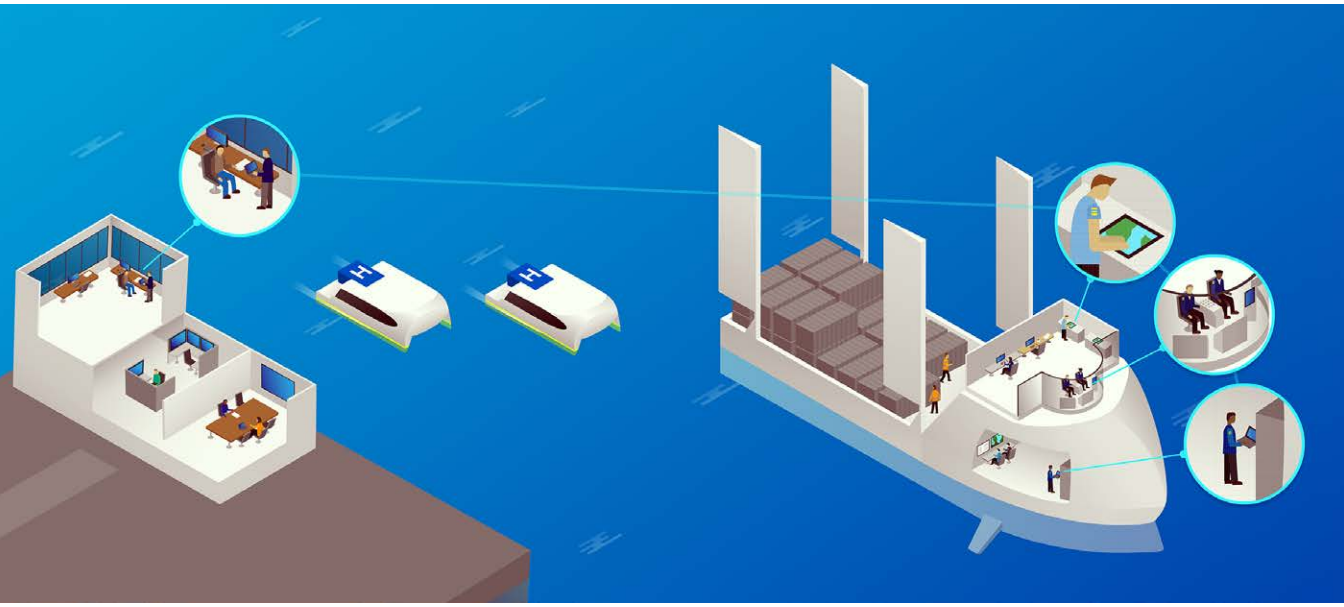
Soundings

Developing User Interface Standards for Energy-Conscious and Safe Maritime Operations
The ongoing efforts towards decarbonizing the maritime industry are creating unprecedented opportunities for innovation in ship technology and operations. New technologies introduced into already complex and safety-critical maritime workplaces can create both foreseen and unforeseen consequences on work systems and its operators (see Further Reading #1). Any new technology added to an existing operational context impacts safety because mariners must simultaneously manage and operate new green shipping systems and protocols, while continuing to manage and execute traditional navigation and operational ship tasks. Due to the diversity of the systems in use on board ships, mariners need to invest considerable effort into developing operational literacy across differing systems and contexts (see Further Reading #2). The introduction of new technologies on board inevitably requires the need for differing skill sets and competencies, updated education and training programs, differing work task considerations and prioritization, and potentially increased cognitive workloads.

One critical area of research in this field is the focus on how new solutions are integrated into current work systems and work practices, both on board individual ships, as well as on a more macro level, such as fleet management and shoreside monitoring of one or multiple ships and their operations. There is currently no guidance or regulation to support the design of user interfaces for energy-conscious decision-making within the larger scope of safe and efficient maritime operations. If new systems are difficult to use, people will not be able to take advantage of their full potential and impact, leading to a gap between theoretical performance of new innovations and the actual performance achieved in the realities of complex socio-technical systems under real-world operations. Furthermore, there is a threat that maritime decarbonization efforts led by introducing new technologies may contribute to new safety challenges. This double threat is aggravated by a current lack in design precedence, design guidance, and design regulation supporting how to design for safe and energy conscious operations in the maritime domain.

To address this challenge, the OpenZero project (full project name: *OpenZero – Digital User Interface Design for Energy-Conscious and Safe Maritime Operations*) is looking to an alternative approach based on user-centred design and open innovation. OpenZero will focus on the end user's perspective and experiences of operating green ships, with the goal to enhance mariners' abilities to learn and safely operate new green technologies to their full theoretical potential. OpenZero will apply state-of-the-art research in user-centred human-computer interaction, user experience behavioural design, and human factors approaches to analyze the end users and context of use requirements to develop an open user interface design system for energy-conscious and safe maritime operations.

As ocean industries are global, heavily regulated, and traditionally slow to adopt new initiatives and changes, there is typically a gap between technological development, research production, and results adopted in the real world. An open innovation approach can help reduce and remove barriers that can impede application and adoption. OpenZero currently has 30 project partners consisting of system developers and integrators, regulatory bodies and authorities, academic and research actors, design consultants, and ship owners. Among these partners are industry



leaders, and together these companies have delivered systems to over 50,000 ships worldwide, accounting for approximately one half of the current global fleet.

OpenZero will build upon a comprehensive and streamlined framework for maritime design developed progressively over the past ten years, a state-of-the-art design guideline crossing all maritime workplaces: the OpenBridge Design System (see Further Reading #3). OpenBridge consists of a large library of design components specifically made for maritime workplaces. The entire library is open source and free. Its components can be used to create many current and future maritime digital user interfaces (e.g., ECDIS, conning, radar, alerts and alarms, fire systems, thruster, and button design, etc.) that adhere to current maritime regulations. The OpenBridge system goes beyond screen-based user interface design and includes support for multi-screen systems, physical interaction devices (e.g., thruster and button design and layout), and entirely new interface technologies, such as augmented reality and remote monitoring and control. OpenBridge is currently in use globally with over one thousand maritime companies having registered to access it. There are regularly new products reaching the market developed with the OpenBridge system, both by our direct industry partner collaborators, as well as maritime companies not officially affiliated with the OpenBridge consortium.

By leveraging the OpenBridge Design System, OpenZero research and development results will benefit from a large body of design case-based precedence as well as established tools and methods for collaborative user centred design (see Further Reading #4). Most importantly, all outputs from OpenZero will be directly integrated into a design system that promotes design consistency across differing systems and context of use. All current and future OpenBridge developers will get direct access to OpenZero results for free, while our open innovation

approach ensures design guidance from the project is available to all interested stakeholders. Furthermore, the relevance of OpenZero outputs may extend beyond the shipping and maritime industries and add value to other transport and safety critical domains or beyond.

The OpenZero project runs from 2024-2028 and is funded partially by the Research Council of Norway through its Collaborative and Knowledge-Building Project Program. More information on OpenZero and related research and development maritime projects can be found online at the Ocean Industries Concept Lab.

Further Reading

1. Mallam, S.C.; Nordby, K.; Johnsen, S.O.; and Bjørneseth, F.B. [2020]. *The digitalization of navigation: examining the accident and aftermath of US Navy Destroyer John S. McCain*. In: Proceedings of The Royal Institution of Naval Architects Damaged Ship V, 55-63. ISBN No: 978-1-911649-05-2.
2. Nordby, K.; Mallam, S.C.; and Lützhöft, M. [2019]. *Open user interface architecture for digital multivendor ship bridge systems*. WMU Journal of Maritime Affairs, 18(2), 297-318. DOI: 10.1007/s13437-019-00168-w.
3. Nordby, K.; Gernez, E.; and Mallam, S. [2019]. *OpenBridge: designing for consistency across user interfaces in multi-vendor ship bridges*. In: Proceedings of Ergoship 2019, pp. 60-68. Western Norway University of Applied Sciences, Haugesund, Norway. ISBN: 978-82-93677-04-8.
4. Mallam, S.C.; Nordby, K.; Haavardtun, P.; Nordland, H.; and Westerberg, T.V. [2021]. *Shifting participatory design approaches for increased resilience*. IISE Transactions on Occupational Ergonomics and Human Factors, 9(2), 78-85. DOI:10.1080/24725838.2021.1966131.

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