# Multimodal perceptually rich interfaces in transport

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**Abstract**
In this paper, I describe research topics in my PhD-project *Multimodal perceptually rich interfaces in transport*. The project aims at exploring the use of multimodal interfaces, focusing on non-visual sense impressions in complex socio-technical systems as the operation of high speed crafts.

## INTRODUCTION

My PhD-project *Multimodal perceptually rich interfaces in transport* is part of an interdisciplinary group looking at the development of user interfaces bridge operations in high-speed crafts.

Norway has had one of the world's biggest fleet of high-speed crafts since the middle of the 1990ies. A typical Norwegian high-speed craft has an operational velocity of about 30 knots and the Norwegian Navy operates a missile torpedo boat with a maximum speed of 60 knots. The challenges for the development of user interfaces for high-speed crafts, are as in other transport areas, numerous. The high speeds require that the operators quickly understand the situation. Complex dynamic environments, such as exposed coastline, nocturnal navigation, insufficiently surveyed and marked shore and locally, occasional high density of traffic makes navigation demanding. The consequences of accidents can be catastrophic.

Visual information has, both in product design and in interface design, a vital role. Visual impressions are comprehensive and give us precise information on this dimension of the world. Still, we know that other sense impressions, in other ways, are significant for the way we perceive and understand products and user interfaces. The sound of a car door slamming shut, the simultaneous shake and the smell of the car is an example of important impressions of for example the quality of a product. Physical, touch properties are important to certain forms of interaction (MacLean 2000), and can be expected to have a potential also in the development of user interfaces in high-speed crafts.

## COMPLEX SOCIO-TECHNOLOGICAL SYSTEMS

Systems where people cooperate on a set of tasks, assisted by technology, are often referred to as complex socio-technological systems (Vicente 1999). The operation of crafts the size of high-speed crafts are examples of such systems. The more traditional approach to complex socio-technological systems has tended to focus on the technical aspects of the systems. The rate of technological development within navigation has increased, and resources spent on technological development have to be followed by an extended training of the navigators using the systems. The convergence of formerly separate systems (navigation with the help of radar, satellite and maps) makes demands on the operators' understanding of the system. It is therefore necessary to question and challenge the perspectives applied to current developments.

## MULTIMODAL, PERSEPTUALLY RICH INTERFACES

Research on human-technology interaction has traditionally been related to the metaphor of the human cognition as a computer. Succeeding this classical cognitive model several new approaches offers alternative perspectives (Hoff, Øritsland Bjørkli 2002; Dourish 2001). A common feature of these is that they are based on an ecological dynamic relationship between the human and its environment. The sense of touch and kinaesthetic seems to be the sense impression most dependent on such a perspective.

Several research findings have shown that the different senses are more tightly coupled than earlier believed, and that they partake in an overlapping interplay (e.g. Ernst & Banks 2002 ; Shimojo & Shams 2001). There is a potential in utilizing this when designing products and interfaces (Monö 1997). To make use of different senses is not at all a new design activity, but rather a natural part of the materialising aspect of design practice. Still, we see that this is not the case in the many electronic products produced, where input and output are reduced to simple buttons, digital screens and the occasional sound signals.

The various sense impressions can strengthen and overlap each other, but they can also allow a more complex, nuanced and therefore "rich" dialog with the user. This quality in an interface may be called "perceptually rich" (Hoff 2004). Although many within the field of human factors acknowledge the significance of perceptual richness, few studies have been carried out on the subject. Little is known about suitable theories and methods for the development of rich interfaces. This gives us the following challenges:

1. Such interfaces are perceptually complex. Because of the complex interaction between the sense impressions and experience it is a research methodical challenge to analyze and acquire knowledge about the mechanisms of such an interaction. Vicente (1997) advocates an alternation between controlled laboratory experiments and qualitative,

descriptive field studies. We have to search for an answer to the question of *How to study such interfaces?*

2. Interfaces utilizing different sense modalities are a technological challenge. There exist interfaces that make use of haptics (force-feedback), theatrical lighting, surround sound and even a small number of scent interfaces. Still these are few and expensive, which makes the experience data limited. This leaves us with the question of *How to prototype such interfaces?*

3. The research on human factors has been greatly influenced by computers. Through Human Computer Interaction (HCI) focus has been put on software and how to utilize the available hardware through screen interfaces without changing the physical constraints and exploiting perceptual richness. There are nevertheless appearances of alternative, less established perspectives, such as tangible and ubiquitous computing (Dourish 2001) and ambient design. We are confronted with the question of *What are the criteria for successful design of such interfaces?*

Although there are few scientific publications on perceptually rich interfaces there is probably a significant amount of experience among interface developers. This experience might exist either as tacit knowledge or as internal information within the company or industrial sector. The car industry is for example interested in sound and scent design and has recently begun exploring the concept of dynamical lighting of the compartment (theatrical lighting). Audi has also a *Control Haptics Team* responsible for how the car models feel.

## THE PhD-PROJECT

The primary goal of the PhD-project is increased knowledge about the consequence and utilisation of perceptual richness of interfaces. Special consideration will be done to the physical, touch based properties and the utilisation of multimodality in complex socio-technological environments as high speed crafts.

The topic will be handled both theoretical and through practical exploration and prototyping. The theoretical foundation for user interfaces is generally related to cognitive psychology and various, partly overlapping research areas in the HCI-tradition, Cognitive Work Analysis (CWA), Usability-engineering, Computer-Supported Cooperative Work (CSCW) and Cognitive Engineering. Since multimodality and perceptual richness generally are not covered by established fields one also has to look into other fields.

The practical exploration will vary between quick prototypes and more complex systems. These will be tested in both controlled laboratory experiments and less controlled field studies.

To face the challenges of user interfaces in high-speed crafts there is also a need to obtain insight into navigation and operation of these. Huthcins (1995) has published a series of field studies of the socio-technological aspects on naval vessels. In addition to such studies this PhD will include participatory observations and video analysis.

The project takes part in an interdisciplinary research group consisting of Thomas Hoff and Cato Bjørkli with background in psychology, Bjarte Knappen Røed with experience as a navigator and expertise in nautical science, and myself with a product design engineering perspective. We have an agreement with the producer of electronic nautical equipment, Simrad on the development of future prototypes as well as close contact with the transportation company HSD and the Norwegian Navy.

## CONCLUSION

The step from theory to design implications is often troublesome. If my PhD-project is to have practical relevance this has to be overcome. The interdisciplinary relations to the rest of the research group are an advantage in this regard. Similarly the group's cooperation with digital and nautical industry contributes to ensure relevance and evaluation of the results.

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