HOW TO IMPROVE ALARM MANAGEMENT SYSTEMS FOR SUBMARINES

POPULAR SCIENCE SUMMARY
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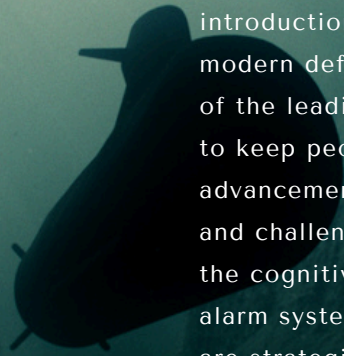
Submarines have evolved significantly since their introduction in 1620, becoming vital components of modern defence. The Swedish company Saab is one of the leading actors of submarine innovation, aiming to keep people and society safe. However, advancements in technology bring both opportunities and challenges. One of the challenges Saab faces is the cognitive load for its users in managing complex alarm systems flooded with excessive alarms. There are strategies to optimise alarm management systems, aiming to improve user experience and ensure effective decision-making during critical operations. What if the key to safety lies not in adding more technology, but in refining how we interact with it?

PROBLEM

When developing submarines, various systems must work together seamlessly, as any error by a person operating the control system can have fatal consequences. Effective management of these systems and the alarms is therefore crucial. Currently, in large complex digital alarm systems, thousands of alarms can be triggered in a short period, resulting in an alarm flood. These alarm floods, typically displayed as a growing list of text, can overwhelm users. It causes mental stress and increased cognitive load as the users try to make quick decisions to prevent severe outcomes.

MOTIVATION

Alarm flooding is a common problem in advanced alarm systems and has previously been studied in fields such as nuclear power plants and military ships. The safety risk described in these studies makes it even more crucial to evaluate and enhance the user experience and interface in submarines, where high-pressure environments are the norm. Hence, a user study helps uncover the daily challenges faced by operators, enabling the development, testing and evaluation of new innovative solutions. The goal of these solutions is to help users improve their ability to process alarm data, prioritize critical alerts and take correct actions to prevent disasters.

SOLUTION

The solutions explored in the thesis study were based on interaction design theories in addition to user-centered design principles:

- Alarm List:
  - An improved alarm list using grouping, combining tab-in and drop-down formats to reduce visual clutter and overwhelming data. Grouping alarms helps reveal patterns, highlights the root cause of the alarm flood and simplifies prioritization.
- Three Graphical Overview Tools:
  - A submarine map showing the locations of triggered alarms.
  - A timeline illustrating the sequence of events.
  - A time-circle graph designed to analyse historical alarms from previous weeks.

This master thesis study included a full design process in combination with an extensive literature study. The results were developed through three prototypes over three iterations and from usability tests with users from Försvarsmakten.