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Radical design processes for systemic change

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Abstract

To enable radical design in safety-critical collaborative workplaces, there is a need to engage a wide range of stakeholders. This paper reports on three design presentations carried out with the purpose of enabling systemic changes necessary to carry out a complete redesign of current ship bridges for advanced marine operations. The presentations showed possible future bridge designs developed from an extensive design-driven research and development project. The presentations were held inside the company commissioning the innovations and publicly at industrial meeting places where customers, sub-suppliers and regulatory authorities meet. We present the objectives, target groups, our strategy, the means of presentation and the results. Our preliminary work suggests there is a close relation between the presentations and the research and development project's ability to introduce radical innovations to marine industry. The presentations have aligned stakeholder expectations of future bridge development and as such prepared the community for systemic changes. We suggest the three presentations are examples of how design presentations can serve as systemic interventions that prime social systems so as to more easily accept and support radical innovation processes.

Introduction

In a modern offshore vessel, up to 40 different systems are physically installed on the ship's bridge, each with different physical and user interface designs. The result is that the ship bridge offers an unsatisfactory working environment with the risk of accidents with potentially disastrous consequences. Today, it is technologically possible to develop integrated ship bridges where users can interface with a more consistent and easy to use working environment. However, to enable such a change, one must engage the diverse stakeholders involved in the development of ship bridges. Therefore, to be able to radically redesign current ship bridges, we need to not only carry out user-centred approaches, but to also involve the complex system of all stakeholders. In this paper, we describe how the Ulstein Bridge Concept design research project has influenced a system of stakeholders through three carefully planned design presentations and discuss how the presentations can be seen as system interventions in light of Meadows' (1999) work.

The Ulstein Bridge Concept design research project

Ulstein Bridge Concept (UBC) is a design driven research and development project that aims to radically change ship bridges of offshore service vessels, i.e. the place from which the Captain and the Deck Officers control the ship. Offshore service vessels are typically commissioned to service the offshore oil industry. Platform supply vessels are a typical example of offshore service vessels. They are designed to bring cargo to and from offshore oil platforms. Other examples are anchor handling tug supply vessels, mainly used to tow rigs to a location and anchor them up. Common to all these vessels is that they carry out critical operations in very difficult environmental conditions.

The design scope of UBC involves everything including room layout, furniture design, fundamental interaction techniques and detailed screen layouts. To do so, we use a practice-based design research approach referred to as *research by design* where "the explorative, generative and innovative aspects of design are engaged and aligned in a systematic research inquiry" (Sevaldson, 2010, p. 11).

The UBC project is unique in that it uses an innovation process where normally confidential innovation work is regularly shared with the general public. The presentations were carefully planned according to the strategic needs of the on-going innovation work. Thus, the process can be seen as a semi-open innovation process where strategic elements from a larger innovation process are shared with the purpose of enabling systemic change that can strengthen radical change in practice.

The project is funded by the Research Council of Norway's MAROFF programme and the Ulstein Group, with participants from the Oslo School of Architecture and Design (AHO), Ulstein Group, Kwant Controls and Ålesund University College (HiALS). The multidisciplinary research and development team consists of researchers and designers from the fields of interaction, industrial, sound and graphic design. In addition, the team consists of experts in human factors and engineering. The multidisciplinary team collaborates to develop detailed concepts that show in practice what future ship bridges may look like. The UBC project followed a pre-study called the Ulstein Bridge Vision (UBV) carried out in 2010. UBV was a design-driven innovation project financed by the Norwegian Design Council and Ulstein.

Analysing design presentations as system interventions

The design deliverables of the UBC project described in this paper are analysed using systems thinking, which involves a holistic view of the world and considering parts as components of a whole, i.e. the *system*. We have specifically used the concept of systemic interventions to describe and analyse the role design deliverables have played in influencing the systems of the offshore ship industry. An intervention can be defined as a purposeful action by an agent to create change (Midgley, 2000). Different ways of intervening with a system will result in various effects, and Meadows' (1999) concept of leverage points can help identify the most effective and powerful interventions. According to Meadows, leverage points are 'places within a complex system (a corporation, an economy, a living body, an ecosystem) where a small shift in one thing may produce big changes in everything'. Using basic concepts from system dynamics including stocks, flows and feedback loops, Meadows describes twelve places to intervene in a system in decreasing order of effectiveness. In this paper, we briefly discuss how three interventions carried out in our project relates to Meadows' leverage points.

Systems affecting bridge design

A ship's bridge does not function in isolation, and there are many systems that affect a design project for offshore industries. To describe the systems affecting a ship's bridge design, we can start by looking at one of the smaller parts of the ship's bridge, an individual human machine interface (HMI) of a particular piece of equipment, e.g. a chart system. Figure 1 gives a non-exhaustive overview of the systems that influence the design of an individual HMI.

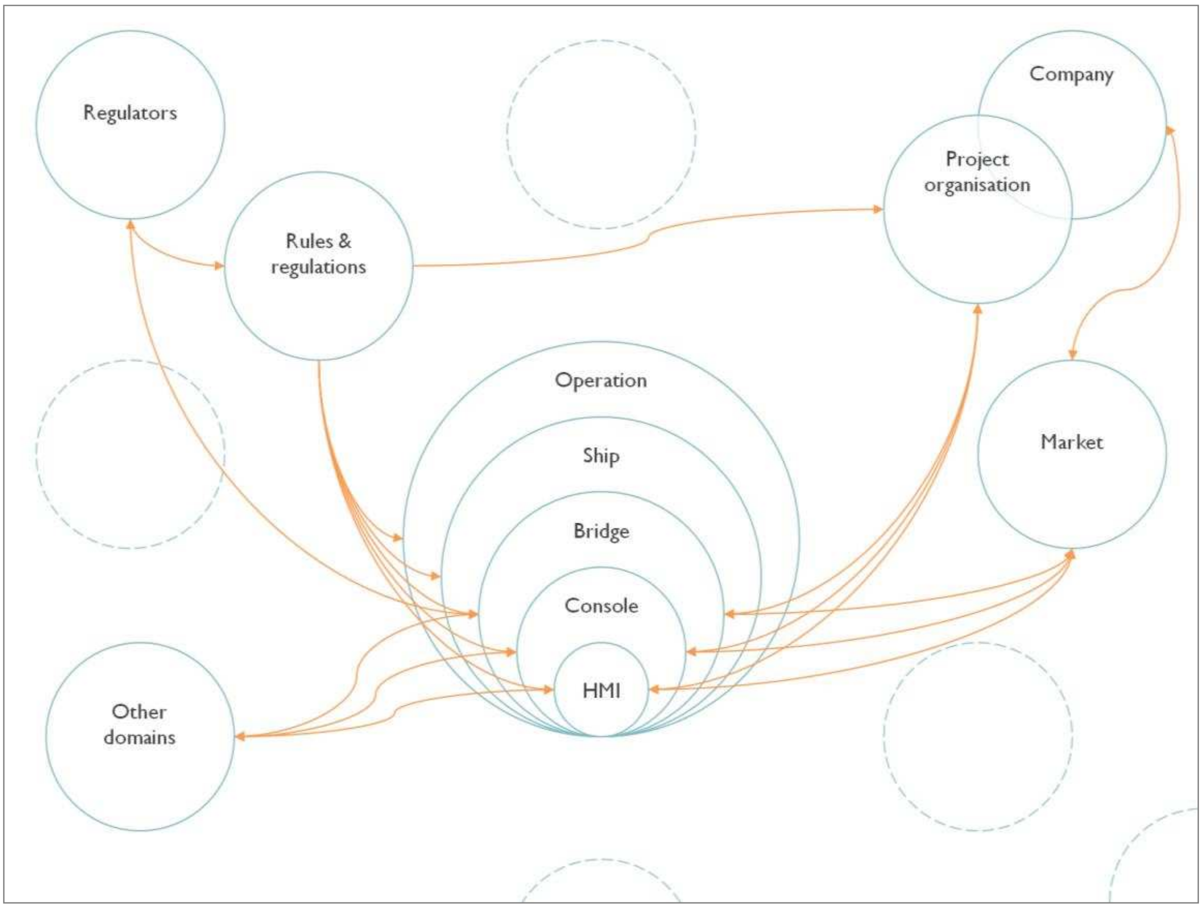

Figure 1: Systems affecting the design of a human machine interface on the ship's bridge. The dotted circles indicate that the illustration is not exhaustive, but that other systems also have influence.

An interface is not isolated function and is usually part of a console consisting of other interfaces. The console is part of the bridge, which does not only serve the function of being a ship's control central but also serves a social function for the crew. The bridge is part of a ship that includes many other systems: technical systems that make the ship operable, human-activity systems needed to operate the ship and social systems, and so on. And the ship is used in operations that involve other actors including, for example, rigs, other ships, and onshore organisations.

The offshore ship industry is highly regulated because of its high-risk nature, and regulations affect the systems all the way from design of the interfaces to how the operations are carried out. The rules and regulations are set at different levels, including:

- At an international level by inter-governmental authorities (e.g. the International Maritime Organization) and by classification societies
- At a national level by politicians and regulatory authorities (e.g. the Norwegian Maritime Authority) both of the flag state (the country in which the ship is registered) and of the country in which the ship operators
- In the contract with the shipping company's client (e.g. an oil company)
- In the internal procedures of the shipping company

When we design for the offshore ship industry, we also need to consider the systems we design within it. A design project is part of a company's organisation that affects and is affected by the design project. In our case the design project is placed partly within Ulstein's organisation and partly within the organisation of the Oslo School of Architecture and Design. We also have collaborative partners involved that affect and are affected by our design work. The market and competitors within the offshore industry as well as other domains also affect and are affected by a new ship bridge design. The challenge addressed in this paper is how can we make radical innovation possible in these systems?

Three interventions

The design interventions were carried out from 2010 to 2013. Here, we present the objectives and target groups of the intervention, our strategy, the means of presentation and the results.

1. Ulstein intervention

In the start of 2010, the Ulstein Bridge Vision pilot study was carried out with limited funding. The aims for the project were to develop a vision for future ship bridges that could help steer future development of ship bridges. The results of the project were presented internally in Ulstein power and control autumn 2010.

The purpose of the first intervention was to demonstrate the design results from the pilot study to Ulstein. It was also used to strengthen the relationship between Ulstein and AHO and serve as a springboard for further collaboration by offering a common understanding of future possibilities. The intervention was carried out as a traditional one-way communication where the bridge concepts were presented though 3D animated renderings and a slideshow demonstrating the design concepts.

The presentation was well received at Ulstein and resulted in an agreement between AHO and Ulstein to collaborate further. To extend the collaboration, the companies jointly developed a three-year research project together with Kwant Controls and Aalesund University College. The project Ulstein Bridge Concept started in April 2011 and was partly funded by the Norwegian Research Council and Ulstein Power & Control.

In retrospect, we were surprised by the power of the design interventions carried out at Ulstein. The presentations were initially developed for Ulstein Power & Control, but the presentation started to live its own life inside the Ulstein Group, finally reaching top level management and the Ulstein family that owns the Ulstein Group. This resulted in a strong, strategic rooting of the project not only at Ulstein Power & Control but also at the other subsidiary companies of Ulstein Group.

2. ONS 2012 intervention

The second intervention was carried out on 29 August 2012 at the ONS trade fair. ONS is a major international event for the energy industry held each year in Stavanger. Our objectives were to create interest for the project in the industry, to communicate the project's ambitions, to position Ulstein as an innovative company and to attract partners for further development of the concept. The presentation was carried out as a one-way communication in the form of a professionally produced film presenting a version of the future ship bridge design.

This was the first external presentation by the collaborating partners and the film[1] was launched by Trond Giske, the Norwegian Minister of Trade and Industry, Tore Ulstein, the head of marketing and innovation in ULSTEIN, at a press conference hosted by the Ulstein Group and the Norwegian Design Council. After the press conference, the film was shown at Ulstein's stand at the fair and also published online. Publicity for the film was further supported by press releases from Ulstein, the Oslo School of Architecture and Design and the Norwegian Design Council.

The intervention generated much interest in offshore and related industries and we received attention from national and international maritime oriented media and a number of potential national and international partners contacted both Ulstein and the Oslo School of Architecture and Design.

[1] The film 'ULSTEIN BRIDGE VISION' is available from http://ulsteinlab.com/

In the aftermath of the intervention, the project won two national innovation prices: a regional and a national prize for the best Norwegian innovation idea of 2012. The feedback generated by the interventions contributed significantly to renewed support in the project at Ulstein and the Oslo School of Architecture and Design. Additional resources were added to the project and we were given permission to go ahead with a third intervention. Moreover, the Oslo School of Architecture and Design committed to design for ocean industries and established one new full-time position with the task of setting up a permanent research group for ocean industries. The research group, called the Ocean Industries Concept Lab, are currently engaging in several research projects.

We also experienced that the project was used in ways we did not anticipate. For example, it was used as an example of desired innovation by major Ulstein competitors. It has been used by engineers working with software safety as a probe for discussing technical challenges with ensuring reliable software. A major supplier of control rooms has used our design as an example of innovative control environments in discussions with one of the world's leading suppliers of process and automation technologies. Multiple politicians have used our project as an example of what Norwegian innovation is capable of. And the Norwegian Design Council uses our project to promote design-driven innovation.

3. Nor-shipping 2013 intervention

The attention of the second intervention resulted in new expectations, from regulatory authorities, competitors, users and other stakeholders, and the third intervention was designed to meet these expectations and to show that Ulstein was capable of fulfilling the future vision. The intervention took place in June 2013 at Nor-Shipping, a major international biannual trade fair for the maritime industry. The main objective of the intervention was to create trust that the vision is achievable and for Ulstein to attract committed partners.

This intervention consisted of a full, interactive installation demonstrating many of the concepts shown in the second intervention. The demonstrator was exhibited at Ulstein's stand at the fair and visitors were allowed to test the concepts. The intervention received a lot of positive attention and stakeholders ranging from end-users to decision makers and regulatory authorities visited the demonstrator. The result of the intervention was that both Ulstein and the Oslo School of Architecture and Design positioned themselves in the industry as leading innovation actors. After the fair, we received more interest from potential collaborators in the project.

Summing up the three interventions

The three interventions aimed at different target groups and had different objectives and, therefore, used different strategies and means of presentation. While the first intervention aimed at engaging internal actors, the second and third ones aimed at external actors. The second intervention told the industry about our project and created interest and the aim was of the third was to create trust in that we are capable of delivering what we envisioned in the second intervention. Table 1 sums up and compares the three interventions.

Table 1: Summary of the three interventions.

	1st intervention	2nd intervention	3rd intervention
Target	Internal Local (closed)	External Local & global (web)	External Local (targeted)
Objectives	Create interest internally Create commitment Establish a common goal for Ulstein and AHO	Create industry interest Communicate the project's ambitions Position Ulstein as an innovative company Attract partners	Create trust in that the vision is achievable Get committed partners
Strategy	One-way communication	One-way communication	Two-way communication
Means of presentation	3D visualisations and presentation	Professional film production Press conference with ”buzz-makers”	Interactive demonstrator
Results	Commitment from Ulstein and AHO New design research project	Interest Innovation awards Further commitment New expectations	Positive feedback and additional interest Position as innovative actors in the offshore ship industry

The interventions in relation to systemic leverage points

Leverage points are places where a small shift in one thing may result it big changes in everything (Meadows, 1999). Meadows suggested twelve places one may intervene in a system that will have different degrees of effectiveness (see sidebar). In this section, we briefly discuss, in relation to four of Meadows' leverage points, how our three interventions affected the internal and external systems concerning related to ship bridge design.

Places to intervene in a system (in increasing order of effectiveness) (Meadows, 1999)

12. Constants, parameters, numbers

11. The sizes of buffers and other stabilizing stocks

10. The structure of material stocks and flows

9. The length of delays

8. The strength of feedback loops

7. The gain around driving positive feedback loops

6. The structure of information flows

5. The rules of the system

4. The power to add, change, evolve or self-organise system structure

3. The goals of the system

2. The mindset or paradigm out of which the system arises

1. The power to transcend paradigms

The structure of material stocks and flows

The structure of material stocks and flows (#10) in a system is related to the physical arrangement of the system. Traditionally, a ship's bridge is based on one physical panel per equipment. If a new piece of equipment is to be included on the ship's bridge, the installer has to fit it wherever there is space. Normally there is no time for consideration of, for example, ergonomic issues, and the result is a fragmented working environment that threatens safety.

Our design of the ship's bridge environment involves carefully placed display areas and input devices to avoid those situations, and introduces a software-based structure that provides a scalable system. This means that if a new piece of equipment is to be installed on the bridge, it can easily be incorporated as software into this structure. Our software structure can change the business models of the offshore ship industry when it comes to how equipment from sub-suppliers is handled. This can involve a step towards thinking services rather than products for some of these suppliers.

The gain around driving positive feedback loops

A positive feedback loop (#7) is self-reinforcing. The more it works, the more it gains power to work more. Presenting a believable future vision like ours can become a positive reinforcing feedback loop in that it creates expectations. The more we talk about our ambitions, the greater the expectations of the stakeholders, and the greater is the pressure on us and our partners to deliver.

The structure of information flows

The structure of information flows (#6) affects systems. Delivering information to new places and people influences their behaviour. Through our believable future vision, we inform the stakeholders of what is possible, and we give them ideas they may not have thought of. In the first intervention, our aim was to inform AHO and Ulstein internally about what the future ship's bridge could be like. In the second and third interventions, we used the vision to engage with end-users, who rarely are involved in product development processes in the offshore ship industry. The stakeholders' new insight into what is possible can result in demands for better bridge environments.

The rules of the system

According to Meadows, the rules of the system (#5) define its scope, boundaries and degrees of freedom. The offshore ship industry is highly regulated, and the regulatory bodies develop the requirements based on what exists. Unless someone shows them what may exist, there will be little development. Therefore it is important to challenge the requirements. Our project has not changed the rules of the systems yet, but we have experienced a lot of interest from regulatory bodies and even been asked to provide input to some of them.

It is still a bit early to conclude whether our interventions have resulted in 'big changes in everything', to use Meadows' words. However, our interventions show the great potential that design can have in affecting complex systems and indicates that design can be used to cause changes at several places in the system of the offshore ship industry.

Concluding remarks and further research

To be able to introduce radical innovation in ship bridge design there is a need to engage with a large network of stakeholders. Regulatory authorities must be challenged, maritime suppliers must commit, financial partners must take the risk and fund projects with uncertain outcomes, shipping companies must get involved and the end-users on the bridge must accept the proposed design. The Ulstein Bridge Concept project has tackled this through performing a semi-open innovation process where three carefully planned interventions have been used to engage with the wider networks involved in the realisation of new bridges. We call the process semi-open because the interventions have not revealed all the developments inside the UBC project but instead some carefully selected elements that we believe will help us in changing the broader system. The main purpose of changing these systems is to gain new business possibilities for Ulstein by contributing to new solutions that increase the wellbeing of the crew and enhance safety at sea.

The achievements of the UBC project make it of interest to ask what role design interventions have in processes seeking to introduce radical innovation. Based on our experiences, it seems likely that we have had an impact on the network of stakeholders directly and indirectly involved in the realisation of a new bridge design. The end-users now know that a different bridge than the current is possible, the regulators have seen that their goals can be achieved by different means, Ulstein has experienced the potential they have and Ulstein's competitors know that they need to keep up to avoid being left behind. The interventions seem to have altered the general expectation and understanding of what comprises future ship bridges, and this effect can be seen simultaneously at multiple places in the complex system of stakeholders. In further work, it is of interest to ask whether our interventions have resulted in systemic change that may be beneficial for further development of new ship bridge design. Can design interventions be used as a tool for priming a complex system of stakeholders so as to prepare it for radical innovations?

We also find it likely that the three interventions benefited from professionally designed presentations. The first used high-end 3D visualisations, the second used high-end 3D visualisations in a professionally produced film and the last used an elegantly designed interactive demonstrator. In future research, it is of interest to consider what role clear and trustworthy communication through design has in processes aiming to introduce radical innovations in complex systems.

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