering representative user groups from the maritime domain to participate in ship and ship systems design or refitting may also be a logistically challenging endeavour due to the nature of their jobs at sea (Österman et al., 2011). Lurås (2016) identified that accessing users and field sites as one of the main challenges that designers face when designing in and for complex contexts. The author suggested, however, how this problem could be improved by adopting systems thinking and HCD, and by initially following users and gaining knowledge about contexts of use through online platforms as preparation for fieldwork.

Active user participation is incentivized, as it is considered a basic principle in participatory approaches (Gulliksen et al., 2003; ISO, 2010; Olsson, 2004). The communication between designers and end-users is positively related to the outcome of the design and a mutual understanding allows for a safer, more efficient ship design and successful operation, as well as it decreases the time and resources spent on problem-solving, design correction and maintenance, and in turn diminishes the exposure of the seafarers to the perils of poor design and implementation (Österman, 2012). Employee participation can elevate crew morale and make the crew feel heard; it can improve business operations and influence purchasing processes. Considering this, Österman, Rose, and Osvalder (2010) propose that employee participation should become part of every organizational culture. It can also facilitate more rapid technological and organizational changes, a higher commitment to agreed-upon solutions and a sense of empowerment in the participants from witnessing the complex decisions that surround a design process (Österman et al., 2011) (see also Vink et al., 2006). Involving operational experts in design practice is the essence of HCD and the key to achieving harmonious interactions (Petersen, 2012).

1.5 Human Centred Design

Society underwent major changes in the 1960s, a period of recovery after World War II. The societal, political, economic, cultural and technological changes represented an opportunity for design fields like graphic, industrial, interaction, service and community design, as well as design management and design research to propagate and diversify. Before this shift, design in the 1950s and early 60s was mainly governed by a rationalistic view, followed by operations research and systems theory, and the design methods movement (Lurås, 2016). This movement was, however, criticized as insufficient in accounting for the human, social, and artistic facets of design, as well as in solving imminent ecological issues that were starting to garner society's attention at the time. The integration of ethnography, behavioural and social psychology into the design process began to play an increasingly important role in design practice and in mitigating the preceding mechanistic paradigm. This turned design into an emergent scientific field of study, and apprenticeship into academic skill development (Koskinen et al., 2011). For this reason, the tacit knowledge of design practitioners had to be

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captured and articulated through design research (Koskinen et al., 2011). This design shift served as a catapult to the User Centred Design (UCD) movement.

UCD developed from a combination of Usability Engineering, Human-Computer Interaction (Williams, 2009), as well as the previously described emphasis on design ergonomics and participatory approaches in the 1970s. UCD firstly became prevalent in computer science and artificial intelligence (Giacomin, 2014; Koskinen et al., 2011), but in the 1990s it also became rampant within industrial and interaction design, and was popularized by the famous Silicon Valley design company IDEO (Koskinen et al., 2011). More recently, the term HCD rather than UCD has been made official by the ISO 9241-210:2010 to advocate the involvement of all stakeholder groups affected by the design, including end-users.

HCD can be illustrated as *"an emancipatory tradition which places human needs, purpose, skill, creativity, and human potential at the centre of activities of human organisations and the design of technological systems. It has broader concerns in the areas of scientific traditions, culture and technology, industrial cultures, technology transfer and development, globalisation, sustainability, and technology assessment"* (Gill, 1996, p.1). As per the ISO 9241-210:2010, an "*approach to systems design and development that aims to make interactive systems more usable by focusing on the use of the system and applying human factors/ergonomics and usability knowledge and techniques*". Making a product "more usable" is about improving usability and this is defined as the "*extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use*" (ISO, 2010). But besides enhancing effectiveness, efficiency and satisfaction, other social and economic benefits for the stakeholders can be achieved through HCD (Maguire, 2001). For example, human well-being, accessibility and sustainability can be improved, reducing discomfort, stress, propensity for errors (Maguire, 2001), and neutralizing possible hazards of use on human health, safety and performance (ISO, 2010). Facilitating the timely and successful completion of the project within budget (Maguire, 2001; Norman, 2013), and reducing customer support and training costs can also result from the integration of HF/E in design (Maguire, 2001; Österman, 2012). Reducing the risk of missing stakeholder requirements and of the system being rejected by its users (Maguire, 2001; Norman, 2013), therefore increasing the acceptance, commitment and trust of the users towards the system (Maguire, 2001; Österman, 2012) can augment technical, commercial and competitive advantage, and improve the image and reputation of the organization (Maguire, 2001). Some of these benefits are further corroborated by the results in this thesis.

Based on the ISO 9241-210:2010, there are five design stages and six key principles that should be considered if the benefits described above are to be attained. The HCD stages are shown in Figure 1:

- Planning the HCD process

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- Understanding and specifying context of use
- Understanding and specifying user requirements
- Producing design solutions to meet context of use and user requirements
- Evaluating the design against requirements
- Iterating if needed or finalizing

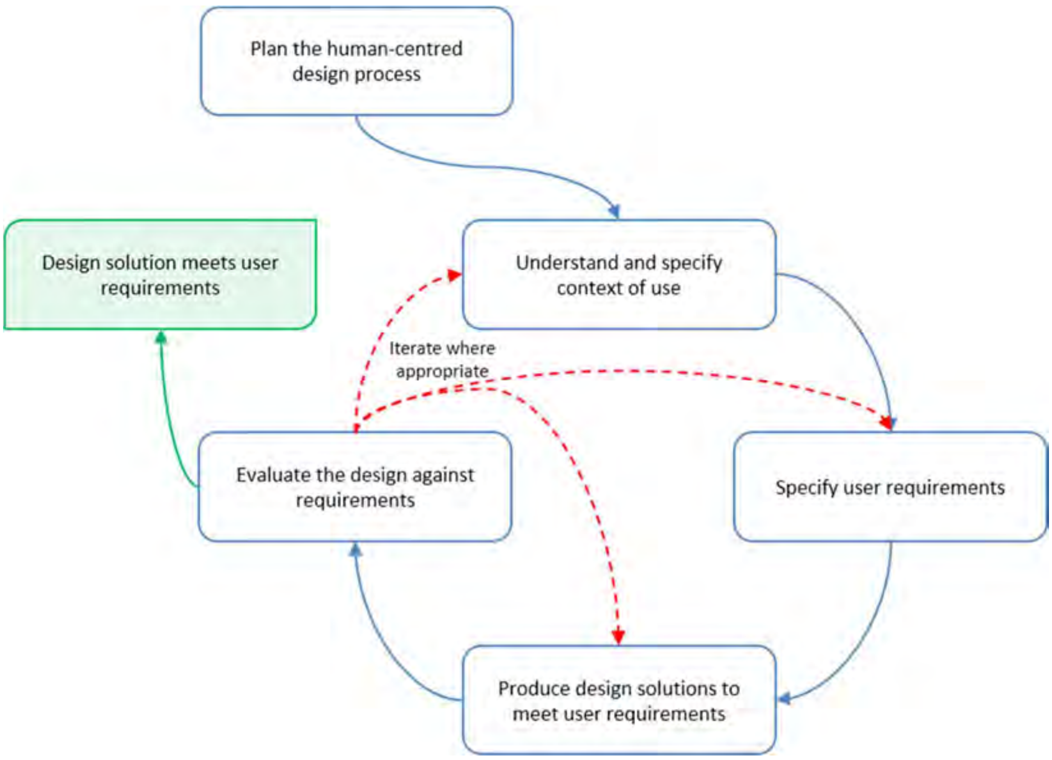

Figure 1. HCD cycle for interactive systems, based on the ISO 9241-210:2010.

This HCD cycle complements other design approaches employed by the designer or engineer. For example, the general model for ship design based on Evans (1959) used by naval architects can be complemented with HCD (see de Vries et al., 2015). HCD should be ensured throughout all design stages (concept, preliminary, contract, and detail design), as well as throughout the whole lifecycle of the system, product or service (ISO, 2010). The following six principles are to be realized in all five HCD stages (the results in this thesis will reflect mainly on the second HCD principle, regarding the involvement of users, and partially on the last principle, regarding the multidisciplinary perspectives in the design team):

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- Explicit understanding of users, tasks and environments
- Involvement of users throughout design and development
- User-centred evaluation-driven and -refined design
- Iterative process
- Addressing the whole user experience (UX)
- Including multidisciplinary skills and perspectives in the design team

As those who pay for the design project are not necessarily the end-users, HCD has made designers' claims more credible when speaking for end-users' needs (Koskinen et al., 2011). To other designers, especially those more artistically oriented, HCD hasn't always been seen as immediately useful. It has been perceived as a research-driven approach rather than design-driven (Koskinen et al., 2011). Another issue with designing for a user is the focus on the cognitive functions and predetermined usage patterns of the product, departing the product from possible future alternative usages that are difficult to predict as they emerge during usage within social interactions and settings (Giacomin, 2014). This is one of the reasons that made Norman (2005) shift his support of UCD towards Activity Centred Design (ACD) instead, as he believed that by focusing on the activities in which the product can be used, one can open up for all these future usage possibilities that the sole focus on the user does not enable. But others have suggested that this is but a misconception of UCD, which encompasses the principles of ACD and more (Williams, 2009). Today, HCD is one of the three main design movements that govern the world of design and the one to put the human first (Giacomin, 2014), having been designated by the ISO and the IEA as the official approach for the integration of HF/E and usability principles, knowledge, and techniques in design practice. HCD has become an overarching approach or a basis for usability, empathic design, design for customer experience, emotional design (Giacomin, 2014), design thinking (Brown, 2008), co-design (Sanders & Stappers, 2008), user centred systems design (Gulliksen et al., 2003) or human centred systems design (Gill, 1996), activity centred design and goal directed design (Williams, 2009), and systemic design (Lurås, 2016). Giacomin (2014) describes the design paradigm shift into HCD from "*what began as the psychological study of human beings on a scientific basis for purposes of machine design*" to what became "*the measurement and modelling of how people interact with the world, what they perceive and experience, and what meanings they create*" (p.612). HCD is being more and more understood as a design philosophy, emphasizing the metaphysical aspects of design and the design process as a conjoint creative practice:

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"a multidisciplinary activity which has as its ultimate goal the clarification of purpose and meaning, and is fully consistent with the assertion that design itself is a pragmatic and empirical approach for making sense of the world around us (…) a pragmatic and applied approach for identifying 'ideological opportunities' and for performing 'cultural design' (…) Today's human centred design is based on the use of techniques which communicate, interact, empathize and stimulate the people involved, obtaining an understanding of their needs, desires and experiences which often transcends that which the people themselves actually realized. Human centred design is thus distinct from many traditional design practices because the natural focus of the questions, insights and activities lies with the people for whom the product, system or service is intended, rather than in the designer's personal creative process or within the material and technological substrates of the artefact (…) human centred design leads to products, systems and services which are physically, perceptually, cognitively and emotionally intuitive."

Giacomin (2014, p.610)

1.6 The Human Element

In 1997, the IMO initiated and adopted a new resolution, A.850(20), dedicated to promoting the safety of life and work at sea and environmental protection – *The Human Element* (IMO, 2003). This resolution provides the following definition for human element:

"*The human element is a complex multi-dimensional issue that affects maritime safety and marine environmental protection. It involves the entire spectrum of human activities performed by ships' crews, shore based management, regulatory bodies, recognized organizations, shipyards, legislators, and other relevant parties, all of whom need to cooperate to address human element issues effectively.*"

IMO (2003)

According to this definition, the importance of a concerted effort from all maritime stakeholders towards solving HF/E issues is recognized. The verb "cooperate" suggests communication between stakeholders, in order to "address human element issues effectively". Although this is part of the IMO's vision and principles, it is a work in progress.

Within the Human Element resolution, the IMO established principles for the promotion of a safety culture and seafarer professionalism, namely on safe manning, fatigue, working groups, work and rest hours, and formal safety assessments. Some of the operational codes and conventions to address human element principles are the International Convention for the Safety of Life at Sea (SOLAS) and its International Safety Management (ISM) code (IMO, 1974), and the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Manila) (IMO, 2010). The Convention on the International

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Regulations for Preventing Collisions at Sea (COLREGs) (IMO, 1972), the International Convention for the Prevention of Pollution from Ships (MARPOL) (IMO, 1973), and the International Convention on Maritime Search and Rescue (SAR) (IMO, 2004) also have human element implications.

The safety and efficiency of sea transport depends greatly on good design, construction and operation, yet there remains room for considerable improvement (Earthy & Sherwood Jones, 2010; Kataria et al., 2015). Between 75-96% of marine accidents have been associated with 'human error' (Hanzu-Pazara et al., 2008; Veysey, 2013) as well as one-third of marine accidents have been linked to poor design (Grech et al., 2008). In a recent study by Kataria et al. (2015), two-thirds of the 129 publically available maritime casualties analysed were associated with human-machine interaction and automation issues due to poor design. These issues draw attention to the need for HF/E integration in the sector.

HCD is well consolidated in ergonomics, computer science, artificial intelligence (Giacomin, 2014), interaction design and industrial design (Koskinen et al., 2011). Despite the efforts of the IMO to address human element issues (IMO, 2003), the practice of more human-centred, participatory approaches remains limited in the maritime domain. This is believed to be due to the predominance of the engineering sciences in this sector, and to hesitancy towards cultural change and investment in the soft sciences, making the conveyance of a usability mind-set difficult (Petersen, 2012) and hence the practice of human-centred and participatory approaches. What is more, maritime authorities and regulatory bodies propose regulations whose compliance is generally voluntary and explained prescriptively and at a high-level, failing to provide sufficient guidance on how to incorporate such knowledge into the design of merchant vessels, and thereby proving difficult to follow up on (Kataria et al., 2015; Rumawas, 2016). Besides, the making of HF/E- and safety-related IMO regulations is often the direct response to maritime accidents, and a more systemic and proactive approach to addressing HF/E issues seems to rarely happen (Lützhöft et al., 2011; Schröder-Hinrichs, Hollnagel, Baldauf, Hofmann, & Kataria, 2013).

Usability testing and systemic intervention programmes may still not be common current practice across the maritime industry, but it is believed that growing automation and technological complexity will mandate these to be more frequent and reliable, and to gain increasing acceptance in future design and development (Grech et al., 2008). This is evidenced by the human-centred focus of current programmes such as E-navigation (IMO, 2014a), although no fully approved guidelines for the application of HCD within ships and marine technology currently exist. Within the IMO's *E-navigation strategy implementation plan*, draft guidelines on HCD and Usability Testing, Evaluation and Assessment (UTEA) for e-navigation systems are currently under consideration (IMO, 2014b). Additionally, an online platform with guidelines to the HCD framework began being developed within the CyClaDes project by the

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classification society DNV-GL and international partners to incentivize and support marine designers and other maritime stakeholders to consider HF/E (van der Merwe, 2015). Research has also investigated HCD of ships, ship workspaces and crew work demands including general arrangement (Mallam, Lundh, & MacKinnon, 2015); the ship's bridge (Bligård et al., 2014), engine department (Mallam, 2014); and the integration of HF/E and HCD into the general model of ship design by Evans (1959) for an offshore wind farm installation vessel project (de Vries et al., 2015).

1.7 Maritime Stakeholders

Although this thesis focuses specifically on seafarers as the end-users of ships and ship systems, it is important to consider the wider range of maritime stakeholders that the HCD approach would affect or be affected by. The maritime industry is global and comprises a vast and complex network of stakeholders (Lurås, 2016; Lützhöft et al., 2011). The needs and roles of four main stakeholder groups have, though, been highlighted in the CyClaDes project regarding the integration of HF/E in the domain. They are the seafarers (users), the naval architects and ship systems designers, the authorities and regulatory bodies, and the ship-owners/ship operators. The needs of the seafarers may be met by implementing a participatory approach throughout the design and operational lifecycle of ships and ship systems; more usable workstations and processes; and new training programmes for crew members. In order to accommodate methodologies for usability and for the incorporation of user input, naval architects and ship systems designers require guidelines and best practices for a human-oriented design of safety-related aspects of ships and ship systems. Authorities and regulatory bodies can contribute by developing an approach for a more comprehensive consideration and analysis of the human element in the context of the rule-making process; and by providing human element training and/or tools for assessors. Ship-Owners/Ship Operators, in turn, may contribute by considering end-user needs during acquisitions or new orders; by providing training for their crews and recognition of best practices.

These findings show that the participants perceived human-centred, participatory approaches to design to be beneficial at the physical, cognitive, psychosocial, organizational, and socio-political levels.

From a physical ergonomics perspective, examples included making space to carry equipment around without hazards in the way (pipes, ceilings, gaps, steps); positioning equipment where it is more appropriate for use by the right users (e.g., *"the second mate has to stretch to reach the VHF"* when the second mate is often the one to utilize the VHF more often when sitting on the bridge); or even simple things as having cup holders to keep computers and screens from getting damaged when liquids spill with ship movements.

Cognitive-related ergonomics examples were also provided in terms of the software systems having easily accessible information; the interfaces displaying less unimportant information,

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having straightforward menus, and being adapted to purpose (*“mission-specific”*; *“not all parameters on the screen are important at all times”*) and adaptable to the individual using it (*“not static!”*). Considering the integration of the cognitive with the physical is also a factor of importance, e.g., *“when tightening, you pull the handle towards you; when you tighten with the remote control, you push it away from you, and that’s bad logic”.*

Organizational aspects should also be designed with the user in mind, such as making basic training and basic safety equipment and procedures standardized across ships and crews to avoid mismatches and mistakes. Some aspects of practice must also be considered with regards to workload, working and resting hours. Participants claimed that *“today seafarers often have to be available at all times”*, on-call even when off-duty, which does not allow them to fully benefit from their resting time.

From a psychosocial perspective, generally more ergonomic living and work areas, equipment and procedures can increase motivation and satisfaction, and facilitate a better social environment. Ultimately, these benefits would increase safety, which considered from an organizational and socio-political perspective would reduce company costs, financially and in terms of reputation and marketplace.

Better Physical Ergonomics & Usability could improve both *Workability* and *Controllability* onboard ships and these dimensions defined as:

- **Workability** refers to the conditions onboard that help the seafarers fulfil their tasks, including equipment (hardware and software), materials and procedures, physical and social environments, information, handbooks, and language (Lloyd's Register, 2008; Rumawas, 2016);
- **Habitability** refers to adequate, comfortable and practical accommodation, cooking and washing facilities, storage and recreational spaces having regards for size, shape, gender, culture and environmental stressors such as noise, temperature and vibration (Lloyd's Register, 2008; Rumawas, 2016);
- **Maintainability** refers to the conditions onboard that allow seafarers to perform the necessary maintenance of the ship, including access, tools, through-life support for the lifespan of the ship, and the design of operational maintenance tasks to be safe and efficient (Lloyd's Register, 2008; Rumawas, 2016);
- **Survivability** refers to the availability of adequate equipment and facilities for firefighting, damage control and lifesaving, and the capabilities of the crew to ensure safety of crew and passengers (Lloyd's Register, 2008; Rumawas, 2016);
- **Controllability** refers to integrating users with equipment and interfaces, and appropriating layout of work stations, communication facilities, controls, displays,

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alarms, lights, etc. to allow the seafarer to perceive the status of machines and systems and provide fitting responses (Lloyd's Register, 2008; Rumawas, 2016).

- **Affordability** refers to the total ownership costs associated with system/technology redesign, manpower, training, human support, and reduction of errors and accidents (Novak, Kijora, Malone, Lockett-Reynolds, & Wilson, 2010).

1.8 Conditional/consequential matrix of success factors for maritime HCD

The participants considered bridging the gap between end-users' needs and ship-owners' demands to be the foremost benefit of user involvement in the design process. As the communication between ship-owners, designers and users is enabled through a participatory approach, "*a foundation is built for all the other success factors that follow*". The participants also stated that *"communication between users and designers can make designers more aware that the users are the seafarers, not the ship-owners (…) there is a difference between the people who use the interfaces and those who tell them to use them".* The participants proposed tools for facilitating user input, such as focus groups, paper mock-ups, interviews and simulators. In the sense of user communication with other stakeholders, it was also suggested that having influence over the regulatory bodies such as the IMO could help better suit certain rules and regulations to the actual work and experiences onboard ships. User input in purchasing actions could also help ship-owners make the right choice for the intended type of operations.

Ergonomics issues might differ for different types of ships and different sections of the ship, and consequently the "right users" must be invited to participate in design, including Able Seamen (AB) and other technicians/ratings. The age group might be an important factor to consider if it has an impact on the seafarers' familiarity with technology: *"there are senior officers getting involved in the design process, but you also need younger people testing this, because they don't have the same perspective of the system – younger people have more experience with computers",* as well as levels of experience and hierarchies.

Provided that these prerequisites are realized, expert user knowledge can be shared with the design team and incorporated to develop design solutions (*"someone who will sit 8 hours in a row in the same position might be able to say more about ergonomics than those who design it"*). Consequently, ergonomic improvements to the onboard work settings can occur (e.g., *"it feels like three technicians created one screen each, because you have speed and heading on three different screens"; "rearrange reality down to the controls of the mooring lines, like when you tighten the mooring lines, you pull it towards you, but when you tighten with the remote controls, you push it away from you"*; *"something that could take 10 minutes takes 45*

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instead (…)"). Such changes could result in improvements on all dimensions. The involvement of users should not only help improve design, but also incite users' intrinsic motivation and a feeling of empowerment as their input becomes materialized.

The increased safety and efficiency of maritime operations were the most valued end-results of participatory design approaches by the participants. They also listed benefits for ship-owners in terms of affordability, such as reduction of casualties and costs, provided that things can be done properly the first time, avoiding unnecessary costs for rearranging and retrofitting. All in all, it is not just about the financial sustainability of the company, but also about sustainability at the social and environmental levels.

The participants emphasized that they believed that there was still room for improvement on all levels. For instance, the safety aspect of a product is usually regulated by IMO conventions and it is difficult to give user input on this, hence the importance of more user representativeness and influence across the maritime network of stakeholders.

2 Conclusions

The implementation of Human Factors concepts and practices should be initiated at the conceptual stages of technology and software design in order to maximize its potential for usability. Typically, a human centered design approach is used, where domain experts are asked to describe needs and inform technology developers how the work is performed. Furthermore, as development iterations are made, the domain experts (the end user) should be allowed to test and provide continuous feedback. Following this approach in the maritime sector will make this complex socio-technical system safer and more efficient.

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8-9 November 2016

This project has received funding from The European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement no. 636329

EFFICIENSEA
2.0 GETTING CONNECTED

Human factors

- and e-Navigation solutions

09-11-2016

Thomas Porathe & Jeanette Juul Jakobsen

Agenda

- Human factors and ship systems
- Examples of project work
    - Ø Design- and interaction review
    - Ø Design work with users
- Display of e-Navigation information

Human Factors and ship systems

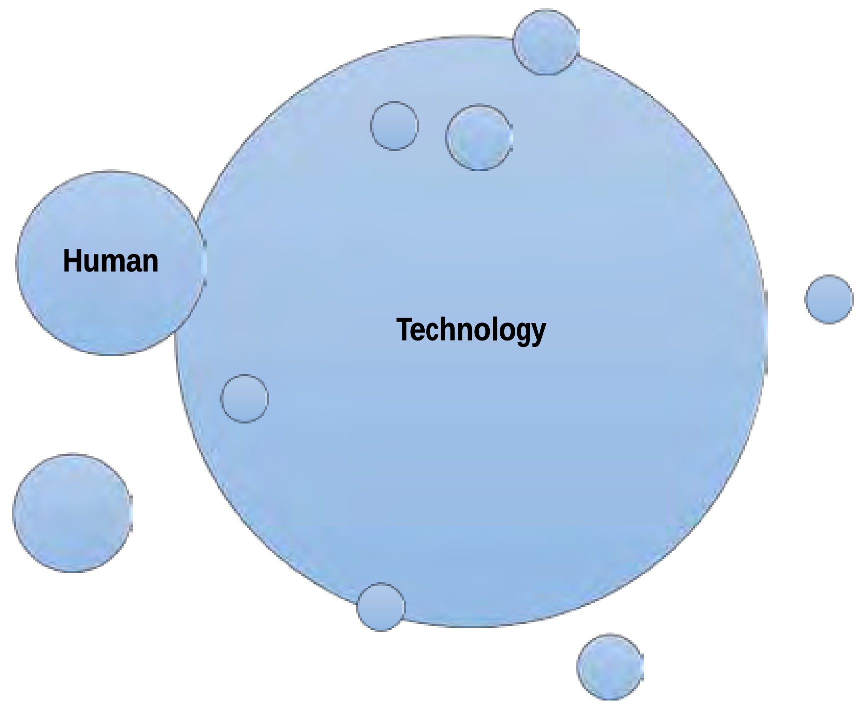
Human factors

- Discipline of research and practice - aiming at design, optimization and improvement of systems with human and technical components

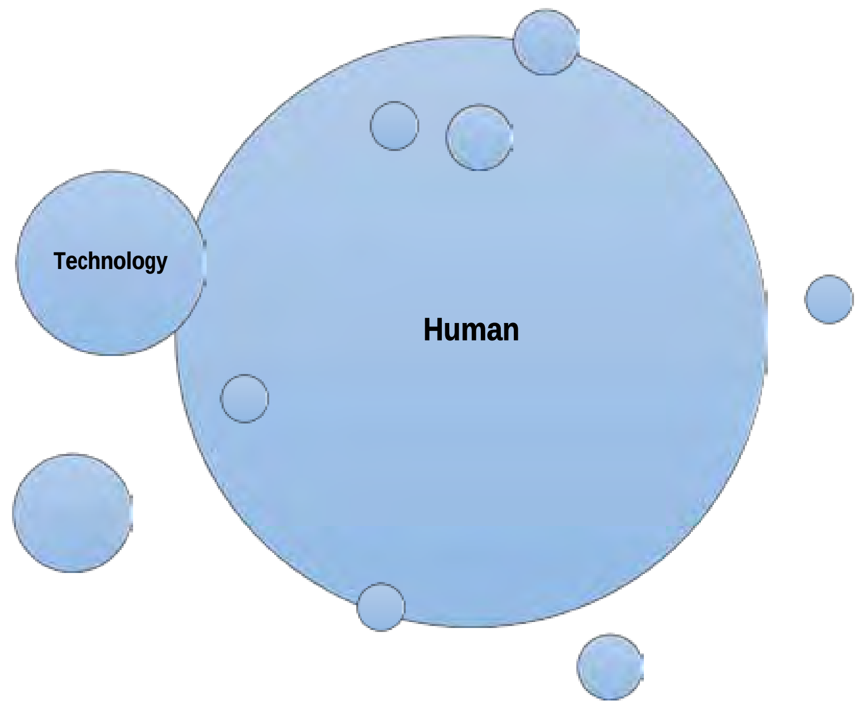
- Focus is primarily on safety, occupational health, efficiency and quality

- The theory and methods used, is based on psychological and ergonomic research and knowledge

Human factors



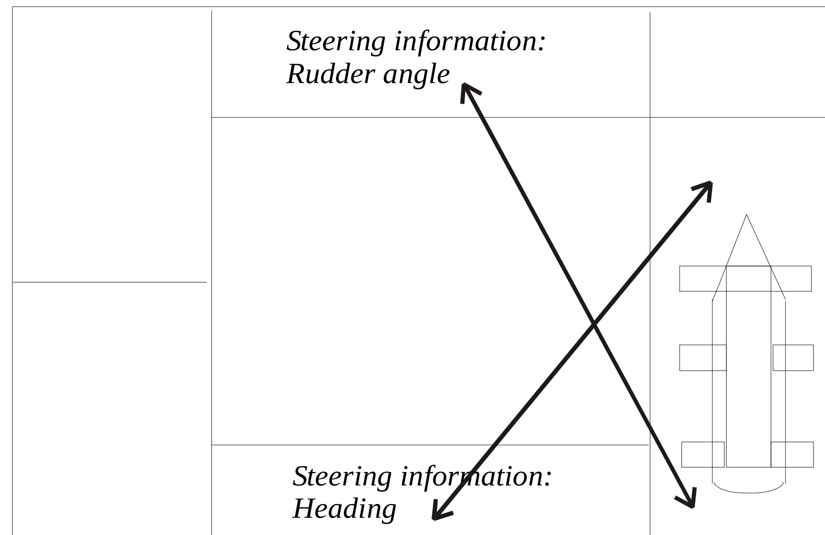
Human factors



The human element

- Perception and attention
- Cognition, memory and decision making
- Emotions
- Motivation
- Behavior

Human factors and ships



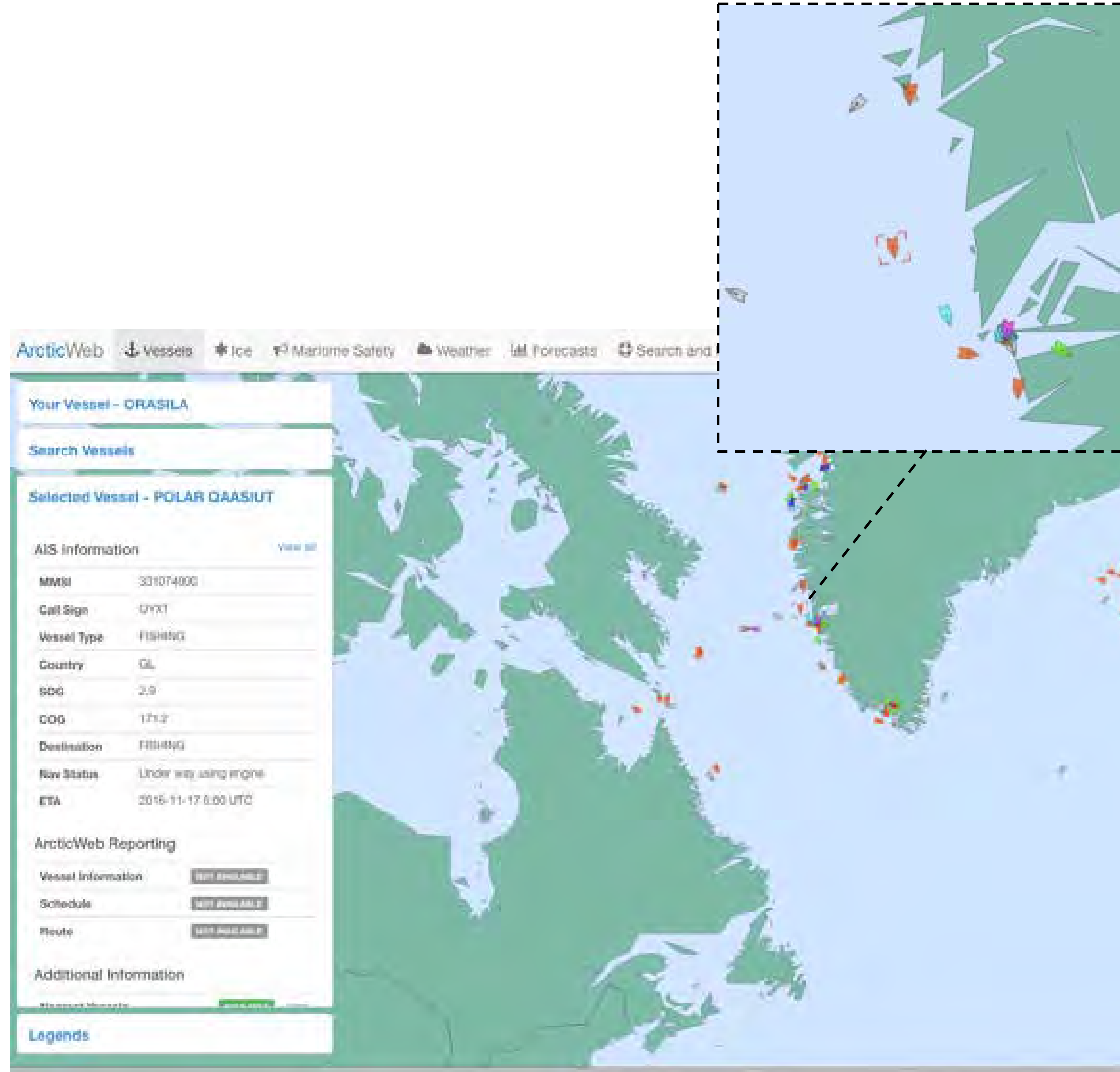
Examples of project work

Design- and interaction review

- An expert based analysis that utilize background knowledge of human behavior and psychological processes to asses the usability of a tool – in this case the Arctic web
- The analysis identified potential issues and provided suggestions for improvements of the ArcticWeb – moreover, these inputs has been integrated in the development of the BalticWeb

Input 1

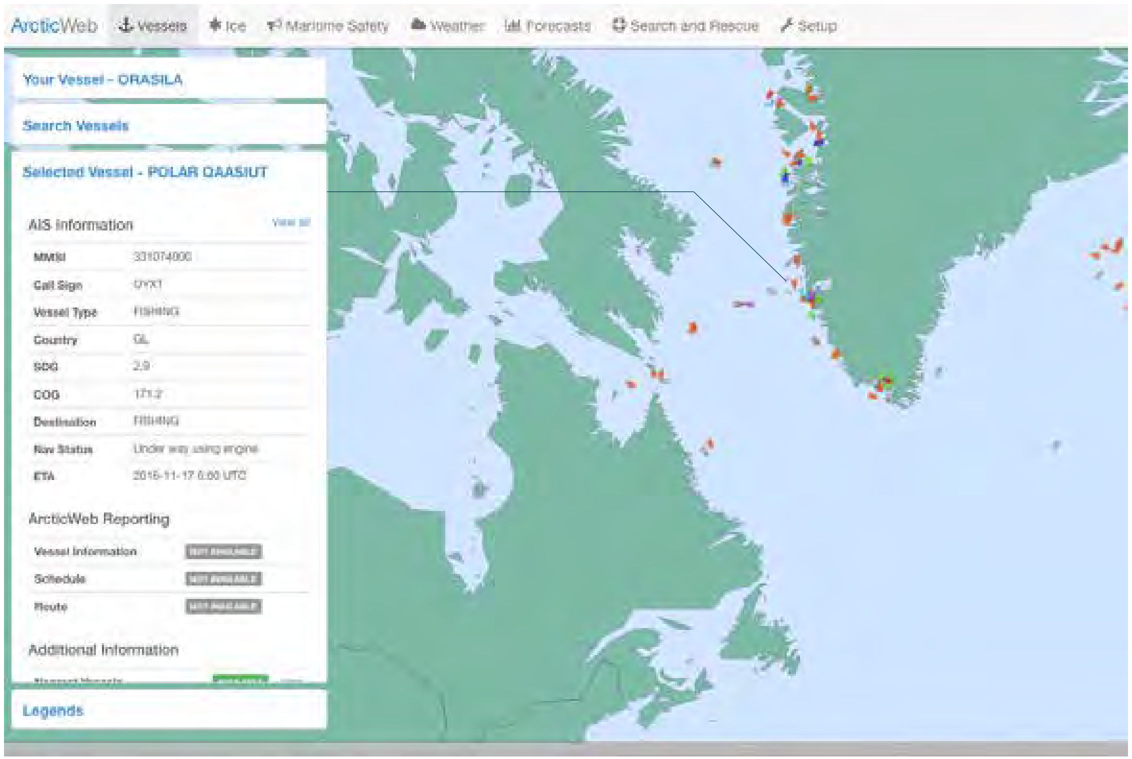
- Selected vessels can be difficult to identify on the map
- The link between selected vessel and information needs to be remembered



Input 1

- A traditional tracking line was suggested

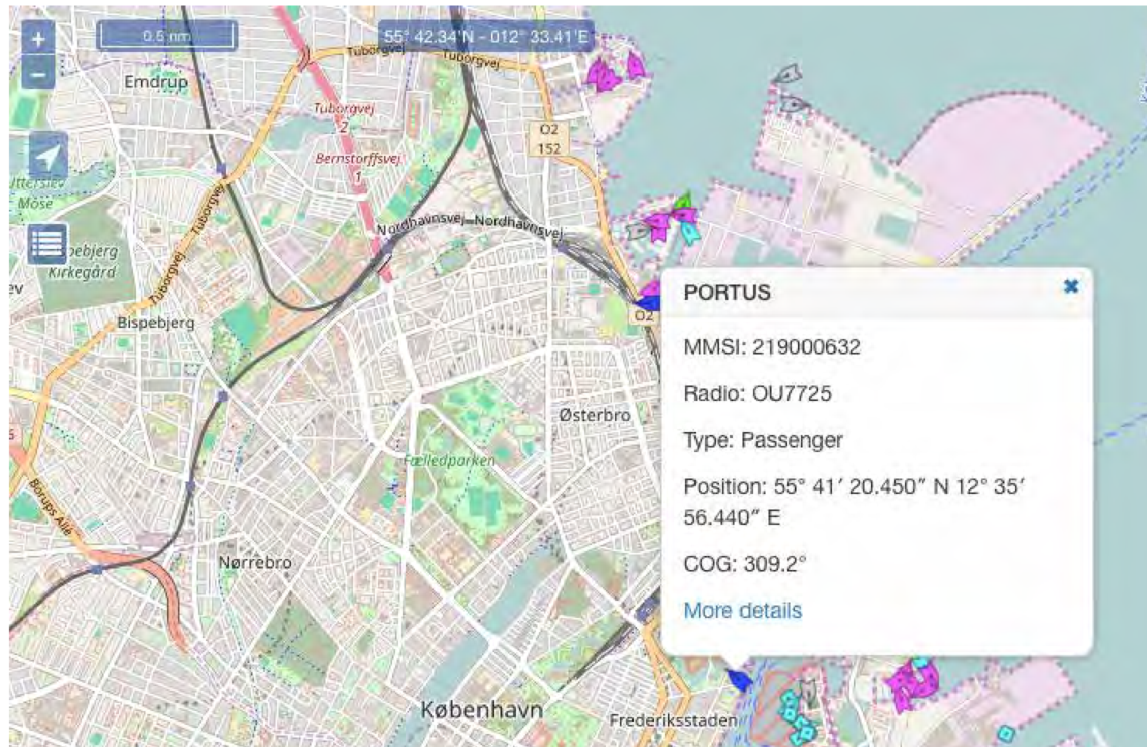
- It helps:
  - à Improve visualization of active vessels
  - à Minimize the load on cognitive ressources



EFFICIENSEA 2.0 GETTING CONNECTED

Input 1

- The tracking line input has been integrated in the development of BalticWeb
- Here, the tracking line is designed as an arrow – creating a direct link between information and vessel



Input 2

- It can be difficult to keep track of which chart layers has been selected from the menu

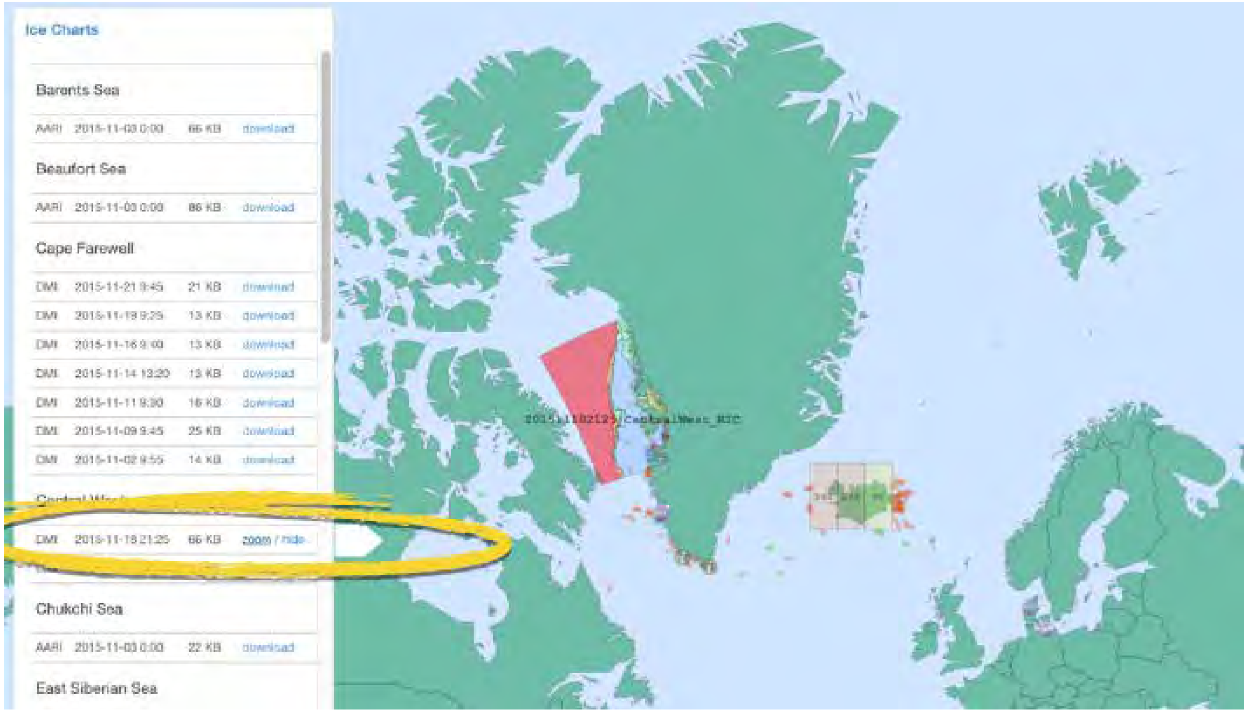
- Without clear indication of selected layers, the load on cognitive ressources increases

zoom / hide

Input 2

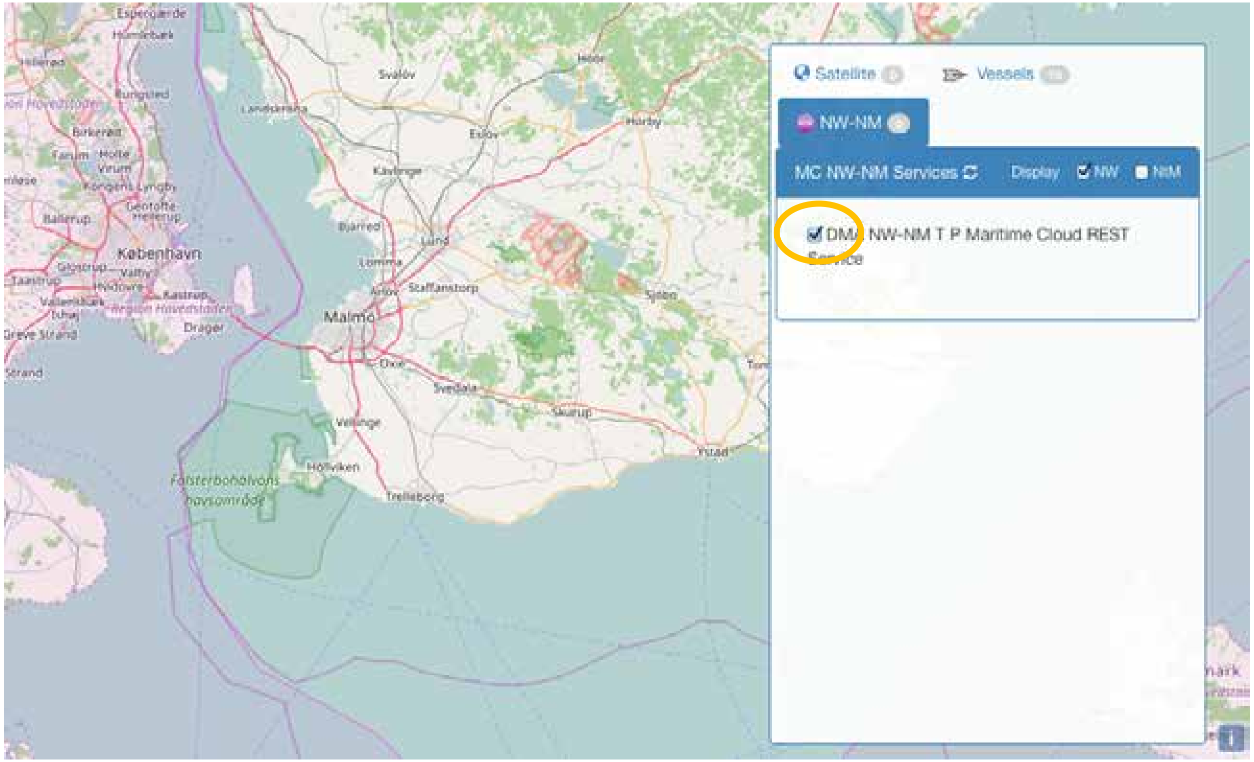
- It was suggested to add an object to the selected information – using the ”squint for eye” technique

- It helps:
  - à Selected informations stand out - overview
  - à Minimize the load on cognitive ressources



Input 2

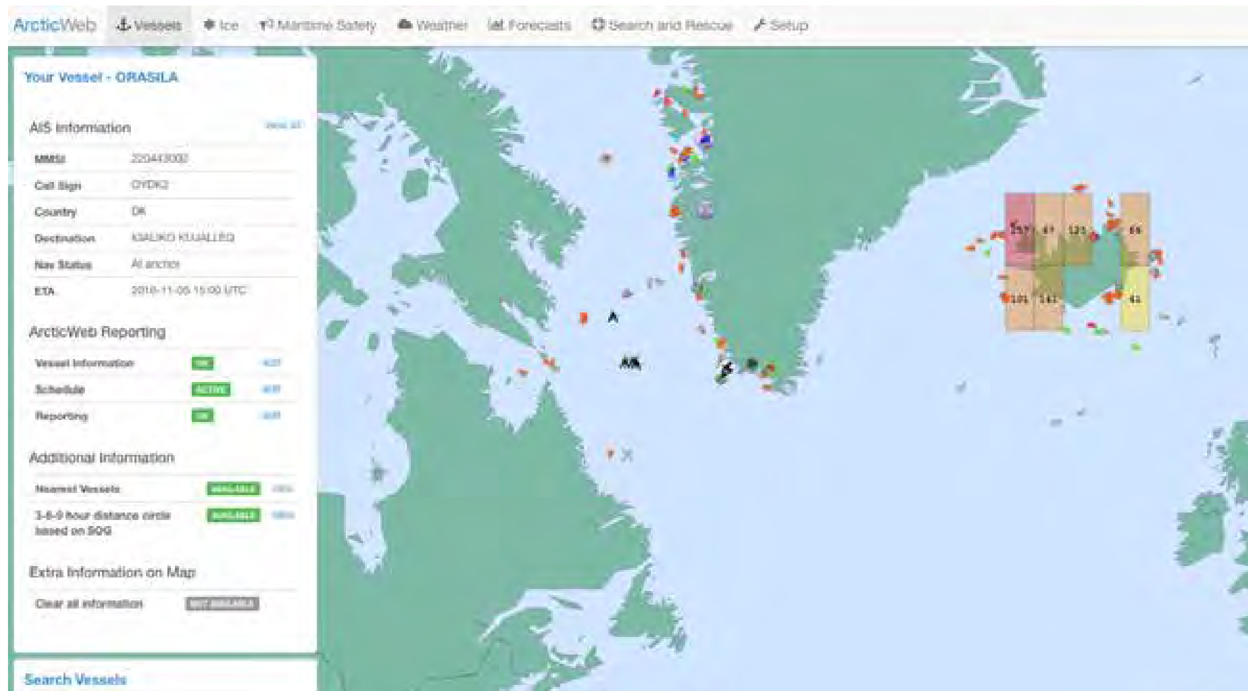
- The ”squint for eye” input has been integrated in the development of BalticWeb
- Here, it is designed as a tick off box – making it easy to see which layers has been chosen



Input 3

- The menu takes up space on the map, causing parts of the map to be hidden

- The menu is not necessary of value to the user – if e.g. the goal is to navigate directly around the map

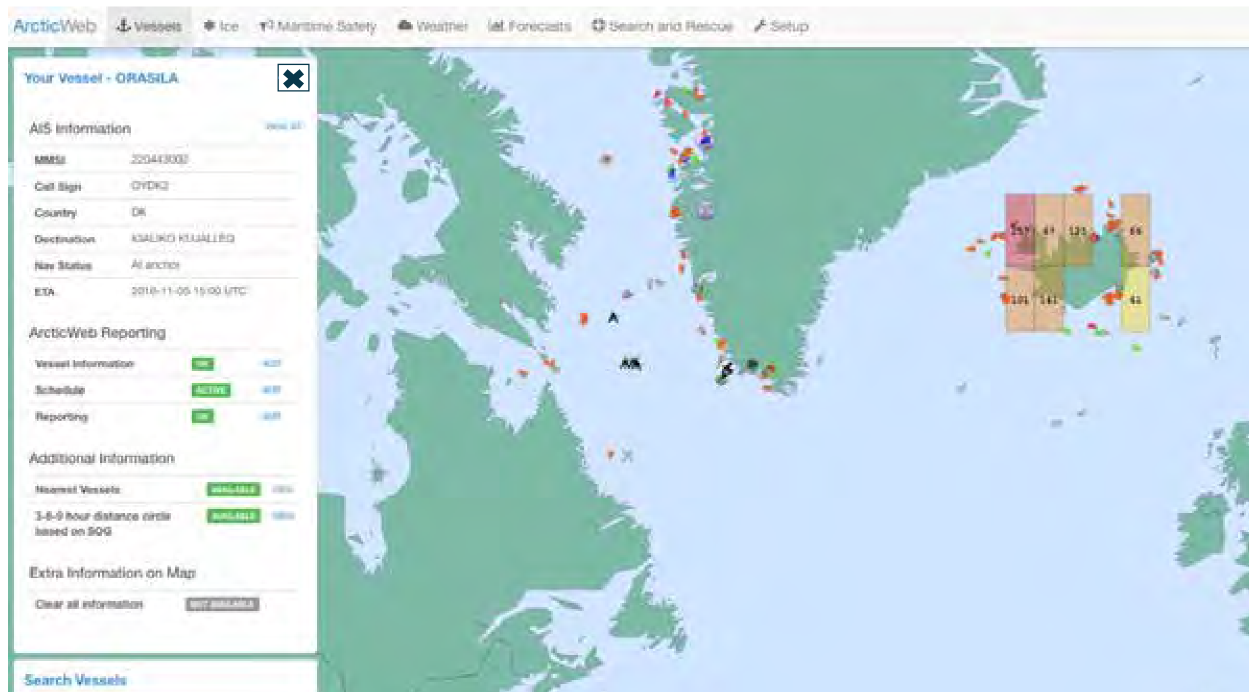


EFFICIENSEA 2.0 GETTING CONNECTED

Input 3

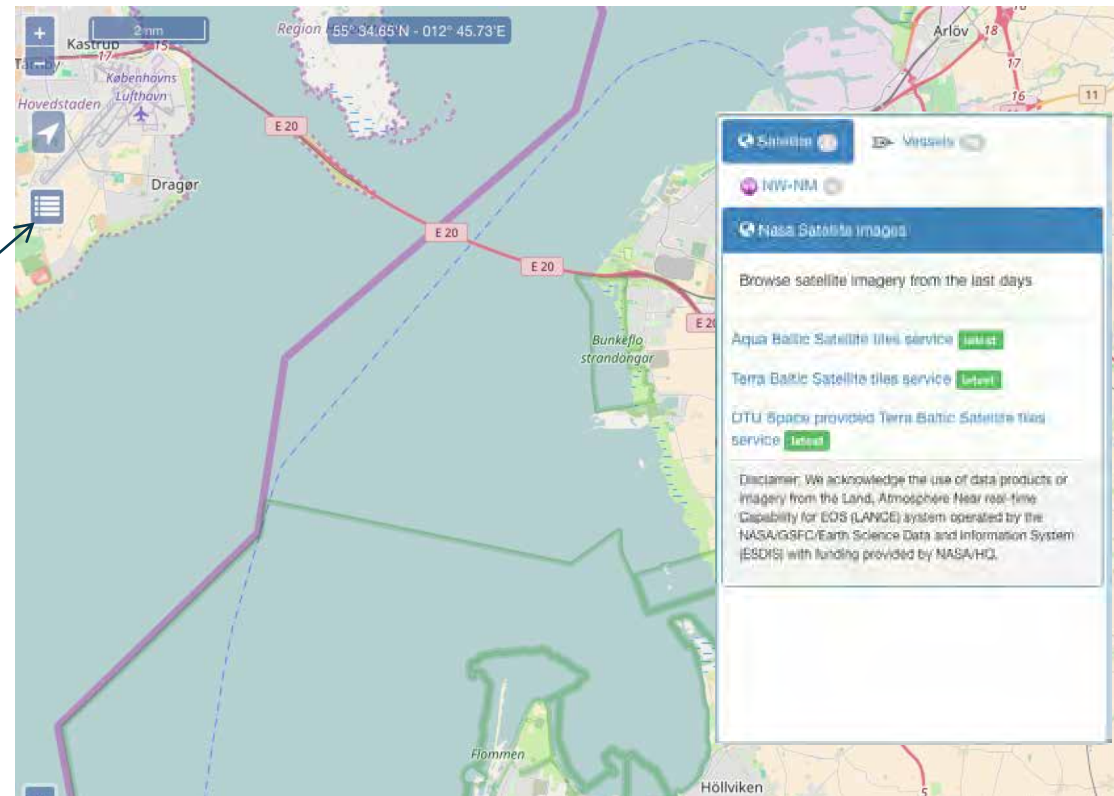
- It was suggested to allow the user to hide the menu bar

- It helps:
  - à The user to navigate undesturbed in the map
  - à The user to subjectively control the interface



Input 3

- The input on the menu bar has been integrated in the development of BalticWeb
- Here, the menu button allows to click the menu on/off – putting the user in control



Design work with users

Project with interaction design students at NTNU in Trondheim

April, 2016

Arctic Web - Design project with 3 masters students in Interaction Design from Norwegian University of Science and Technology

Linn, Aurora, Truls and the captain on the Hurtiguten's M/S Midnatsol

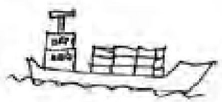

HURTIGRUTEN


FRAM

"Papirkart kommer aldri til å forsvinne fra broa"

"Kan jo være det fungerer på de gode skjermene på laben, men må fungere når er sjøsyk og kan nesten ikke stå oppreist."

ØNSKE OM Å FRAKTE GODS FRA SØR-KOREA TIL TROMSØ VIL TA ARKTIS RUTE



HAR ET SKIP SOM KUN ER KLARERT [redacted] TIL "LAVERE ISKLASSE"

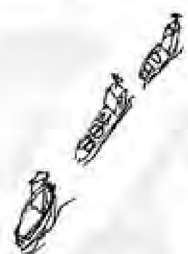
LEGGER UT MAN PÅ [redacted] NETT-TJENESTE

ET ANBUD.

ØNSKE

- ISBRYTER
- FLERE BÅTER I KONVOI

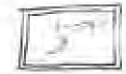
TJENESTEN MATCHER MED ANDRE PASSENDE RUTER, ELLER MÅ MAN



FØR REISE

SØREN PÅ BÅTEN WALRUS

PLANLEGGER



LEGGER INN RUTE

SER ANDRE RUTER

FORESLÅR

IS

VÆR

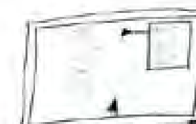
SKIPE

LAGRER RUTE OG TRANSFER TIL BÅTSYSTEM

UNDER REISE

ISEN TETNER SEG TIL TIDLIGERE ENN FORVENTET

SJEKKER FORESLÅTT IGJEN



SJEKKER ETTER DE ANDRE BÅTENE SOM SKULLE VÆRE I OMRÅDET.

TIMESLINE VISER AT SKIPS

BÅTEN SÅ LÅN I OMRÅDET

WALRUS[redacted]

[redacted] DE SITTER FAST I IS.

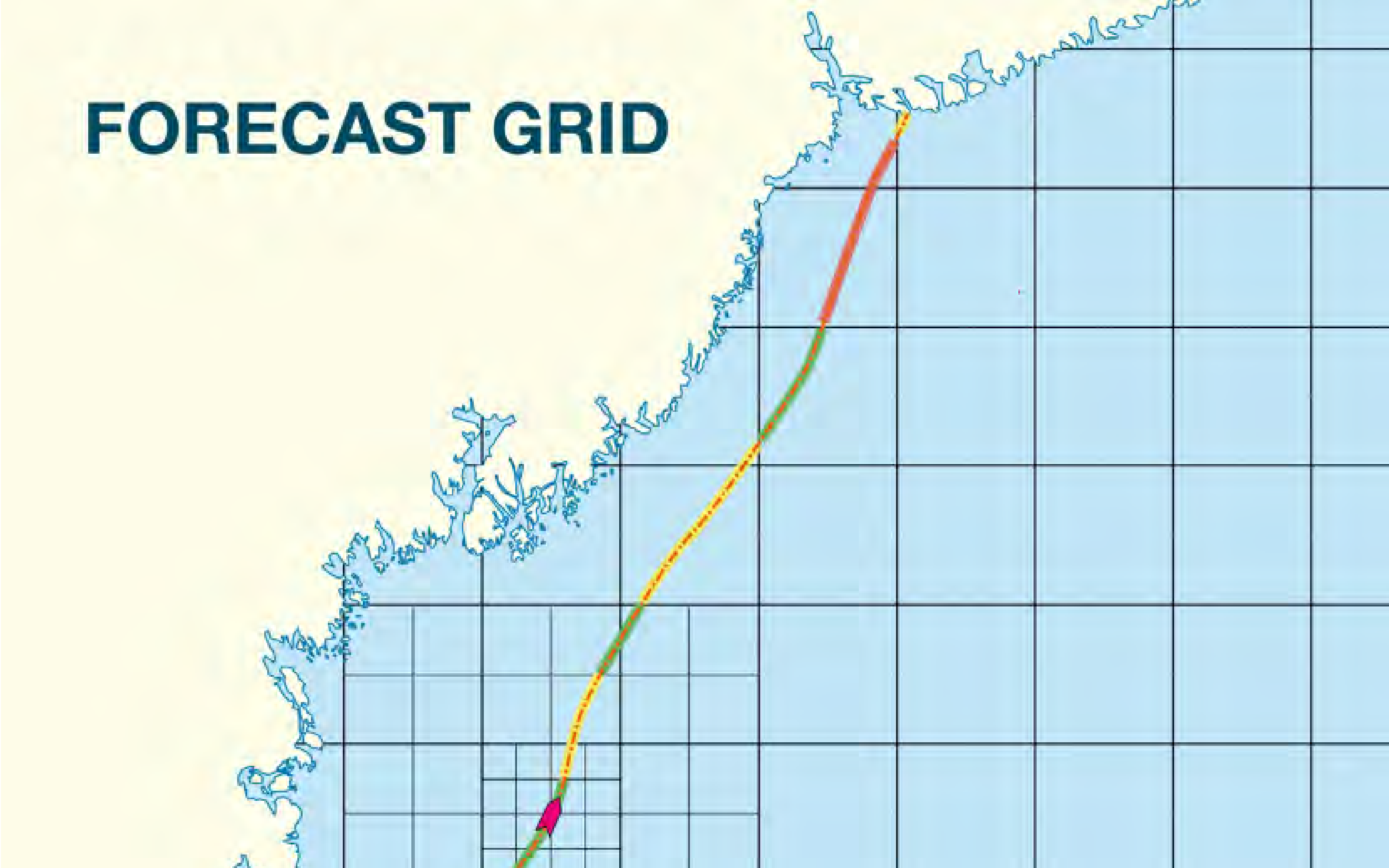
MED INFORMASJON FRA SYSTEMET.

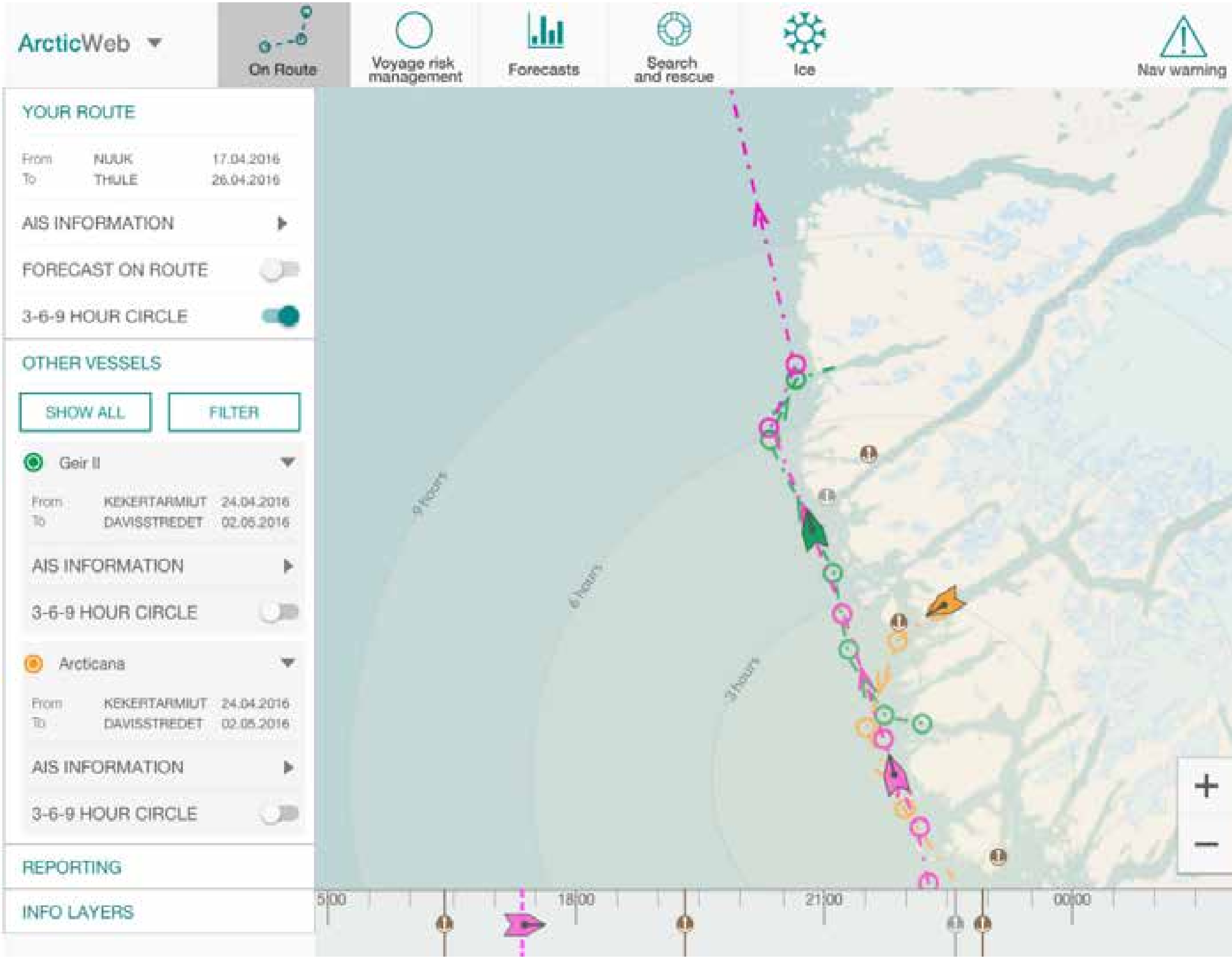
KONTAKTER ISBRYTEREN

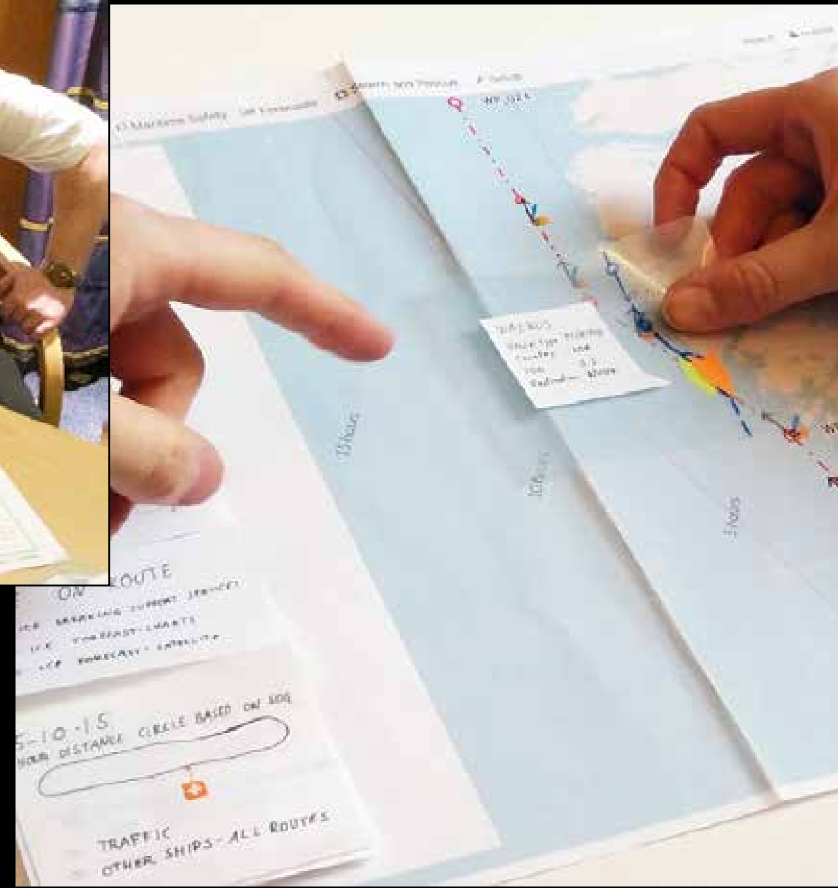
DEN [redacted] SKAL GUIDE SKIPS

UT OG LEGGER INN INFORMASJON

FORECAST GRID




ArcticWeb
On Route
Voyage risk management
Forecasts
Search and rescue
Ice
Nav warning
YOUR ROUTE
From NUUK 17.04.2016
To THULE 26.04.2016
AIS INFORMATION
FORECAST ON ROUTE
3-6-9 HOUR CIRCLE
OTHER VESSELS
SHOW ALL
FILTER
Geir II
From KEKERTARMIUT 24.04.2016
To DAVISSTREDET 02.05.2016
AIS INFORMATION
3-6-9 HOUR CIRCLE
Arcticana
From KEKERTARMIUT 24.04.2016
To DAVISSTREDET 02.05.2016
AIS INFORMATION
3-6-9 HOUR CIRCLE
REPORTING
INFO LAYERS
9 hours
6 hours
3 hours
18:00
21:00
00:00



User test with paper prototype

Display of e-Navigation information

Maritim Service Portfolio

MSP 1	VTS Information Service (IS)
MSP 2	Navigational Assistance Service (NAS)
MSP 3	Traffic Organisation Service (TOS)
MSP 4	Local Port Service (LPS)
MSP 5	Maritime Safety Information (MSI) Service
MSP 6	Pilotage Service
MSP 7	Tugs Service
MSP 8	Vessel Shore Reporting
MSP 9	Telemedical Maritime Assistance Service
MSP 10	Maritime Assistance Service (MAS)
MSP 11	Nautical Chart Service
MSP 12	Nautical Publications Service
MSP 13	Ice Navigation Service
MSP 14	Meteorological Information Service
MSP 15	Real-Time Hydrographic and Environmental Information Services
MSP 16	Search and Rescue (SAR) Service
MSP ...	More to come...

MSPs	Information items
1 INS	• The position, identity, intention and destination of vessels; • Amendments and changes in promulgated information concerning the VTS area such as boundaries, procedures, radio frequencies, reporting points; • The mandatory reporting of vessel traffic movements; • Meteorological and hydrological conditions, notices to mariners, status of aids to navigation; • Maneuverability limitations of vessels in the VTS area that may impose restrictions on the navigation of other vessels, or any other potential hindrances: or • Any information concerning the safe navigation of the vessel.
2 NAS	• Risk of grounding; • Vessel deviating from the recommended track or sailing plan; • Vessel unsure of its position or unable to determine its position; • Vessel unsure of the route to its destination; • Assistance to a vessel to an anchoring position; • Vessel navigational or maneuvering equipment casualty; • Inclement conditions (e.g. low visibility, high winds); • Potential collision between vessels; • Potential collision with a fixed object or hazard; • Assistance to a vessel to support the unexpected incapacity of a key member of the bridge team, on the request of the master.
3 TOS	• vessel movements need to be planned or prioritized to prevent congestion or dangerous situations; • special transports or vessels with hazardous or polluting cargo may affect the flow of other traffic and need to be organized; • an operating system of traffic clearances or sailing plans, or both, has been established; • the allocation of space needs to be organized; • mandatory reporting of movements in the VTS area has been established; • special routes should be followed; • speed limits should be observed; • the VTS observes a developing situation and deems it necessary to interact and coordinate vessel traffic; • nautical activities (e.g. sailing regattas) or marine works in-progress (such as dredging or submarine cable-laying) may interfere with the flow of vessel movement.
4 LPS	• berthing information; • availability of port services; • shipping schedules; • meteorological and hydrological data.
5 MSI	• National Hydrographic Offices, for navigational warnings and chart correction data; • National Meteorological Offices, for weather warnings and forecasts; • Rescue Co-ordination Centres (RCCs), for shore-to-ship distress alerts; • The International Ice Patrol, for Oceanic ice hazards.
6 Pilotage	
7	

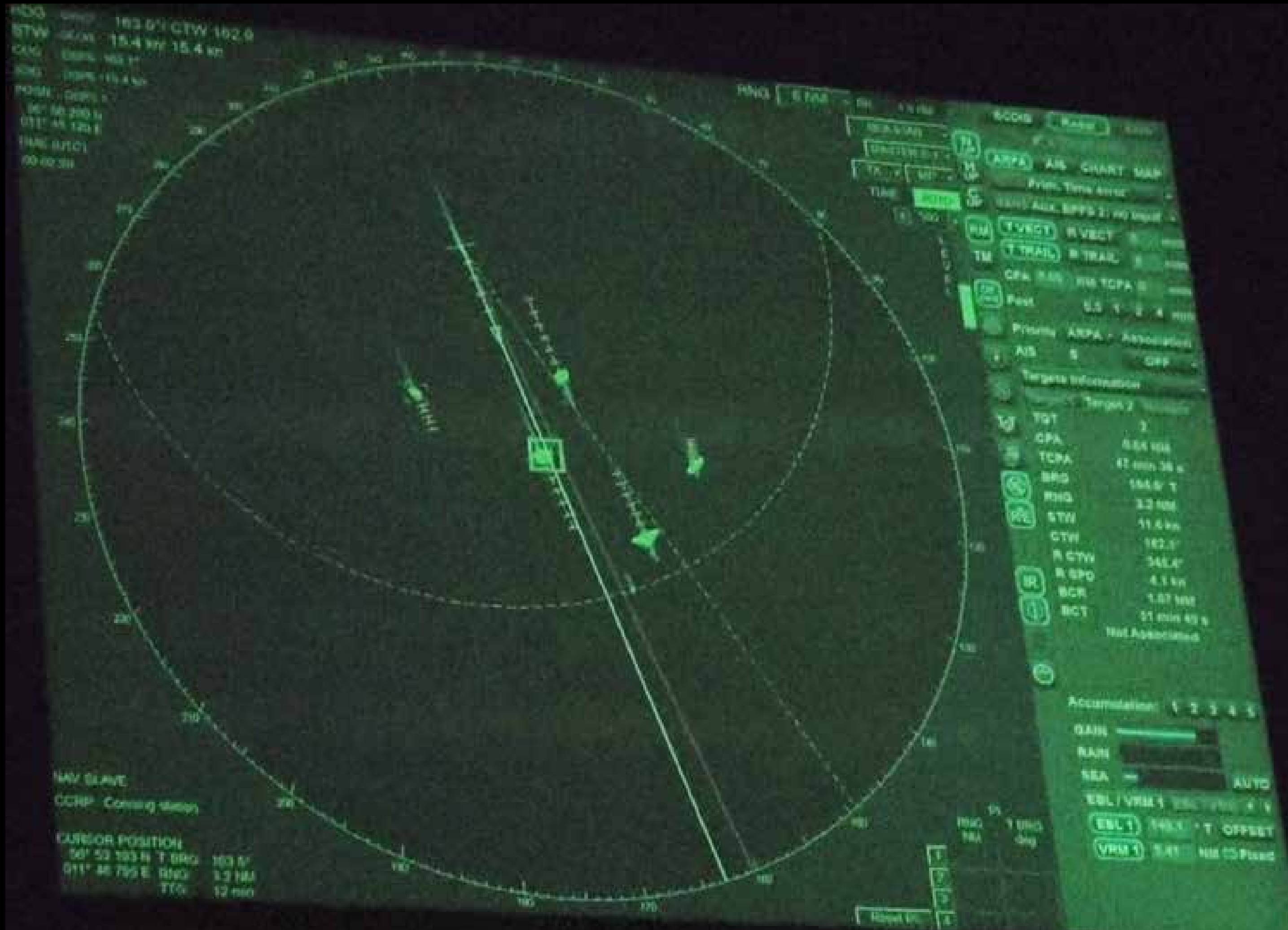

05°46.93'N
107°09.95'E

M/V Kong Harlad

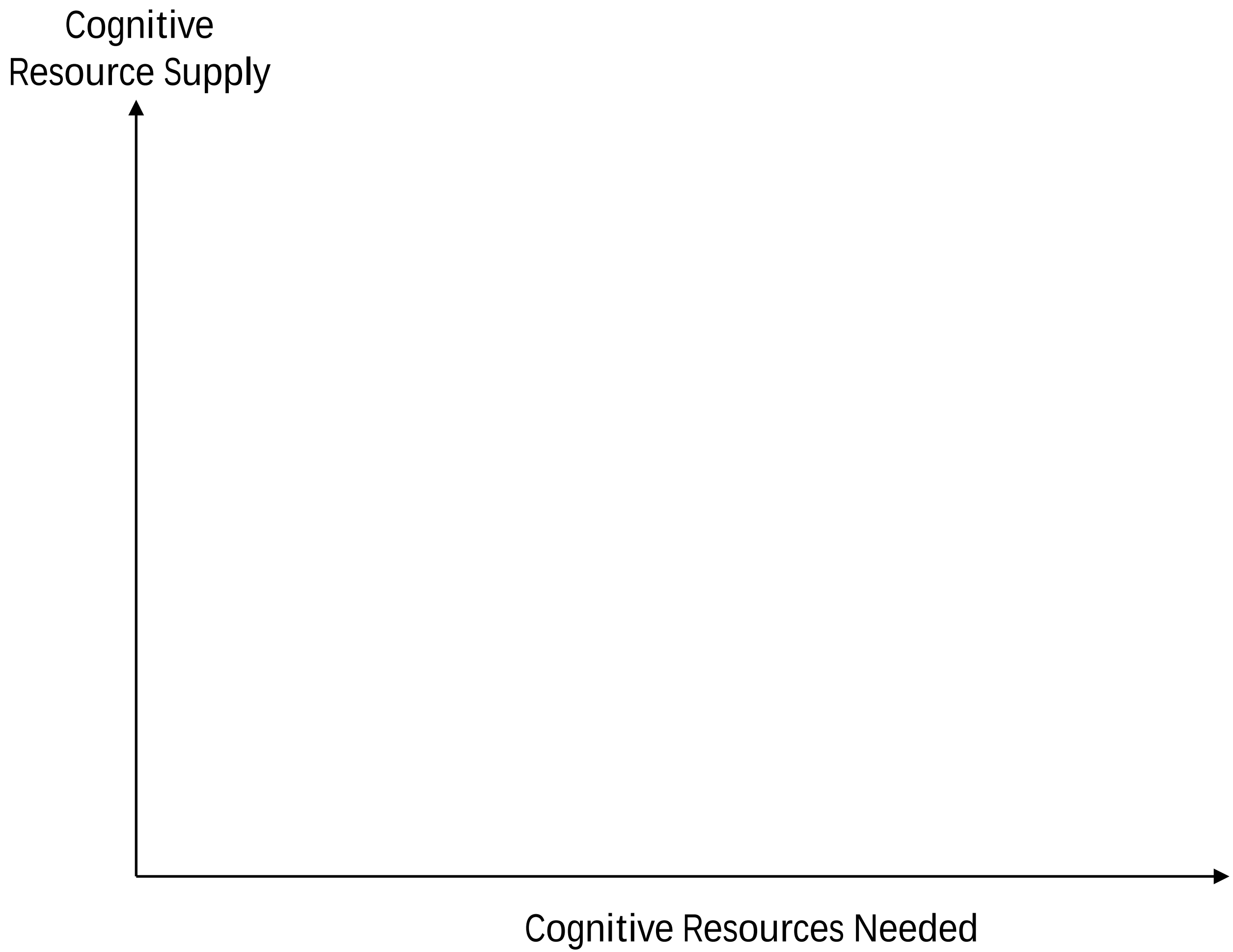
P&O North Sea Ferries' M/V Pride of Hull


ECDIS
Radar

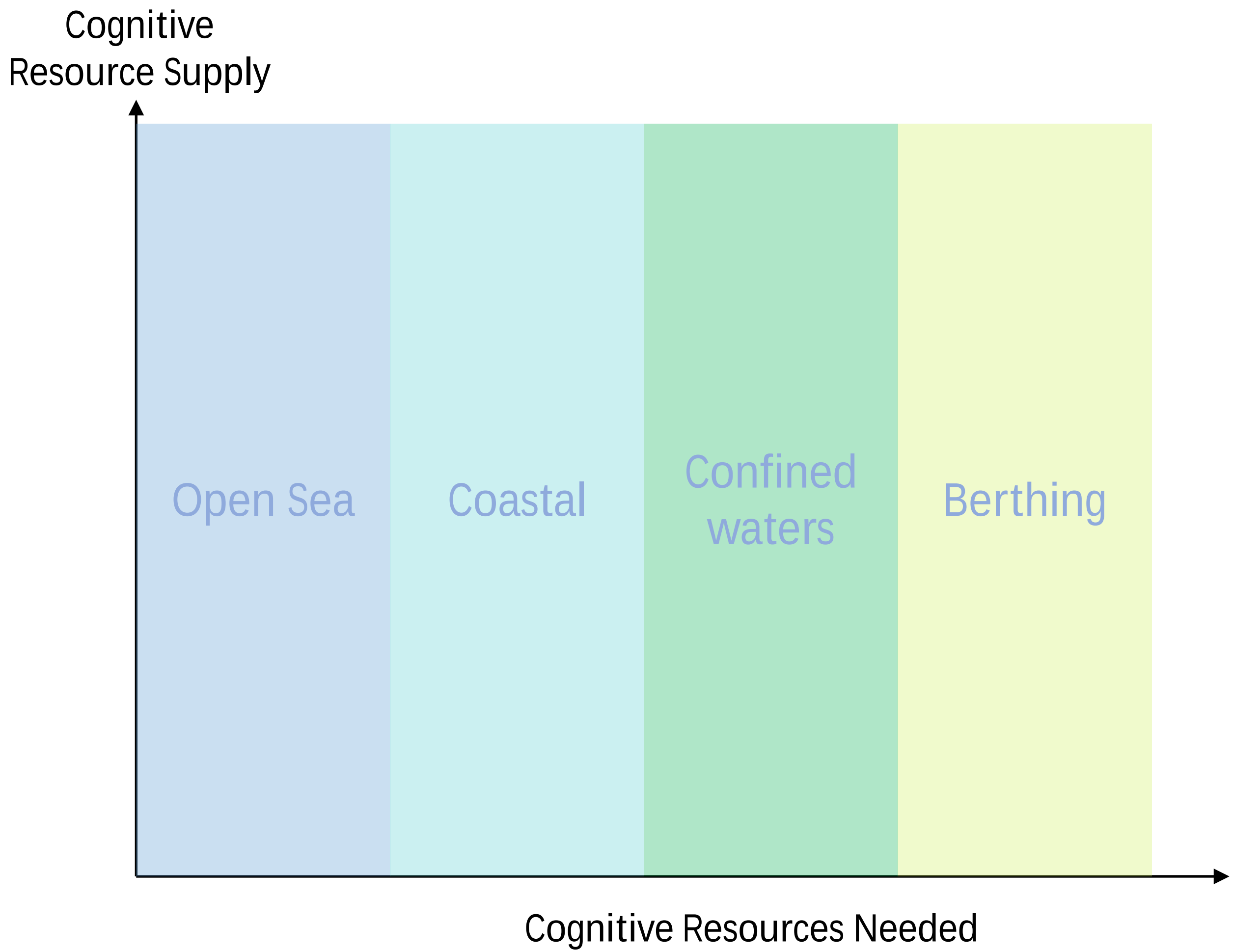
Radar
TM
1:1
Prim. Time error
CHART Non navigational chart
UTC
Sec: NONE
COG
SOG
HDG
GYRO 1
STW
DLOG 1
15.4 kn
1 : 150,000
Man. Corr.
System information
Drift
Current
Sf.contour
True wind
Rel. wind
Water t°
7.2 °C
DPTH
34.4 m
Tide height
No data
No data
STD Display
Event
3 min
Main
Dual
Config
Tasks List
Depth in Metres
WGS-84


STW
ARPA
AIS
CHART
MAP
T VECT
R VECT
T TRAIL
R TRAIL
Targets Information
TGT
CPA
TCPA
BRG
RNG
STW
CTW
R CTW
R SPD
BCR
BCT
Not Associated
GAIN
RAIN
SEA
AUTO
EBL / VRM 1
EBL 1
VRM 1
OFFSET
NAV SLAVE
CURSOR POSITION

Captain Jason Ikiadis, right, and First Officer Nikos Ninios on the bridge of the Azamara Journey. (ERIC WYNNE)
http://thechronicleherald.ca/titanic/slideshow/83244-azamara-journey



Christopher D. Wickens, Justin G. Hollands, Raja Parasuraman, & Simon Banbury. (2012). “Engineering Psychology & Human Performance (4th Edition)”. Pearsons. p. 348



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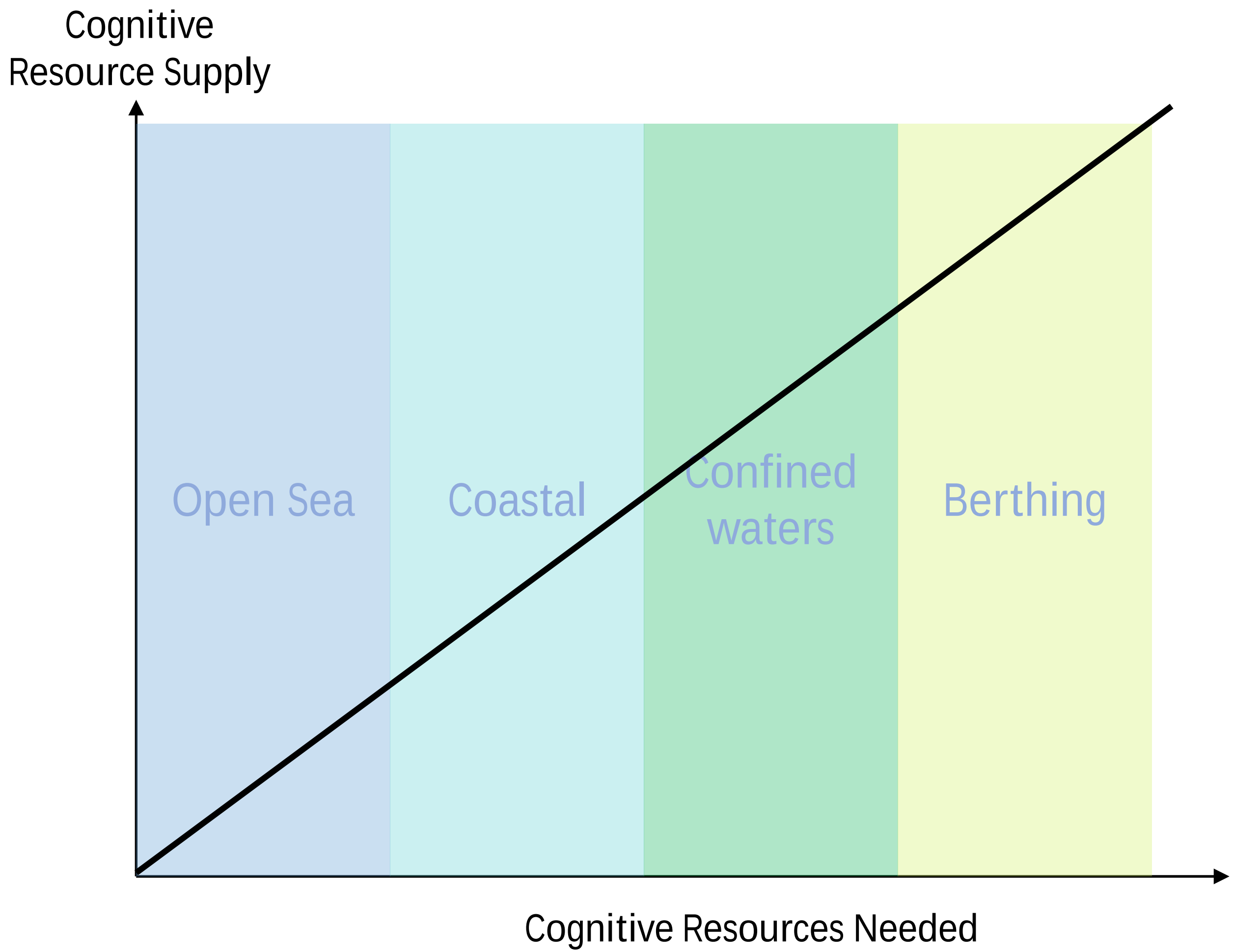

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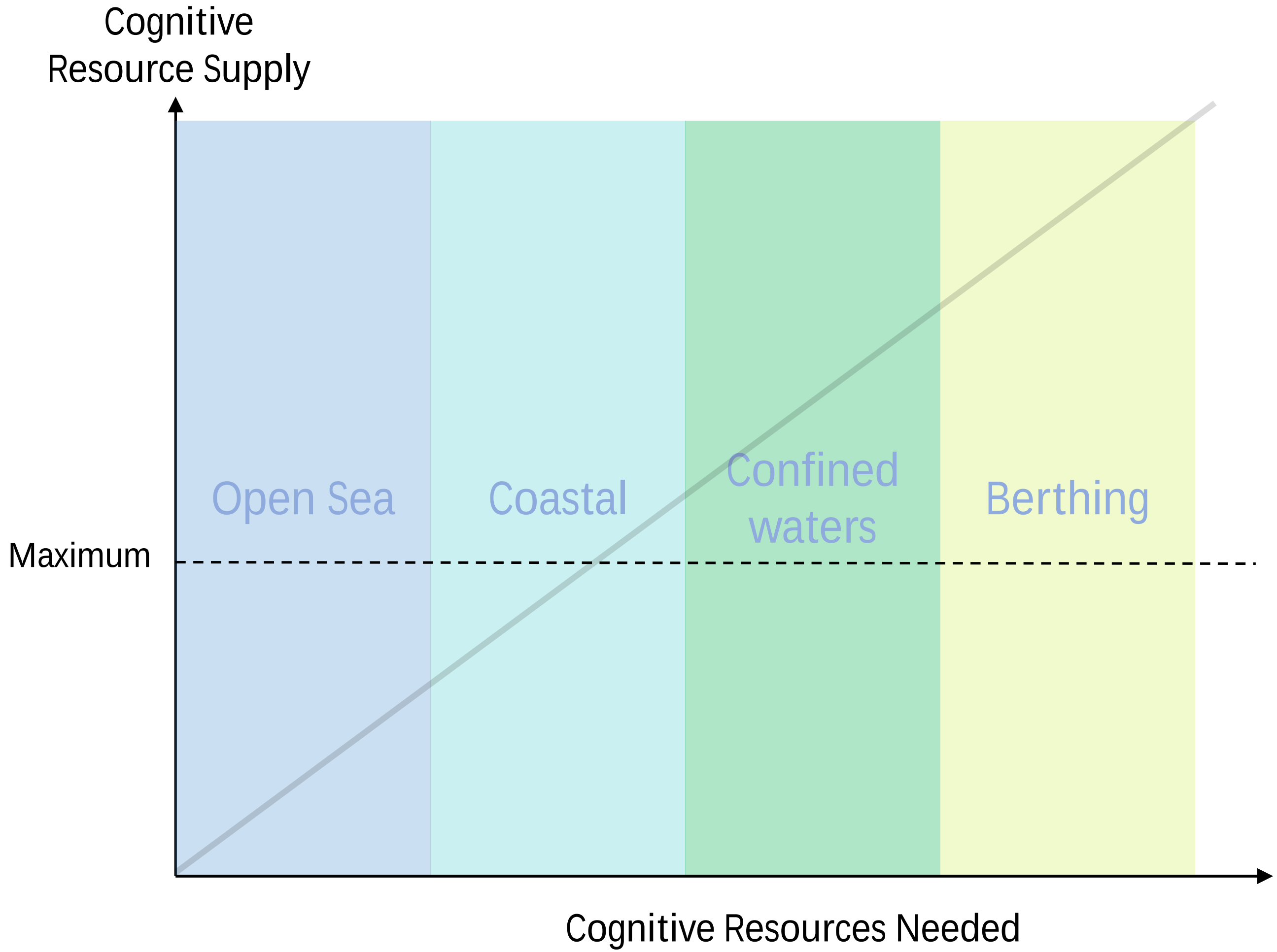

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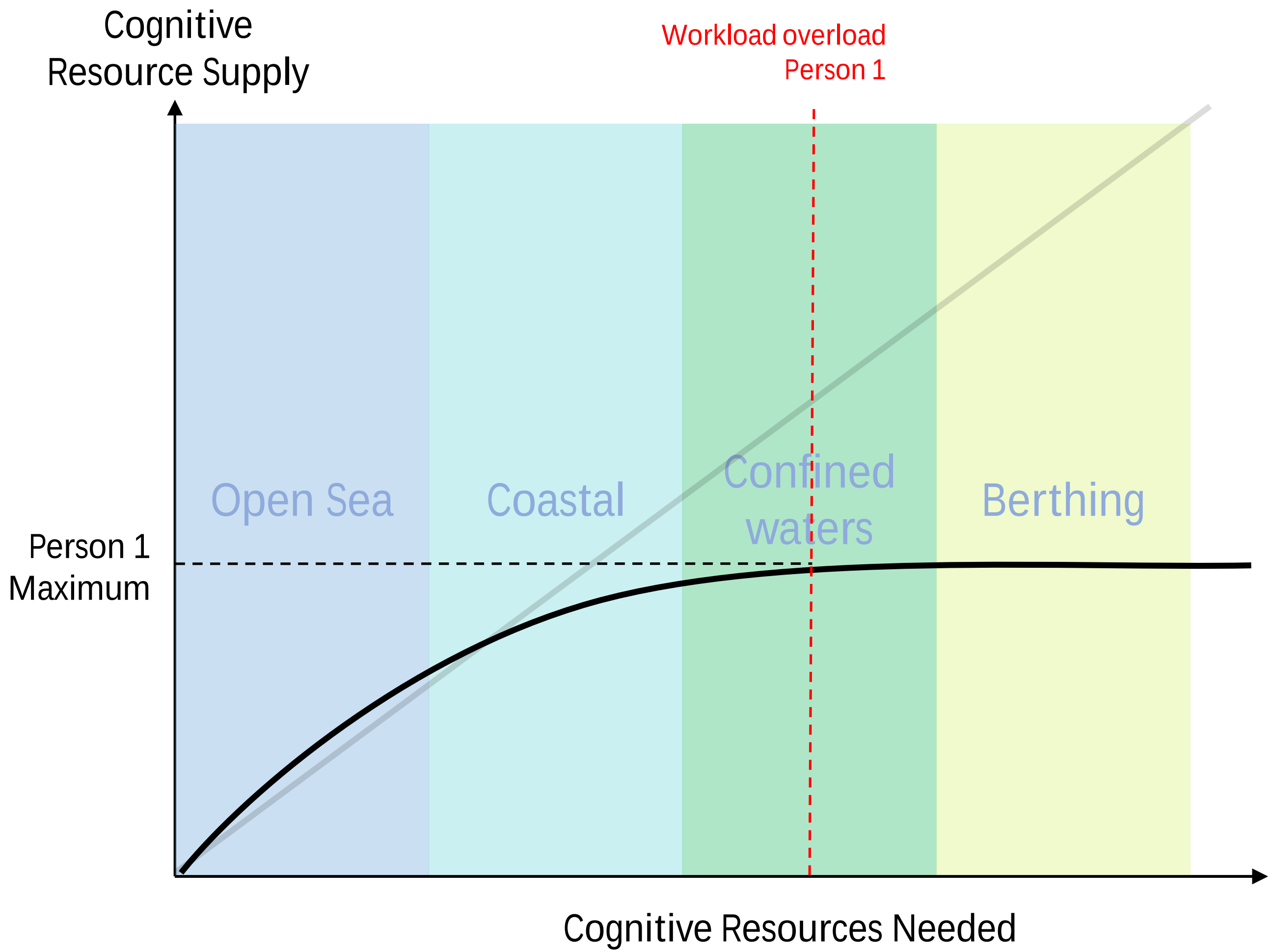

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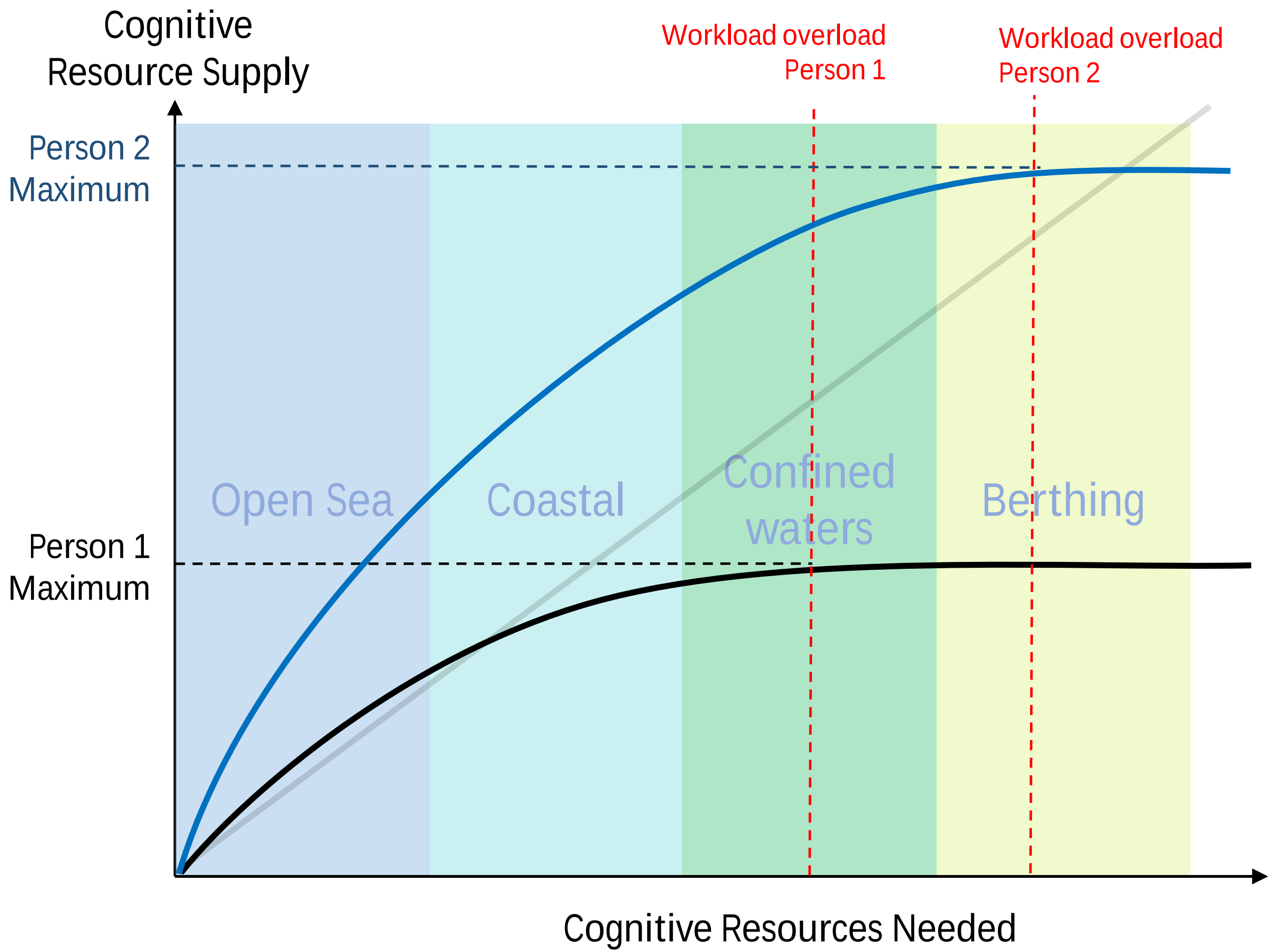

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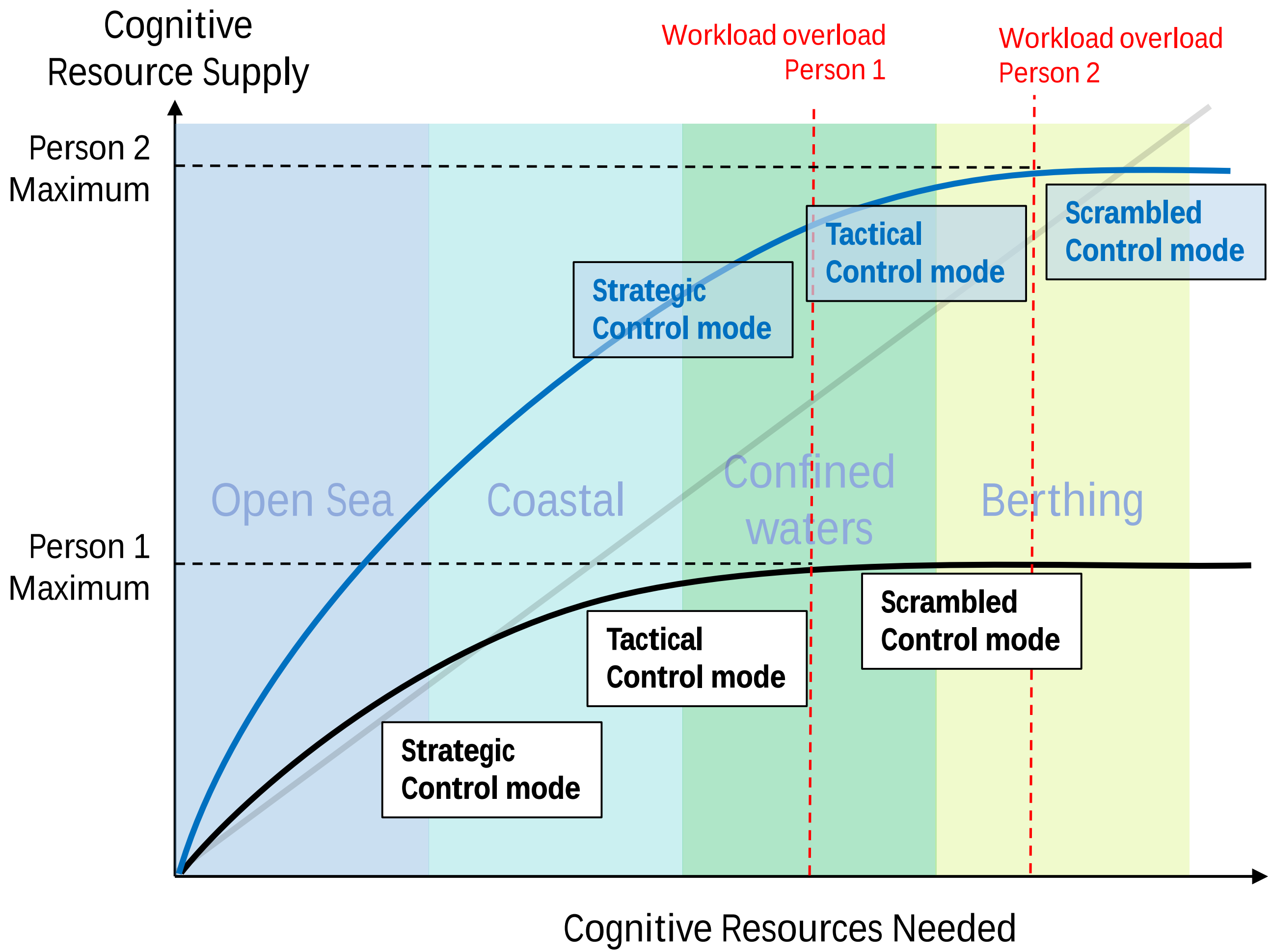

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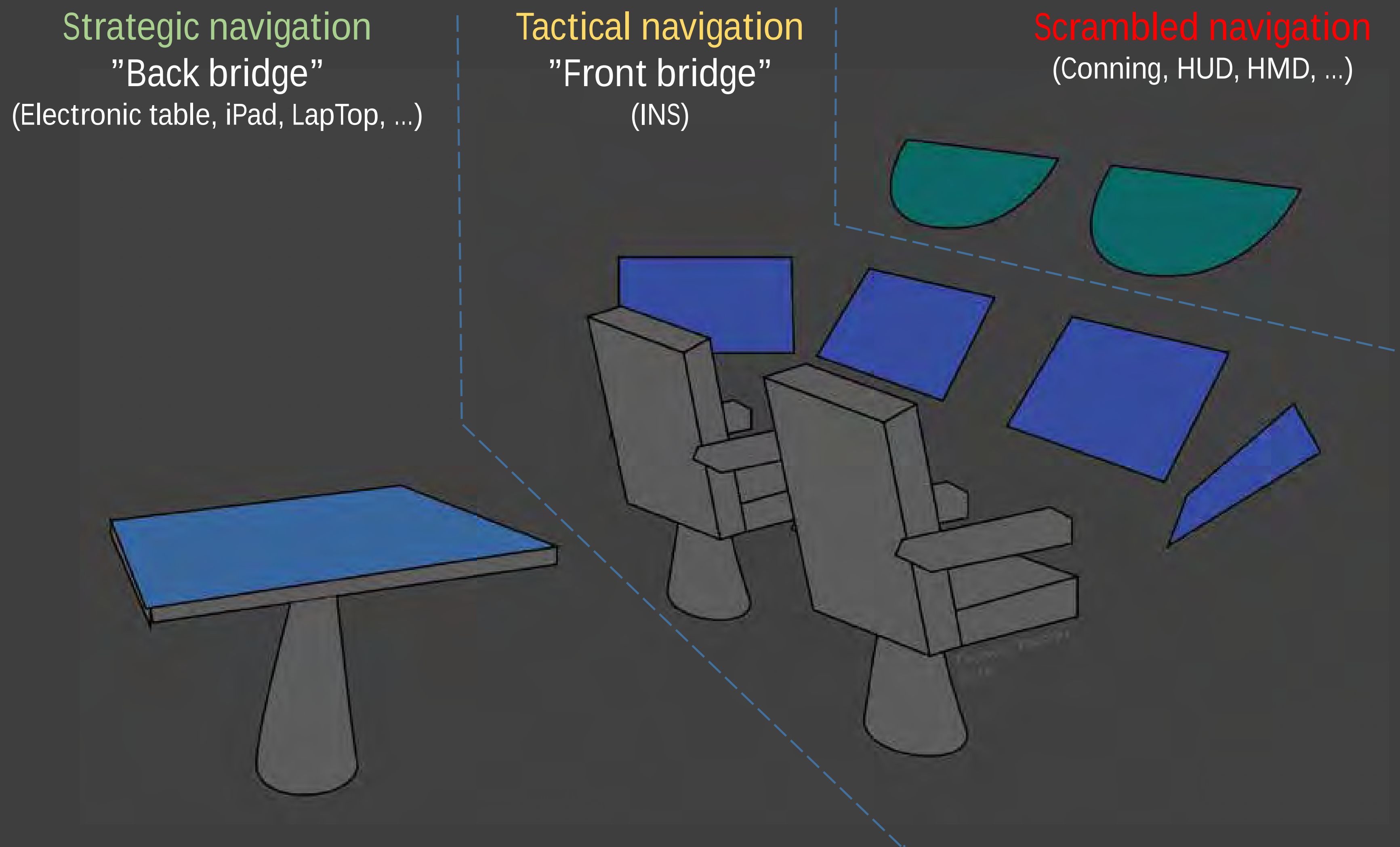

Strategic navigation
"Back bridge"
(Electronic table, iPad, LapTop, ...)
Tactical navigation
"Front bridge"
(INS)
Scrambled navigation
(Conning, HUD, HMD, ...)

Strategic navigation

"Back bridge"

(Electronic table, iPad, LapTop, ...)

Tactical navigation

"Front bridge"

(INS)

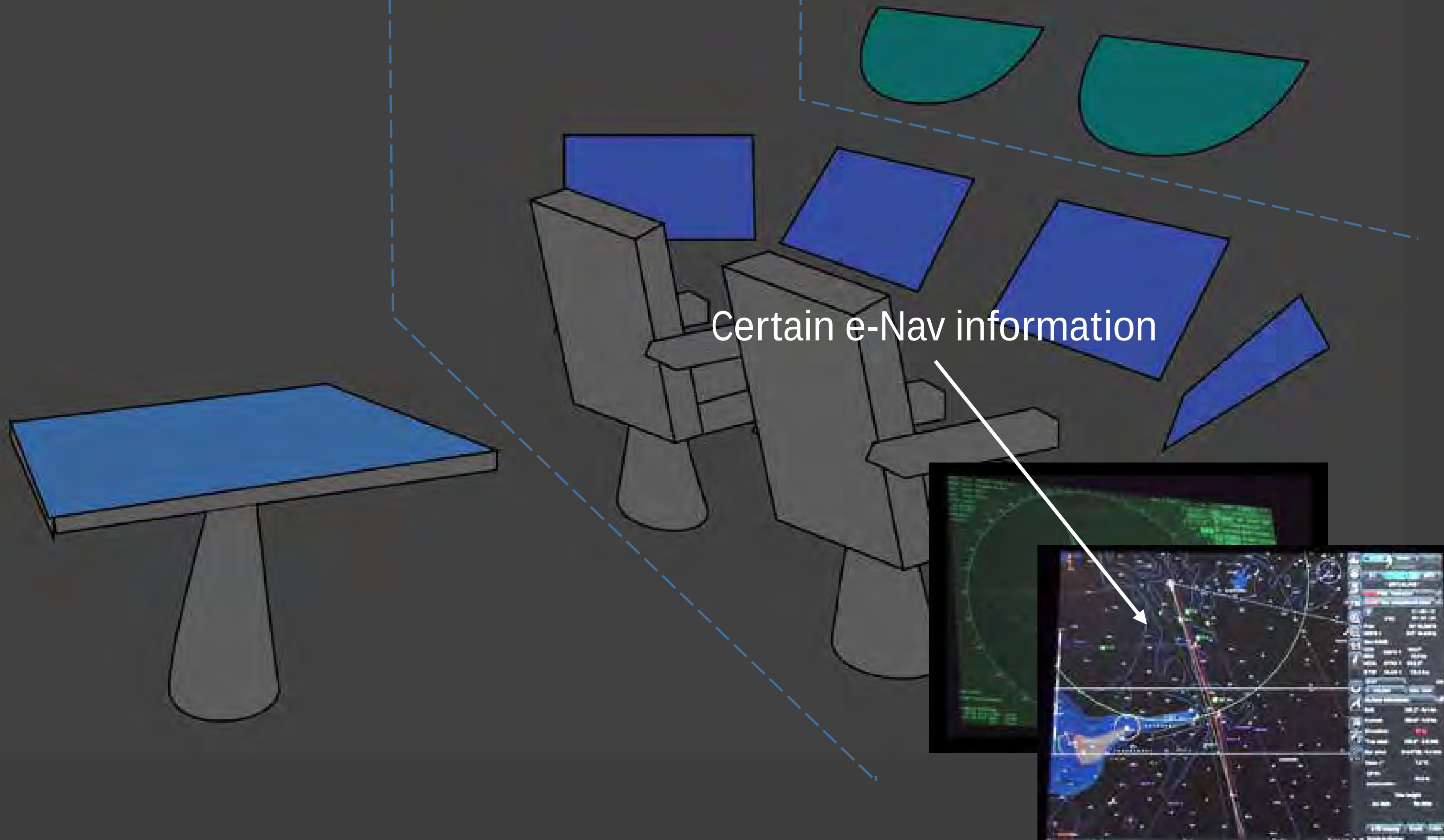
Scrambled navigation

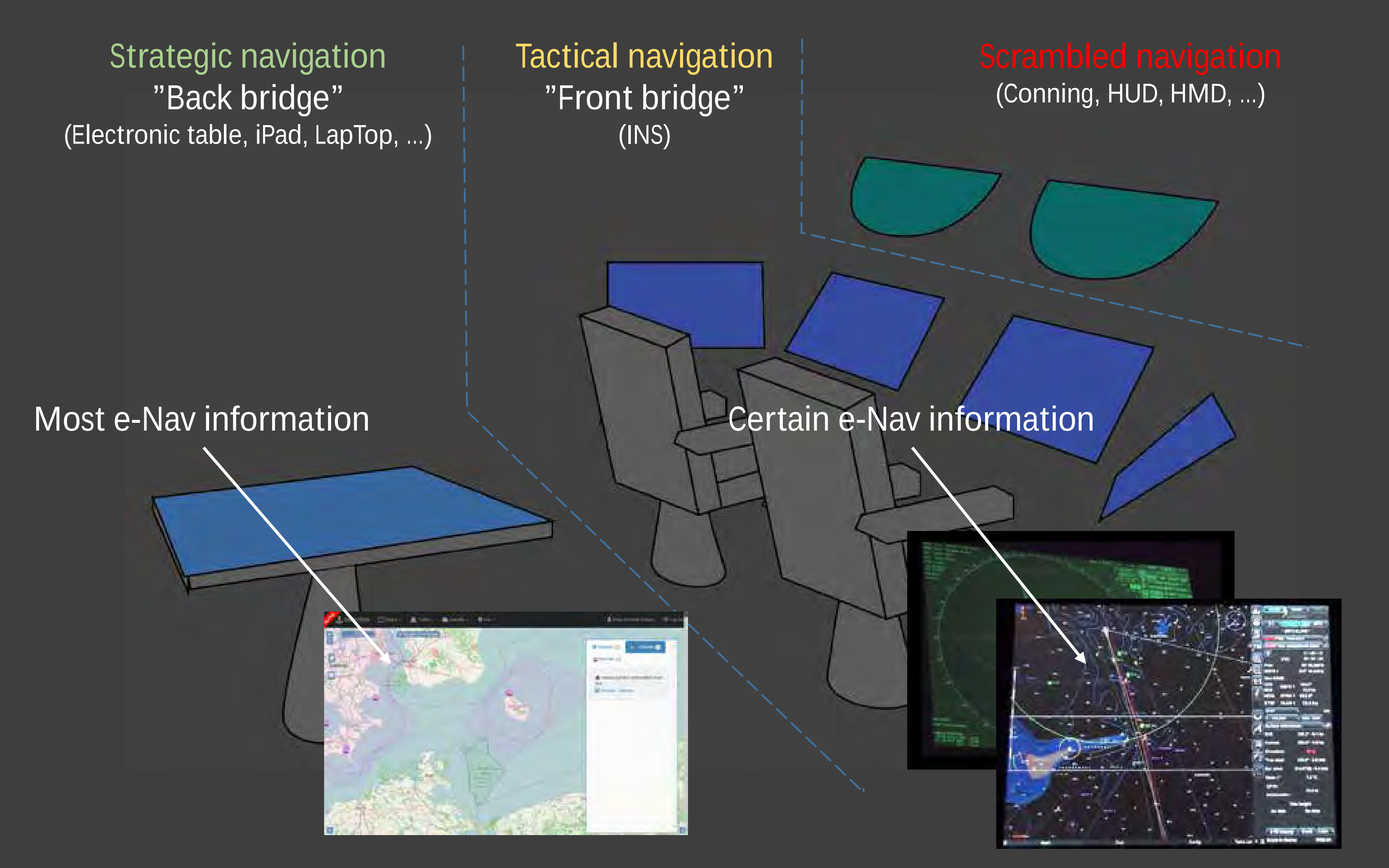
(Conning, HUD, HMD, ...)

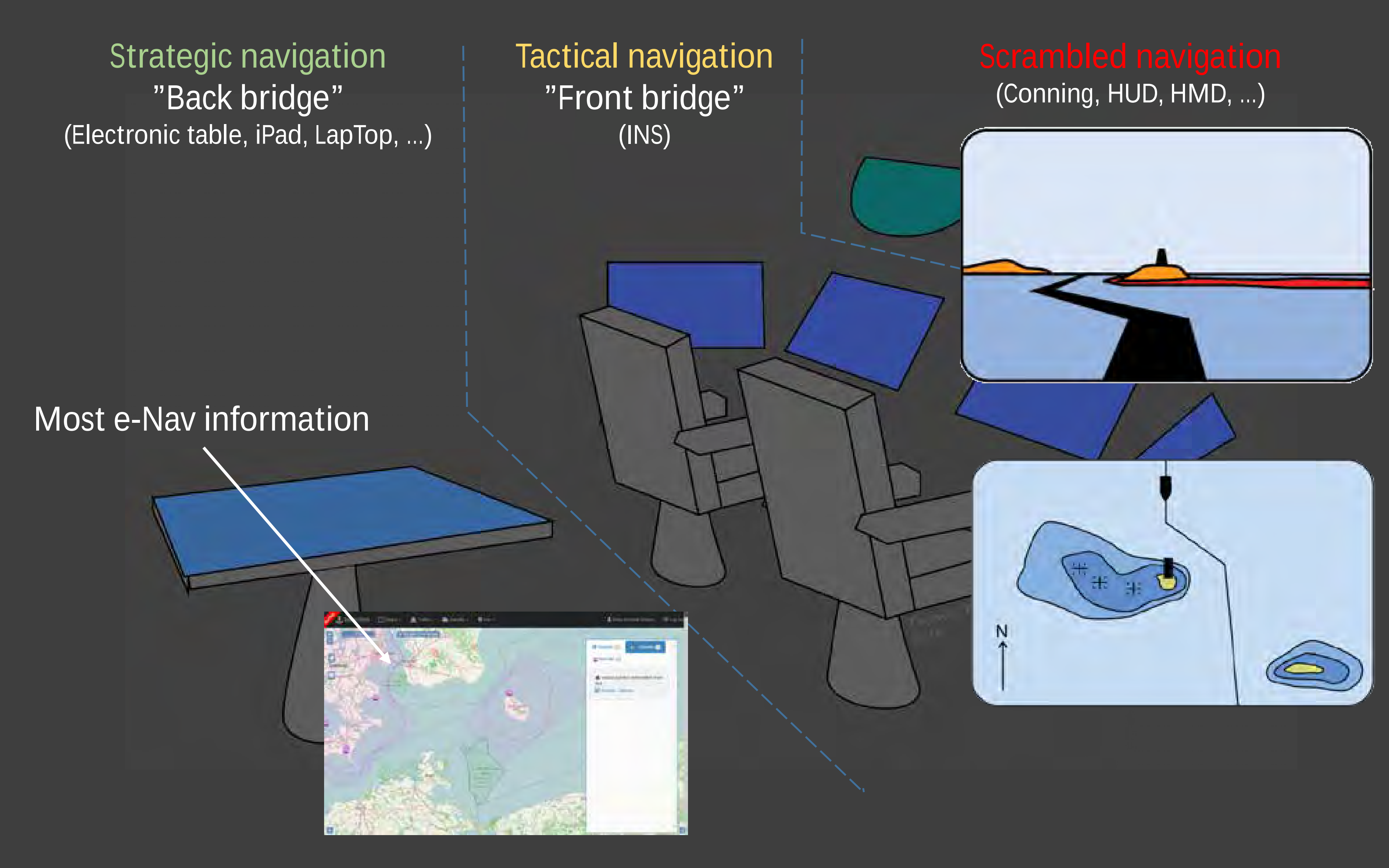
Strategic navigation
"Back bridge"
(Electronic table, iPad, LapTop, ...)

Tactical navigation
"Front bridge"
(INS)

Scrambled navigation
(Conning, HUD, HMD, ...)




Strategic navigation
"Back bridge"
(Electronic table, iPad, LapTop, ...)
Tactical navigation
"Front bridge"
(INS)
Scrambled navigation
(Conning, HUD, HMD, ...)
Most e-Nav information
Certain e-Nav information



Strategic navigation
"Back bridge"
(Electronic table, iPad, LapTop, ...)
Tactical navigation
"Front bridge"
(INS)
Scrambled navigation
(Conning, HUD, HMD, ...)
Most e-Nav information
N

Task 1.6 Ensuring the proper methodology is used for identifying and solving user needs

Task Lead: CHALM – Contribution: FORCE, MDCE, DMA

The task is responsible for ensuring that the proper methodology is used for identifying and solving user needs.

The task will harmonise human element and usability aspects across the project, especially the services related to WP4, WP5 and WP6

Particular focus will be on measuring the influence and impact of the proposed services and their potential to support users in strategic and tactical decision-making.

- The task will coordinate both design and evaluation activities involving actual users.
- The task will educate project partners by preparing guideline documents on human factors
- Arranging and performing workshops for project partners in human factor principles.
- Finally, the task will assist other WPs in actual user involvement in field test and simulator test campaigns.

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Particular focus will be on measuring the influence and impact of the proposed services and their potential to support users in strategic and tactical decision-making.

- The task will coordinate both design and evaluation activities involving actual users. — Not yet
- The task will educate project partners by preparing guideline documents on human factors — Not yet
- Arranging and performing workshops for project partners in human factor principles. — 1 workshop
- Finally, the task will assist other WPs in actual user involvement in field test and simulator test campaigns. — Not yet

Deliverables:

D1.6.1 Final usability evaluation report, including

- recommendations on training needs as well as
- methods for measuring impact
- M33

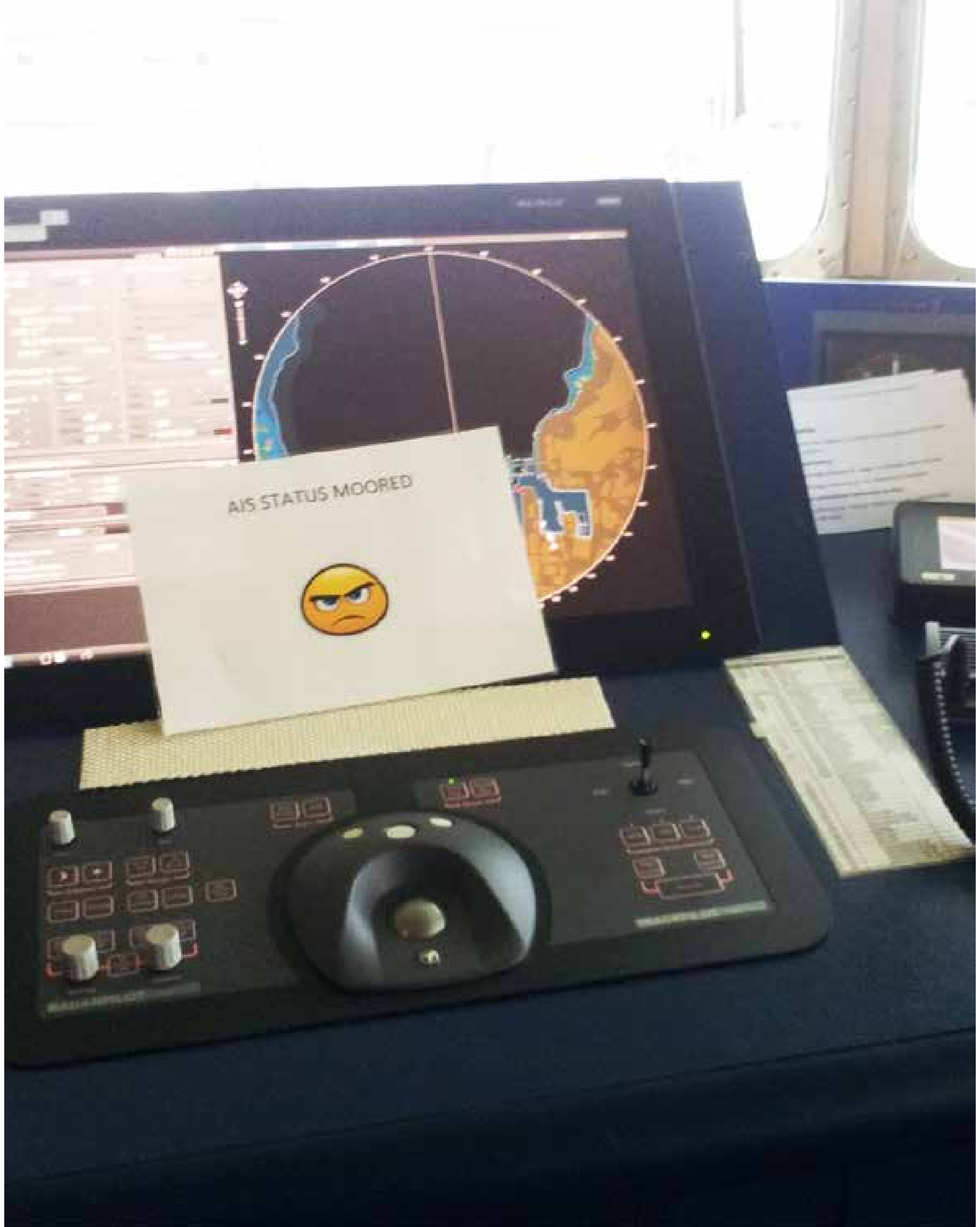
Three interaction design students at NTNU using HCD methods developing the Arctic Web, spring 2016

Contextual inquiry/Field study

BESØK HOS BRUKER

- Første besøk på Hurtigruten
- Innsikt

- Tur med Hurtigruten til Ålesund
- Brukertesting


AIS STATUS MOORED

User requirements

BRUKERENS MÅL

- Sikkerhet for alle ombord
- Oversikt: fra start til slutt

Prototyping

LENGE FØR REISE

Coordinated voyage

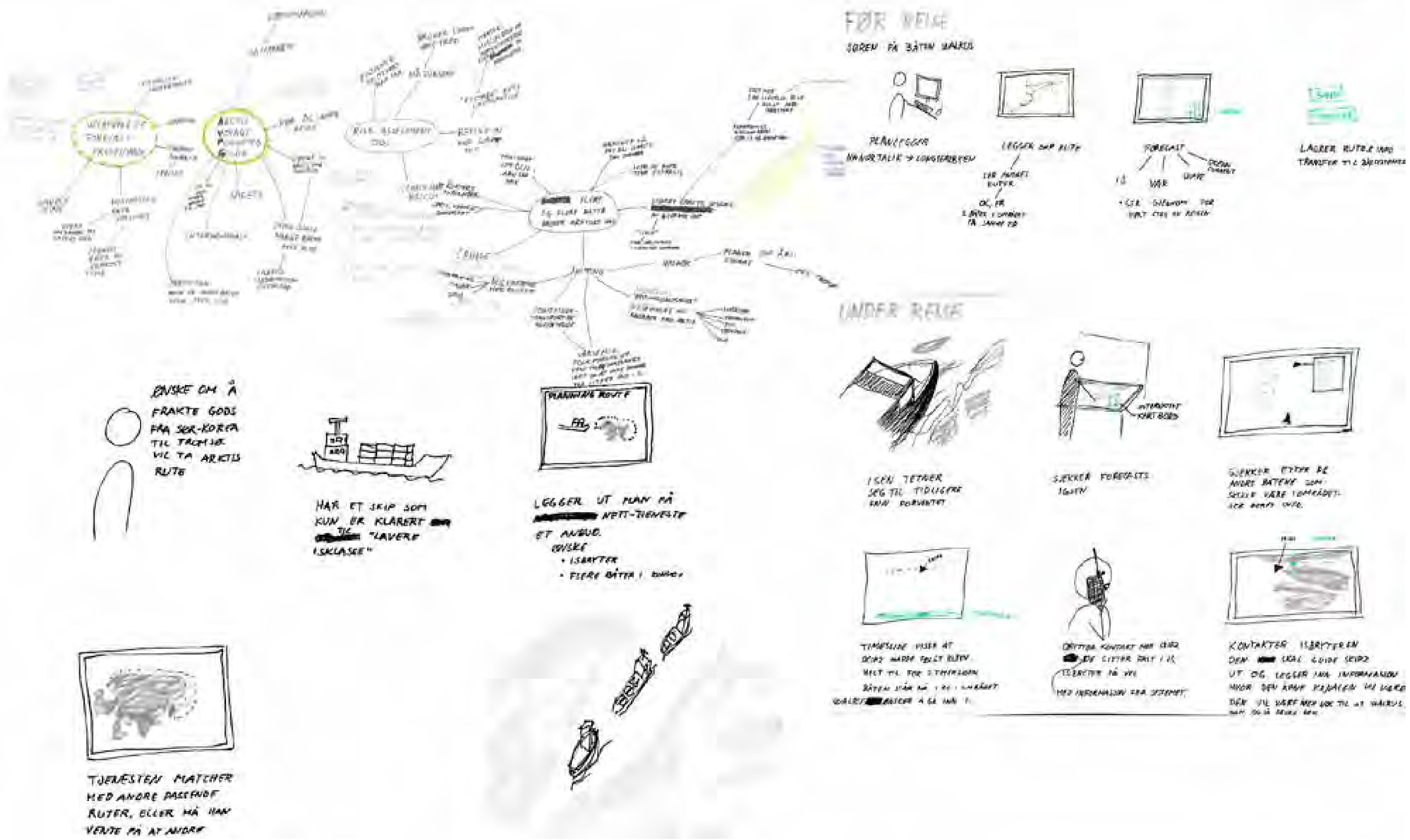
FØR REISE

Grafisk presentasjon av
forecast og is

UNDER REISE

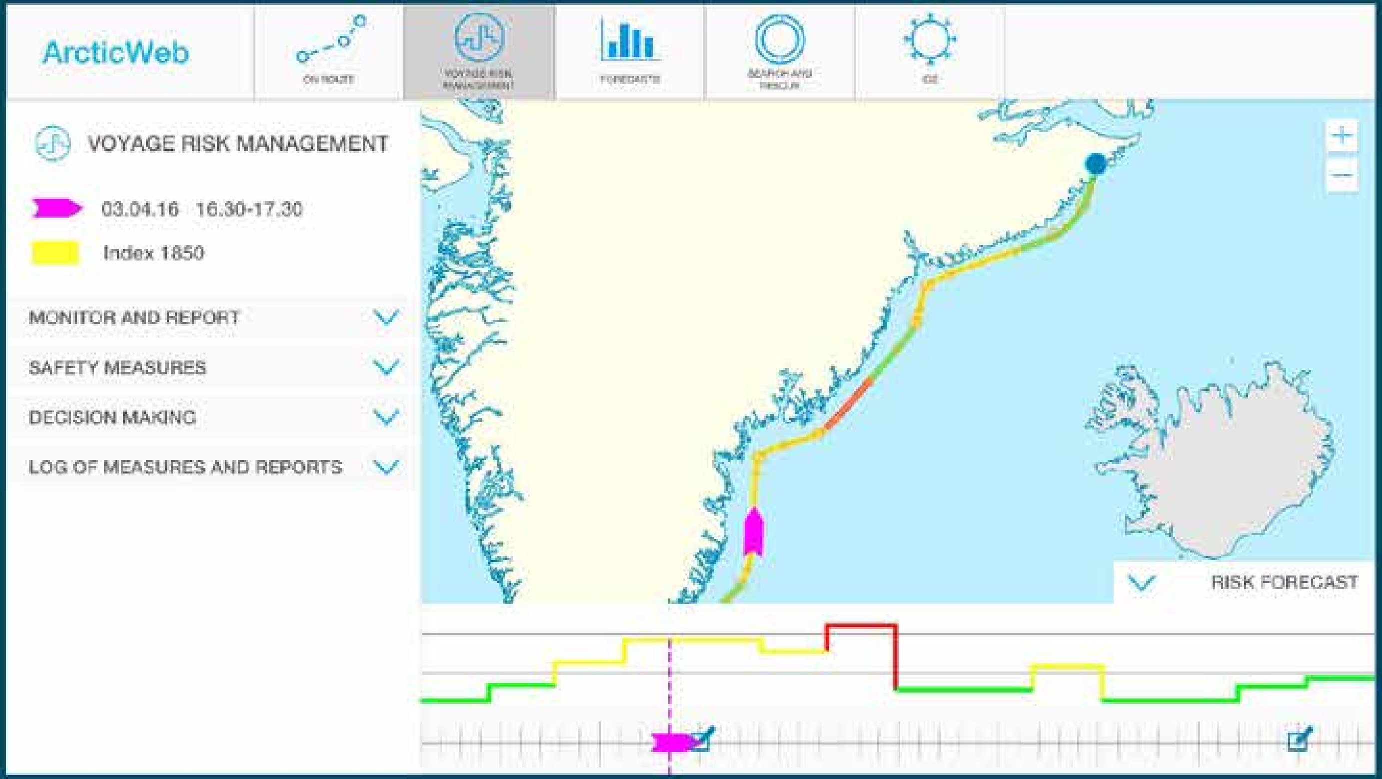
Info på ruten

SKISSER FOR KONSEPT



FØR REISE
SØREN PÅ BÅTEN WALRUS
PLANLEGGER
LEGGER OPP RUTE
FORECAST
IS
VÆR
LAGRER RUTER OG
UNDER REISE
ISEN TETTER SEG TIL TIDLIGERE ENN FORVENTET
SJEKKER FORECASTS IGJEN
SJEKKER ETTER DE ANDRE BÅTENE SOM SKULLE VÆRE I OMRÅDET
TIMELINE VISER AT
KONTAKTER ISBRYTEREN
ØNSKE OM Å FRAKTE GODS FRA SØR-KOREA TIL TROMSØ VIL TA ARKTIS RUTE
HAR ET SKIP SOM KUN ER KLARERT TIL "LAVERE ISKLASSE"
PLANNING ROUTE
LEGGER UT PLAN PÅ NETT-TJENESTE
ET ANBUD.
ØNSKE
• ISBRYTER
• FLERE BÅTER I
TJENESTEN MATCHER MED ANDRE PASSENDE RUTER, ELLER MÅ HAN VENTE PÅ AT ANDRE

PROTOTYPE FOR VOYAGE RISK MANAGEMENT



User testing

"Kan jo være det fungerer på de gode skjermene på laben, men må fungere når er sjøsyk og kan nesten ikke stå oppreist."

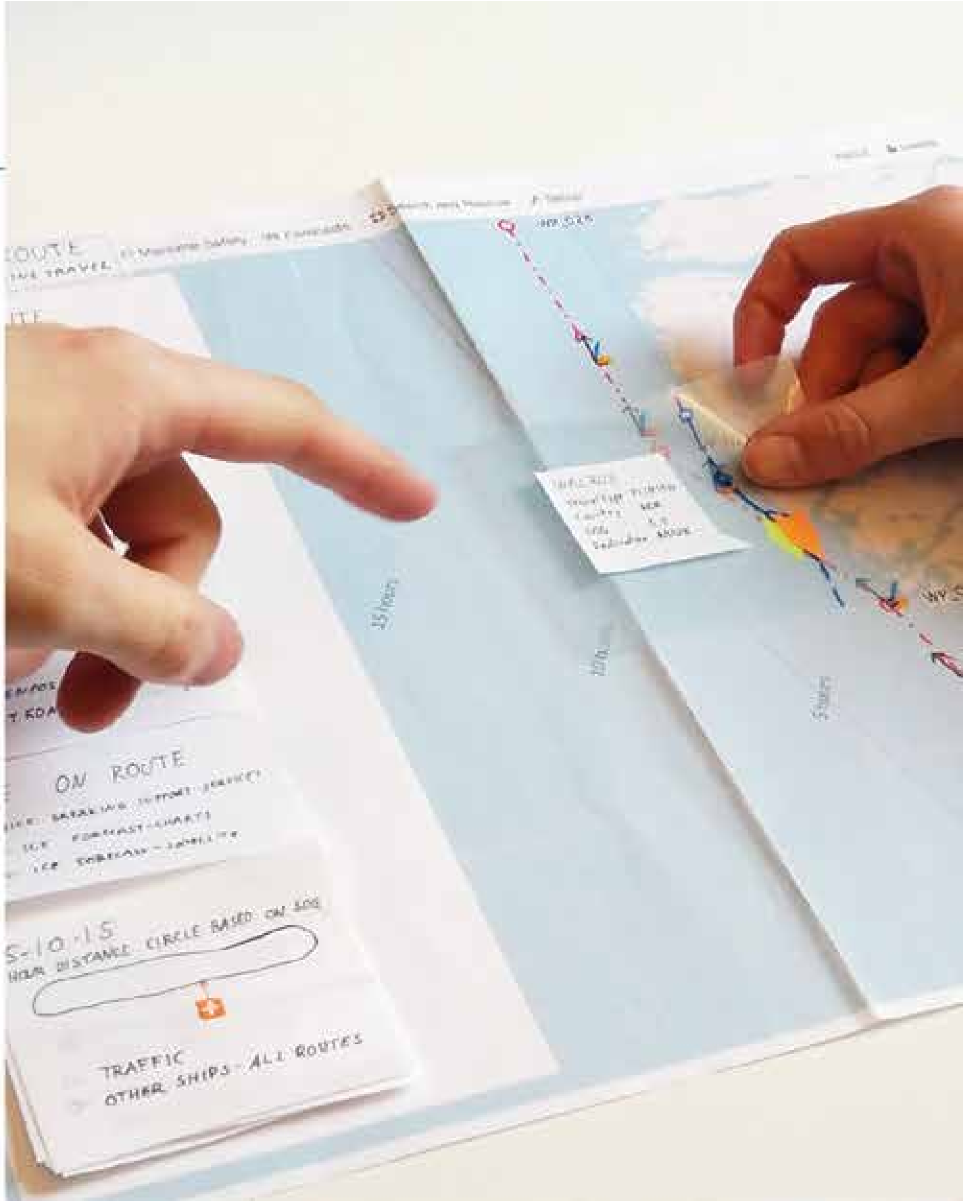
KONSEPT 3 - UNDER REISE

+

- Spennende med timeline
- Mer ArcticWeb - passe visjonært
- Lagvis info

-

- Traffikk featuren ikke nødvendig
- 5-10-15 får for mye fokus



GETTING CONNECTED FOR EFFICIENT, SAFE AND SUSTAINABLE TRAFFIC AT SEA

BALTIC WEB USABILITY REPORT

Task 6.4 Human factors in the integration of e-navigation services

By
Jeanette J. Jakobsen, jjja@force.dk, Force Technologies
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November 3rd, 2017

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This report provides feedback on the e-navigation solutions tested at Chalmers University of Technology in Gothenburg, Sweden, during May/June 2017. The report contains observations of usability issues related to effectiveness, efficiency and user satisfaction with the solutions – and gives input to how the future development of these solutions optimally should be carried out from a human factors perspective.

The tested services include:

Route optimization

VTS reporting

MSI's (Notices to mariners + navigational warnings)

No-go areas

EFFICIENSEA

2.0 GETTING CONNECTED

Content

- **Test setup, methods and definitions of terms used**
- **Route optimization**
  - Effectiveness
  - Efficiency
  - Satisfaction
- **VTS Reporting**
  - Effectiveness
  - Efficiency
  - Satisfaction
- **MSIs**
  - Effectiveness
  - Efficiency
  - Satisfaction
- **No-go Areas**
  - Effectiveness
  - Efficiency
  - Satisfaction
- **Additional general input from the users**
- **Additional input from the Human Factors Researchers**

Test setup

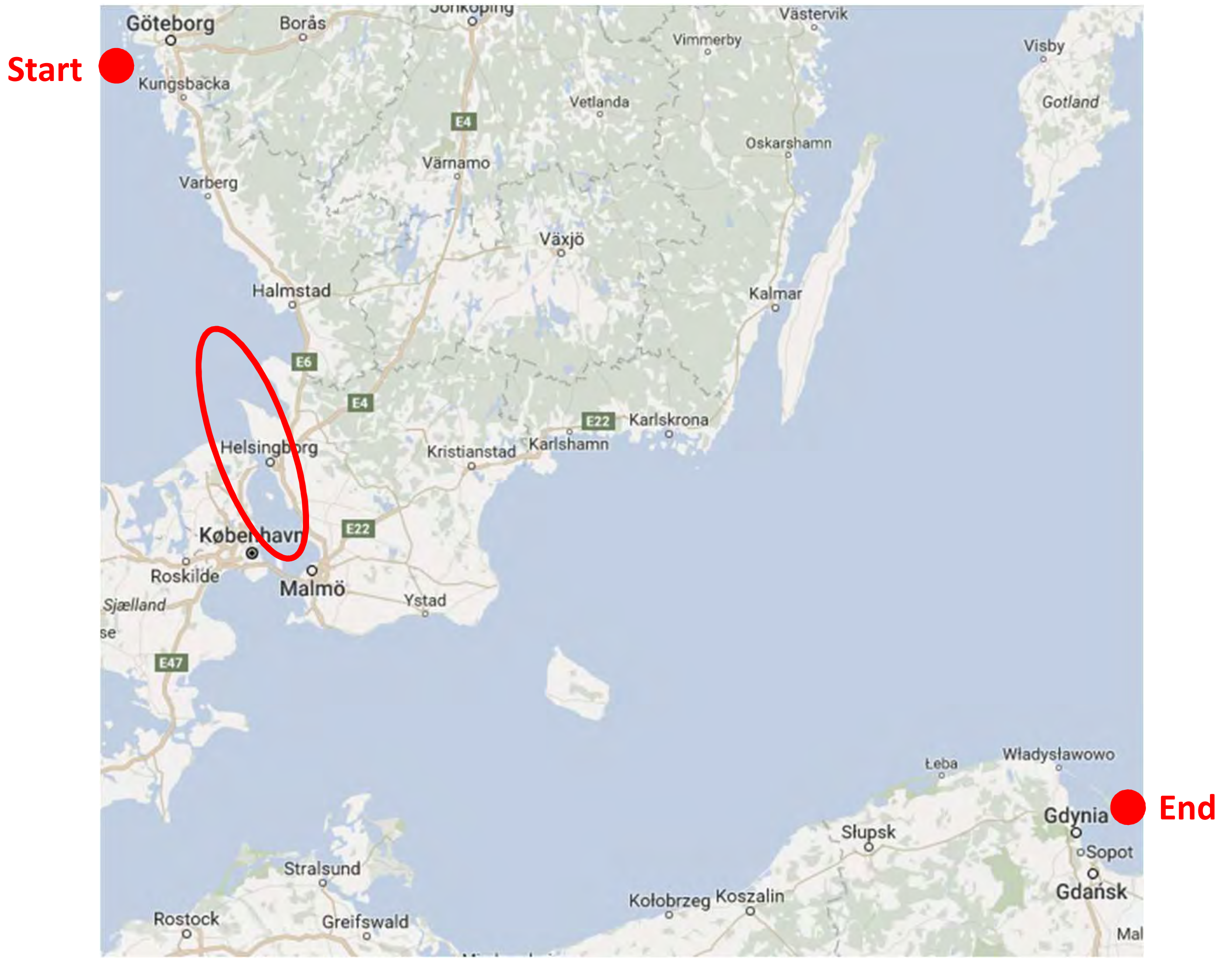
Simulator Study
Chalmers University

Group	Date	Testpersons	Age
Baseline (÷ BW)	Week 22, 2017	10 (5 groups)	33-50
Intervention (+ BW)	Week 24, 2017	8 (4 groups)	27-58

Test setup

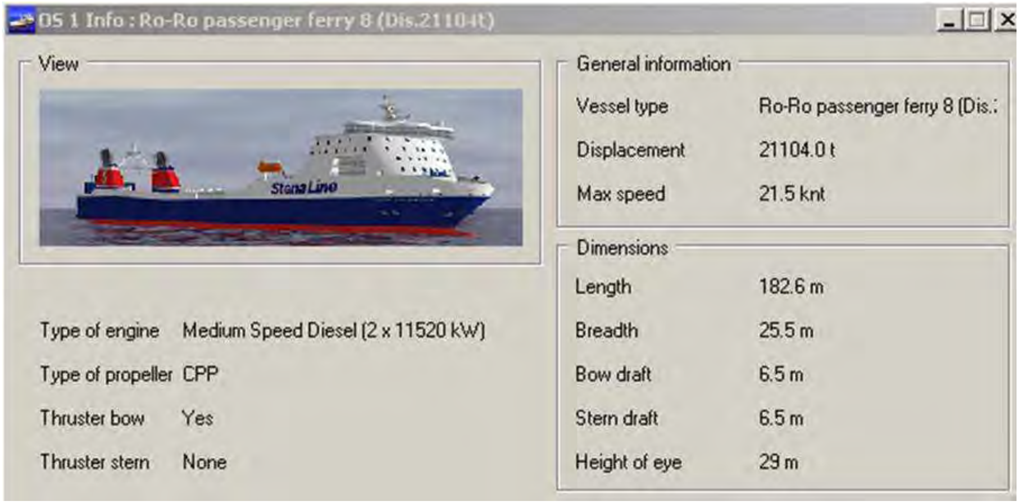
Scenario

- Planning route from Gothenburg to Gdynia (approx. 2 hours)
- Navigation through The Sound (approx. 2hours and 15min)



EFFICIENSEA 2.0 GETTING CONNECTED

Test setup



Simulated vessel type	Ro-Ro passenger ferry with 182,6 meters of length (displacement 21104,0 tons)
Draught	7 meters even keel
Speed	Maximum 21 knots
Simulated traffic conditions	Medium dense
Simulated day	The 21st of April 2017 (day time navigation scenario) – with normal weather patterns

Methods for data collection

Eye tracking

GSR

Video & audio recording

+ Interviews and questionaiers

Definitions of terms in use

Effectiveness

The term refers to accuracy and completeness of users' tasks.

In other words *”is the user capable of producing the desired result and to what extent?”*

Efficiency

The term refers to the support and challenges in the process of users' tasks – by focusing on minimizing steps, removing roadblocks and handling error.

In other words “is the users' perception, cognition or actions challenged in the process?”

Satisfaction

The term refers to the subjective experiences and statements related to the users' tasks.
In other words ”*is the user accepting, trusting and is satisfied in the process?”*

ROUTE OPTIMIZATION

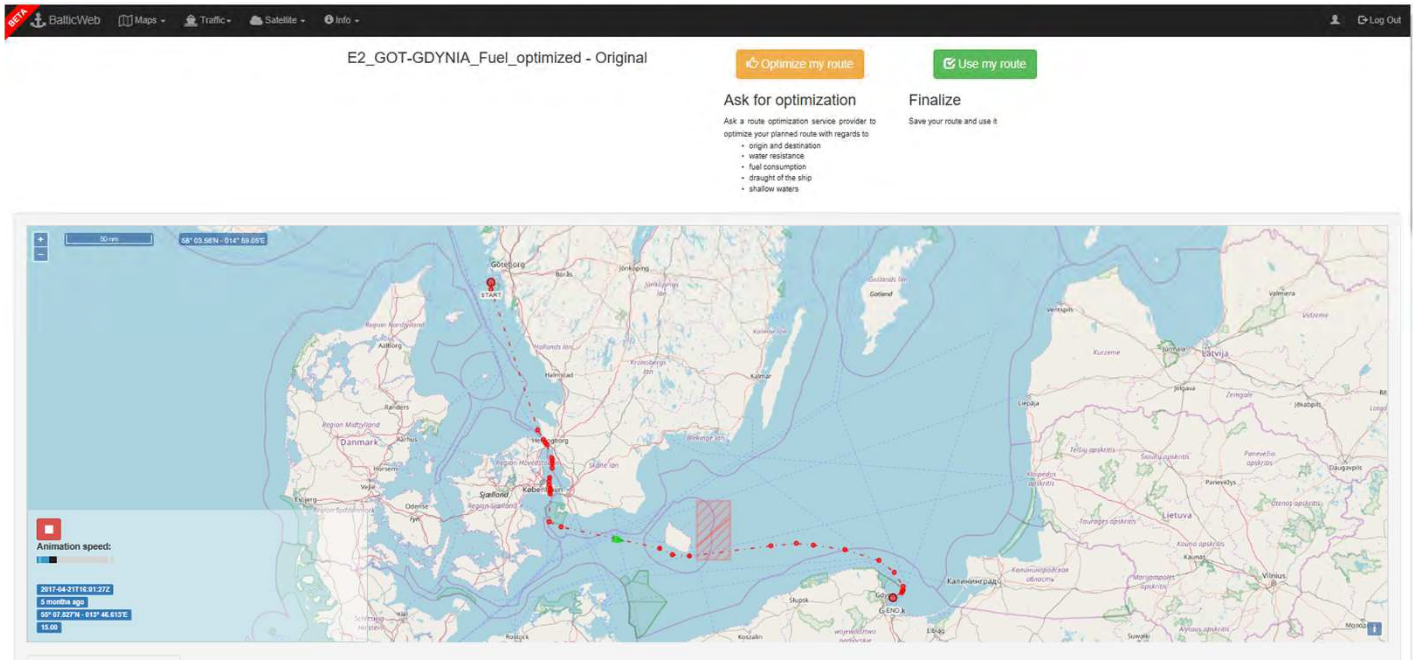
Route optimization

Service provider: SSPA

Aim: To increase the efficiency (time and fuel) of the transport and reduce environmental impact

Function: Standardized and easily accessible service for acquiring an optimized route for a vessel

Context of use: Predicted to be requested before departure during route planning, to later support a more efficient voyage



Effectiveness

Is the user capable of producing the desired result and to what extent?

Route optimization

- **Is the route optimization solution tested during planning?**

Group 1	Group 2	Group 3	Group 4
✓	✓	✓	✓

- **Is the optimized route used for navigational planning during planning phase?**

Group 1	Group 2	Group 3	Group 4
Not used	Used (but adjusted to TSS etc.)	Partly used (adjusting way points in own route)	Partly used (changing flint to drogden in own route)