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Involving users in a ship bridge re-design process using scenarios and mock-up models

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ABSTRACT

The context for this study is the maritime domain and the design of shipboard workspaces. Due to the globalized nature of shipping, the traditional approach to a participative ergonomics process can be a logistical challenge since stakeholders like designers, manufacturers and operators are often scattered both geographically and organizationally. The participative design study presented in this paper addresses this challenge by exploring the ability of three types of simple three-dimensional (3D) models to act as mediating objects for representative users in order to elicit design feedback in a use scenario-workshop format. The study found that all three types of 3D models, when coupled with a scenario description, elicited several types of useful design feedback that served not only as direct input to changing proposed design parameters, but also as an unprompted long-term learning opportunity for the design team to gain insight into the lives and challenges of their users, who both work and live on board. *Relevance to industry:* The paper presents a procedure for a participatory design process in the maritime domain where the involved stakeholders are geographically and organizationally dispersed. Mock-up models coupled with use scenario descriptions elicited useful design feedback and an unprompted long-term learning opportunity for the design team.

1. Introduction

Frequently, ships are built without a designated crew in mind, thus there are no obvious end-users to appoint to a user-centred design process. Consequently, it becomes necessary to engage other *representative users* as domain experts. The benefits of involving operators in the design and development processes of new work systems, workspaces and equipment are well established (e.g. Broberg, 2010; Eklöf et al., 2004; Koningsveld et al., 2005; Launis, 2001; P. Vink et al., 2006). The operators as end-users bring important knowledge about processes, tasks, equipment and potential risks into the development process; knowledge that contributes to both the quality and acceptance of the design outcome. A participatory approach to ergonomics is believed to create a sense of ownership and commitment to agreed-upon solutions, more rapid implementation of workplace changes, and increased learning within the organization (e.g. Mallam et al., 2015; J.R. Wilson and Haines, 2001; P. Vink et al., 2006). The earlier in the development process the intended operators can be involved, the greater the possibility to improve the work environment in a cost-efficient way (Hendrick, 2003). It is always costly and not always possible to make alterations once the actual construction has started.

To this end, the present paper explores the types of feedback that can be elicited using model representations to support operator involvement in ship-bridge design evaluation. Focus is placed on the ability of three types of simple three-dimensional (3D) representations – 1) a 1:1 plywood scale model, 2) a 1:16 foam-board scale model, and 3) a digital CAD-model – to act as *mediating objects* (Broberg et al., 2011) for representative users with limited work experience and engineering skills in order to elicit design feedback in a use scenario-workshop format.

The context for this study is the maritime domain and the planning of new or altered shipboard workspaces, where the traditional approach to a participative ergonomics process can turn

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into a logistical challenge by assembling a collaborative team of designers, manufacturers and operators. Due to the globalized nature of shipping, these stakeholders are often scattered both geographically and organizationally. Furthermore, to the extent that seafarers as end-users do participate in the planning and designing of workspaces onboard, this is traditionally addressed by an invitation to comment on technical drawings, chiefly in the form of two-dimensional paper drawings. With different educational and professional backgrounds, the seafarers' command of technical drawings and ability to communicate in engineering terms with designers can vary greatly, thus further complicating a collaborative design process. At the same time, the 2D paper representation is familiar and therefore usually taken seriously. It is therefore necessary to explore and develop complementary means to elicit, communicate and utilize the seafarers' knowledge and experiences into the early stages of design and development process of shipboard workspaces.

The range of organizations and decision-making structures involved in the shipping industry can be illustrated by the example of the ill-fated oil tanker Prestige (CEDRE, 2014), that broke up and sank off the north cost of Spain in 2002, spilling 64,000 tons of oil. The Bahamas-flagged Prestige was built in Japan, owned by a Liberian company, managed by a Greek operator, chartered by a Russian-owned Swiss-based oil trader, classed by American Bureau of Shipping and insured by the mutual London P&I Club. On her last voyage, Prestige was carrying Russian heavy fuel oil bound for Singapore. The multinational crew consisted of 27 seafarers from Greece, Philippines and Romania, using English as the working language on board. With such a multitude of stakeholders of different nationalities, the regulation of the shipping industry is inevitably complex with intra- and inter-organizational relationships within and among various members of the global maritime community.

2. Purpose and aim

The purpose of this study is to investigate the potential of using 3D-representations as enablers for involving seafarers in a participative design process. Based on the established success of using 3D representations in other product design domains, it is believed that also the ship-building domain can benefit from using 3D representations as a feasible, useful, effective and inexpensive way to elicit use-related design feedback. The aim of the paper is to examine whether *representative users* (as opposed to end-users) are able to generate useful feedback on design parameters using simple 3D representations, and what kind of feedback a designer can expect from using a combination of scenarios and 3D models.

3. General framework of participative ergonomics and workspace design

Participative ergonomics and workspace design are disciplines based on the acceptance of the employee's expertise on how and within which context work tasks are performed. The participatory approach establishes design processes that enable employees to influence the design so that it is compatible with their goals and beliefs (Eason, 1995). The overarching aim is to improve working conditions, ergonomic fit and acceptance of the workplaces (J.R. Wilson and Haines, 2001). Involving those who are affected by the outcome of a design process is a way to exploit user knowledge and experiences of work and to fulfil user requirements and needs. Moreover, a participatory approach generates feelings of ownership and commitment to the solutions among the specific target group of a designed product or system (J. R. Wilson and Haines, 2006), often referred to as the *end-users*.

Thus, 'know thy users' is a popular mantra in ergonomic design research and practice, pointing towards issues of face validity and optimal end-results. Often, this is accomplished through observations or direct involvement of either the end-users or *typical users*. These persons are not necessarily the same persons that eventually will use the finished product or systems, but may share some characteristics and background with the intended end-users, such as age, sex, education or job experience.

A *mediating object* is any material object or immaterial aspect that can be comprehended and interpreted by all participants. Mediating objects serve to enable connections and discussions between different participants and work practices in a collaborative design process, for the purpose of eliciting user needs and requirements (Engelbrektsson, 2002). It may be a representation of the product or workspace, ranging from simple sketches to fully functional prototypes. It can also be mental, a thought or an idea that may support dialogue and the transformation of an object into an outcome (Hiort af Ornäs, 2010). The degree of realism in a mediating object does not necessarily predetermine the detail level of feedback from the user (Söderman, 2002). Rather, the users' previous knowledge and experience of different representations influence their capabilities to focus their feedback on the actual design proposal, rather than the model itself.

The outcome of a participative design process in terms of user requirements can be more or less accessible. Karlsson (1996) divides user requirements into three categories; captured, elicited, and emergent. *Captured user requirements* are easily accessible; the users are already aware of and have reflected over the problems. If a designer simply asks users for requirements, these are the ones received. By creating systematic breakdowns, e.g., by probing with questions or by using different mediating objects such as mock-ups, prototypes or scenarios, requirements can be *elicited*. *Emergent requirements* are impossible to articulate before a new solution is tried. Conversely, the value of the latter two more elusive types of requirements may require greater skill or better tools on the part of the designer, for it to be possible to access them as design input.

4. Research design

The research methods in this study consist of observations, an on-site questionnaire and focus group interviews. A proposed design of a ship bridge workstation (a limited section of the whole bridge) was evaluated by the participants using four different representations of the bridge; one 2D drawing and three different 3D models. This procedure was used to pre-empt participants' feedback on a familiar basis, since 2D drawings are commonly used as a starting point for evaluation of a ship design (as evidenced by Mallam et al., 2015). Three different use scenarios were presented in writing to trigger each participant to reflect on the proposed design as an enabler for the implied tasks. Each evaluation was first made individually on the questionnaire before being discussed in groups. The participants were given no instructions about what kind of feedback was desired, in order to examine what unprompted reactions could be obtained using the models.

All focus group material and discussions were written, presented and held in Swedish. Translations into English for the benefit of this paper were made carefully based on the verbatim transcripts in agreement between the three authors, one of whom is a native speaker of both Swedish and English. The order of shown models was alternated for each group to cover all possible cases. This was to eliminate the effects of bias or preference caused by a) the order that the 3D representations were shown in and b) the effect of fatigue on the participants' motivation to contribute to discussions as the experiment progressed.