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CML

BEYOND



# Ergonomic design of navigation systems



# BEYOND Toolbox

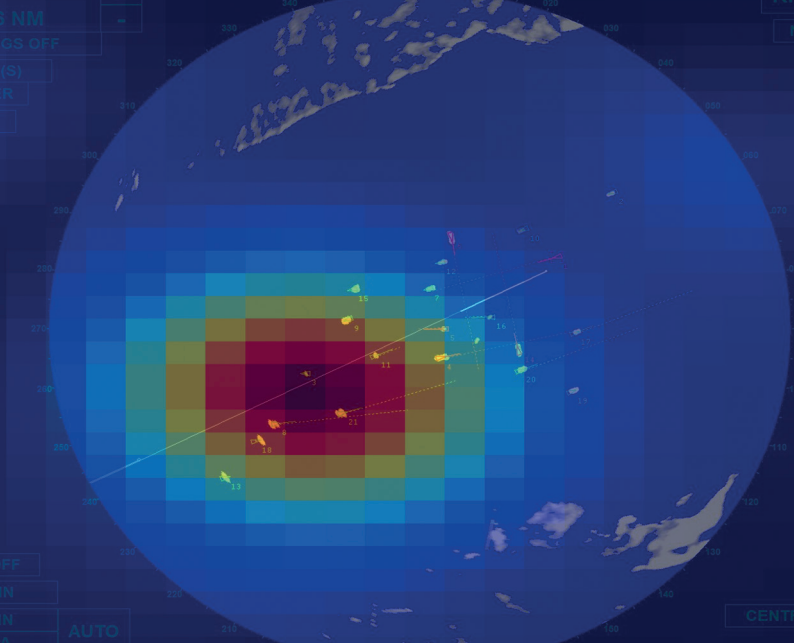
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The growing digitization and integration of ship operations, navigation, communication, safety equipment and systems have expanded the functional scope of modern navigation systems. However, this has also increased the workload for the crew, making it more challenging to cultivate situation awareness (SA) and make appropriate decisions, particularly in critical situations.

An appropriate HMI (Human Machine Interface) for the user in a maritime context should be intuitive and present information clearly and concisely to support SA. Key features include ease of use, reliability and accessibility of critical information in a way that reduces cognitive load. Effective HMIs should integrate seamlessly into the operator's workflow, enabling rapid interpretation and response to changing conditions. In addition, feedback mechanisms are essential to inform the operator of system status and necessary actions.

In the research project BEYOND – Building an Experience to Yield Optimal Nautical Displays – researchers at Fraunhofer developed and validated a comprehensive toolbox for the evaluation of maritime HMIs.

The toolbox consists of several components – navigation scenarios for ship handling simulators, a tool to present and evaluate SA questions based on the scenarios (SA tool), a tool to automatically load, start and freeze the scenarios running on the simulator (simulation control tool), and questionnaires for subjectively rate the simulator's HMI. On top of that, eye-tracking helps to identify where navigators focus their attention, how they interact with the interface, and detect any usability issues. The evaluation includes objective assessment through the integration of the SAGAT (Situation Awareness Global Assessment Technique) method as well as subjective assessment using standardized questionnaires. The SAGAT method is a tool used to



*Eye tracking reveals which information the viewer perceives as either important or eye-catching.*

evaluate situational awareness by freezing a simulation at random intervals and querying participants about their perception, comprehension, and projection of the current situation. This technique helps to measure how well individuals understand and anticipate elements in their environment during complex, dynamic tasks. SAGAT enables a comprehensive assessment by incorporating subjective assessments that capture the nuanced aspects of navigators' awareness that purely objective measurements may miss.

With the BEYOND toolbox the effectiveness of new HMI designs can be evaluated in various maritime scenarios before they are implemented in real operations. These pre-tests can ensure that the interfaces meet the cognitive needs of operators under different conditions, such as bad weather, high traffic or emergency situations. Furthermore, incorporating the BEYOND toolbox into simulation-based training programs can help identify specific areas where pilots have difficulties with situation awareness, allowing for targeted improvements in the training curriculum.

## Contact

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