

FIELD STUDIES INFORMING SHIP'S BRIDGE DESIGN AT THE OCEAN INDUSTRIES CONCEPT LAB

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SUMMARY

In this paper we discuss the use of field research in multidisciplinary design processes when designing the ship's bridge of offshore service vessels. From carrying out ten field studies at sea over a three year period we have gained considerable insight into the role which field research may play in design projects for the offshore ship industry. We have found that allowing the designers to experience the onboard environment first hand is vital when designing for such a complex domain. Building on the experience we have gained, we have developed a *model for design-driven field research* relevant for these kinds of design projects. Our model encourages designers to engage in design reflection while in the field. This we believe is particularly important when designing for use situations unfamiliar to most designers, like a ship's bridge.

1. INTRODUCTION

Industrial, interaction, sound and graphic designers are increasingly involved in the development of marine product, and it is important that they have sufficient insight into the marine working environment. Field studies are an effective way of gaining such insights. One designer, after conducting a field study at sea, had the following to say:

The field study represents an important juncture to me. Now I know what I need to relate to and can avoid a lot of assumptions in my design work. I know how offshore operations are carried out, how the mariners perform their tasks and how they communicate. I have seen the humour they may have in the midst of demanding operations and I have got to know them as human beings. The field study gave me an embodied experience. It let the experience of being at sea get under my skin. (Designer in the Ulstein Bridge Concept project)

Despite the importance of field-related knowledge, designers of products and systems used at sea frequently have difficulty in gaining access to the field sites. It is therefore particularly important that field research is well conducted whenever access to the field is granted.

At the Ocean Industries Concept Lab of the Oslo School of Architecture and Design, over a three year period, we have conducted ten field studies as part of the Ulstein Bridge Concept (UBC) design research project. In this paper we discuss our experiences of field studies done at sea as part of the design process when developing a new ship's bridge. The paper is based on the authors' own experiences when conducting field studies, the field study experiences of other project members, and also on the experiences of sharing insight from the field within the project team and attempts to incorporate this insights into the design process. Input from other members of the UBC project were captured through short, semi-structured interviews.

1.1 THE ULSTEIN BRIDGE CONCEPT DESIGN RESEARCH PROJECT

The Ulstein Bridge Concept (UBC) is a design research project which aims to redefine the bridge environment of offshore service vessels. The scope of the project includes all functions of the bridge, and extends from room layout to graphical user interfaces. The UBC project is a collaborative project 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), the Ulstein Group, Kwant Controls, and Aalesund University College (HiALS). The multidisciplinary project team consists of researchers and designers from the fields of interaction, industrial, sound and graphic design, as well as experts in human factors and engineering.



Figure 1: Future ship bridge design developed by the Ulstein Bridge Concept design research project, and presented at Nor-Shipping 2013.

1.2 FIELD RESEARCH IN DESIGN

To design usable products and systems it is necessary to have a comprehensive understanding of the users, their tasks and the context of use. Conducting field studies is

an acknowledged approach for gaining such understanding, as designers can seldom rely on their own prior experiences as a guide to design [1]. Going to the field to learn about a product's users and the context of use is not new in design practice. In Europe socially-oriented design can be traced back to the Bauhaus school operating in the interwar period [2]. In the USA, already in the 1940s and 50s, the famous industrial designer Henry Dreyfuss and his colleagues went out into the field and collected data to inform and inspire their designs [3]. Since 1965 some industrial designers in the USA continued to incorporate field research into the design process, and from this has emerged a call for integrating the social sciences into design research [4]. In the 1970s and 80s the participatory design movement evolved in Scandinavia with the aim of involving workers in workplace designs. Participatory design requires the designers to have a deep understanding of the situation they design for, which makes visits to the work-place an important early activity in the design process [5, p. 57]. Around the same time, Xerox PARC and other research labs, working with human-computer interaction in the USA, started carrying out user studies, applying ethnographic methods [1], [2]. In recent years, the practice of observing and interviewing users in their natural surroundings has become common in design [6]. In commercial design projects this approach is often referred to as design ethnography [7]. However, Button states that not all field-work is ethnographic, and claims that real ethnography is something designers of collaborative work systems rarely do [8]. Arnold has defined the more general term 'field research' in the context of design as: 'activities during the product development process where the designer gathers information about the user while in the user's environment - which can then be used to influence design' [4]. As Arnold points out, this may include methods similar to those used in ethnography, but it also involves other approaches.

1.3 THE IMPORTANCE OF FIELD RESEARCH WHEN DESIGNING A SHIP'S BRIDGE

The aim of the UBC project is to improve the bridges of offshore service vessels. In order to create such changes through good design, designers have to make sense of, and frame, the situation they design for. Sensemaking and framing are needed to judge what it is possible to change in the situation, and what means are available to accomplish the desired changes. Nelson and Stolterman stress how judgement making is essential in design [9]. They describe design judgements as a unique form of judgement, and explain how these are necessary in order to create 'that-which-is-not-yet', i.e. design solutions that are fit for the future. Schön describes this judgement process through the concept of *reflection-in-action*, where designers move between doing design work and reflecting on the outcomes [10].

Although reflection-in-action, to some degree, explains the designer's practical approach to designing, it does not deal with the complexity of design requirements in situations such as the marine and offshore environments. In the UBC project we approached this complexity by using systems thinking. This implies a consideration of the parts as components of the whole, i.e. of a system, with an emphasis on the relationships and connections between the parts of the system. A ship's bridge does not function in isolation, and there are many systems that influence the design of the bridge, which need to be understood by the designers [11]. As Nelson and Stolterman state, designers 'must be able to create essential relationships and critical connections in their designs and between their designs and the larger systems in which they are embedded' [9, p. 57]

We suggest that there are two partially overlapping systems of which one needs to make sense when designing for complex domains like the offshore ship industry: 1) The system one designs within, which we refer to as *the design situation*. This includes domain specific aspects, organisational issues of the industry, the client and project organisation, as well as the means (e.g. technology) available for designing. 2) The system one designs for, i.e. *the use situation*. This includes the users, their roles, the operations they are part of, their tasks, the equipment used, and other human, technical, organisational and environmental factors relevant during use. As suggested by Figure 2, we view the use situation as making up a substantial part of the design situation.

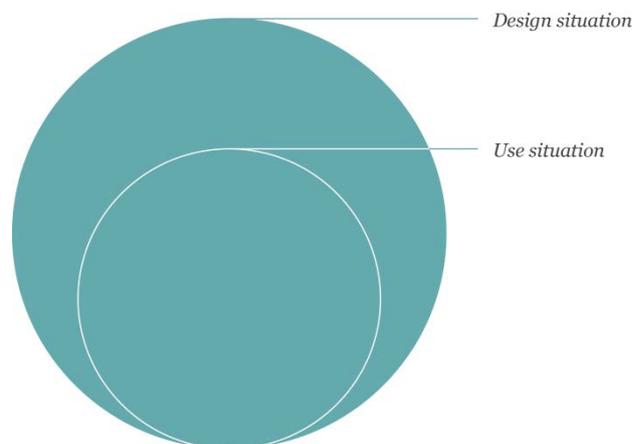


Figure 2: The use situation is a substantial part of the design situation.

When designing a ship's bridge this use situation is unfamiliar to most designers, and is very different from use situations the designer knows onshore. Given this uniqueness of the use situation at sea, we believe that it is particularly important to conduct field studies when designing a ship's bridge.

2. FIELD STUDIES AT THE OCEAN INDUSTRIES CONCEPT LAB

As shown in Table 1, we have conducted a total of ten field studies as part of the UBC project. The first field study was conducted in January 2010 and the last three were conducted in the summer of 2013. All field studies were carried out on board offshore service vessels serving the oil industry in the North Sea. Eight of the studies were carried out on board platform supply vessels (PSVs), one was carried out on a well simulation vessel, and one on an anchor handling tug supply vessel (AHTS). Three of the studies were conducted by individual designers, while seven were carried out by a team of two designers. A total of twelve designers were involved in the field studies, and three of these were involved in more than one field study. The field studies lasted from 2-8 days, and the total number of hours spent on board was 1800. In addition to the field studies conducted as part of the UBC project, the reflections in this paper are based on three field studies conducted by Masters level students at the Oslo School of Architecture and Design in Norway in 2011 and 2013.

Anonymity of participants was ensured in the field studies. The field studies were approved by the Data Protection Official for Research in Norway, and informed consent of participants was obtained.

No.	Type of vessel	Conducted by	When	Days
1	Platform Supply Vessel	2 designers	Jan 2010	3
2	Well simulation vessel	1 designer	Sept 2011	2
3	Platform Supply Vessel	1 designer	Oct 2011	5
4	Platform Supply Vessel	1 designer	July 2012	3
5	Platform Supply Vessel	2 designers	Sept 2012	8
6	Platform Supply Vessel	2 designers	Dec 2012	6
7	Anchor Handling Tug Supply	2 designers	Feb 2013	4
8	Platform Supply Vessel	2 designers	July 2013	3
9	Platform Supply Vessel	2 designers	July 2013	4
10	Platform Supply Vessel	2 designers	Aug 2013	4

Table 1: Overview of field studies carried out from the Ocean Industries Concept Lab.

2.1 AIMS OF THE FIELD STUDIES

The field studies in our project had three partially overlapping focus areas, as indicated in Figure 3: Data mapping, experiencing life at sea, and design reflection. We refer to this kind of focused field study as *design-driven field research*.

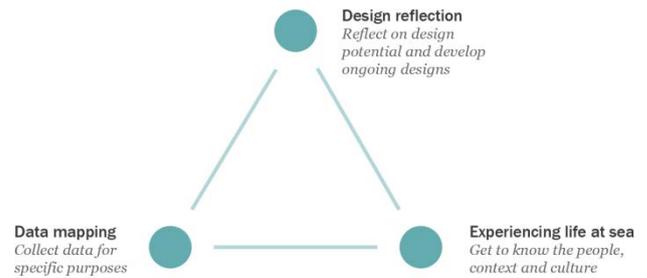


Figure 3: Focus areas in the UBC field studies, important in our *model for design-driven field research*.

Data mapping involves collecting the specific data designers need in order to develop relevant designs. This can include recognising the user groups, documenting functions and tasks, identifying the equipment used to conduct the different tasks, mapping out the physical working environment etc. *Experiencing life at sea* suggests an ethnographic-inspired approach. The purpose of ethnography is to get a deep, detailed understanding of how a group of people experience and make sense of what they do [2]. It deals with people in the collective sense, and involves an examination of the culture of the group, i.e. their learned and shared behaviours, customs and beliefs [12]. For us, the ethnographic-inspired approach involves becoming familiar with life on board the vessel, gaining insights into the offshore culture, and getting to know 'the men behind the users', i.e. what kind of people choose to work at sea, how they experience their life at sea, and what their needs are, beyond those of their work performance. Another important aspect of experiencing life at sea is to understand the environmental, temporal and bodily aspects of staying on board. *Design reflection* involves reflecting on possible design opportunities and on the potential of design ideas while in the field. It also concerns being conscious of using the field study to create a basis for generating ideas and for getting 'aha-moments' later in the design process. This involves being curious, not setting strict boundaries for the scope of the field study, and seeing everything on board as interesting. It also relies on documentation of conceptual thinking while on board.

The field studies we have carried out have had different objectives in relation to these focus areas. The aim of the first study, conducted in 2010, was to get an overall understanding of what happens on board a platform supply vessel, to identify the main functions and tasks of the deck officers, and to map out the physical environment and the systems used to conduct these tasks. The report and images from this field study were used by the other designers to prepare for subsequent field studies to make sure that we did not start again from scratch on each field study, but rather built on the insights gained by others in the project. The second field study was a less formal, familiarisation trip to a well simulation vessel. The third field study was carried out by the sound designer in the project, and looked, particularly, at the

alarm situation and the sound environment on the bridge. Field studies 3-7 placed particular emphasis on the operators' sensemaking of the situation at sea, the operations the vessels were part of, and the communication between the actors involved in these operations. In field study 5, in-depth interviews with all crew members were also carried out in order to learn more about the people on the whole ship and their roles and tasks. A typical scenario for platform supply vessels, based on these observations, were mapped out in detail in field studies 3-6. Field study 7 aimed to document as much as possible of anchor handling operations. Field studies 8-10 aimed at an in-depth understanding of the use of the integrated automation system, both on the bridge and in the engine control room. Important in all field studies was not only to understand and assess the current situation, but also to generate new design ideas.

2.2 APPROACH

Our approach to carrying out field studies has evolved over the course of these three years. Building on the experience we have gained, we have developed an approach to planning, conducting and reporting on the field studies. From field study no. 6 onward we used the guide shown in Figure 4 to prepare for the field studies.

This guide has also been provided to Master level students doing field studies.

Since the aims of the field studies differed, we used a mix of methods and approaches. We have conducted pre-planned activities while on board, but also kept our eyes open and sought opportunities as they presented themselves. Our ethnographic-inspired approach meant that we tried to see everything as interesting and potentially of significance.

On all field studies we relied heavily on note-taking, sketches and photography of what we saw. We have consulted human factors literature for formal methods, and tested out the Comms Usage Diagram in documenting the communication taking place; and used the Applied Cognitive Task Analysis interviews to analyse cognitive demands and the expertise needed to carry out particular tasks [13, pp. 87-93, 374-379]. On some of the field studies we presented the users with designs and ideas from the project in order to get their feedback to guide our designs. On other field studies we developed new ideas with the users in co-design sessions on board. In the later field studies we started using ZIP-analysis as a design-oriented technique to analyse what we had observed. In the ZIP-analysis we identified areas that need more research and which we need to zoom in

Field studies in UBC

Planning & preparation

Design reflection
Reflect on design potential, develop ongoing designs

Data mapping
Collect data for specific purposes

Experiencing life at sea
Get to know the people, culture and context

Define the purpose of the trip, what you will do to achieve that purpose and how you will document it.

It is useful to prepare as much as possible in advance, e.g. observation forms, interview guides, design proposals you want to discuss, list of what to photograph etc. During the field study one gets quite tired, so having a plan to follow is helpful. Note: The plan should not restrict you onboard! Familiarise yourself as much as possible with the ship and types of operations before going. This includes technical design of ship, equipment onboard, type of operations etc. Consult books, the Internet, reports from previous studies, information provided by Ulstein etc.

What to pack?

- Passport
- Comfy casual clothes
- Indoor shoes (sandals)
- Drinking bottle (the air is quite dry)
- Motion sickness pills
- Consent forms and everything you need for the studies. Minimum a sketch book and a camera.

Bed linen, towels and soap will normally be provided.

Once out there

One of the first things to do onboard is to inform the captain that you need to go through the consent forms with him and all the officers on the bridge. Ask when is the best time to go to do it. During transit may be a good choice.

Safety is important onboard. Pay attention to the information provided during the safety instructions. Pay particular attention to muster stations and safety zones. During an exercise or if an emergency situation occurs, do as told by the captain or officer in charge.

Humour never hurts. Always keep your social antenna out. Be courteous and respectful, but at the same time interested in what goes on. Be honest about your intentions. Ask questions if the situation allows for it, but accept it if the users don't want to talk. Note customs onboard, for example fixed seating arrangement in the mess and whether you are expected to clean the cabin before departing the ship.

Empathy takes you a long way, and some humour never hurts. Always keep your social antenna out. Be courteous and respectful, but at the same time interested in what goes on. Be honest about your intentions. Ask questions if the situation allows for it, but accept it if the users don't want to talk. Note customs onboard, for example fixed seating arrangement in the mess and whether you are expected to clean the cabin before departing the ship.

Be explorative! Everything is interesting, it's just a matter of recognising the value. Use all your senses when observing. Pay attention to details in the situation without being critical. Look for patterns and make connections. Notice things that puzzles you and are not as expected. And be conscious about what is just as you thought it would be. Document anything, also trivial stuff.

Explore, explore, explore, until there is no more!

Ask the captain on a general basis if it is ok to take photos and/or make video/audio recordings. Always ask the individual users before taking any photos of them or if you want to make video/audio recordings. If the users accept it, be clear on when you start and stop the recording. Respect it if the users say no.

Beware of "photo & documentation fatigue". The users may think you are too eager, always using your camera or writing in your book. Being open and telling them why you do the things you do is good for increased understanding and acceptance.

Make notes and sketches while doing observation most of the time, but also allow yourself to hang out with the crew with no special purpose in mind. Remember that these notes may be read by others, e.g. over your shoulder or while you are out if you leave your book on the bridge. It is a good idea to tag the notes with where you got the information from, e.g.:

- Something someone said
- Something you observed
- An idea you got

After each observation session (day) make a summary of the most important things the users said or you observed, and reflect on how that is important for the purpose of the field study and your design work. This may be tough to do after long hours doing observation studies, but is very important for later. Remember: You cannot rely on your memory!

You may want to keep a separate account of these summaries, e.g. on your computer. This way you can reflect openly about what you have observed without being afraid of others reading it.

Before you depart the ship, ask the participants if they want information about how the project evolves. If so, note down the email address.

Back home you need to finalise the analysis and communicate your findings and ideas to the rest of the UBC project. The more analysis you've been able to do onboard, the easier this will be. Do this as soon as possible, it gets more difficult the longer you wait. See own guidelines.

Field studies in UBC v2
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Figure 4: Guide used to prepare for field studies in the UBC project.

on (Z-points); points where we have a design idea (I-points); and problem areas or areas with a potential for improvement (P-points) [14]. We are currently testing communicating insights gained during field research by authoring a detailed scenario, based on multiple field studies.

The field studies have been documented and reported to the rest of the team using different means, as shown in Table 2.

Approach	Field studies no.
Written report	1, 2, 3, 4, 5, 6, 8, 9, 10
Images	1, 2, 4, 5, 6, 8, 9, 10
Video recordings	5, 7
Audio recordings	3, 7
Spoken reports (informal)	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
Spoken reports (formal 10 mins presentations)	2, 3, 4, 5, 6, 7
Spoken reports (formal 1 hr presentation)	8, 9, 10
Personas	4, 5, 6, student projects

Table 2: Approaches used for documenting and reporting on field studies to the rest of the project team. Personas is a technique for modelling typical users that is frequently used in software design [15].

3. GAINING AND SHARING INSIGHT

Through the ten field studies carried out in the UBC project we have gained considerable understanding of life and work on board offshore service vessels. This has served as an important basis for developing our new ship's bridge design. In order to incorporate the diverse insights gained into the final ship's bridge design, it has been necessary for the individual designers to share their insights with the rest of the design team effectively. Not all members of our team have been to sea, and of the twelve designers who have conducted field studies, a number have only been involved in the project for a relatively short period of time. Five designers who have been to sea are currently working on the UBC project. The twelve designers who have conducted field studies have been on board nine different vessels at different times of year, meeting 40-50 different deck officers. Factors like weather, crew culture and vessel type have given the designers different onboard experiences.

3.1 THE DESIGNER IN THE FIELD

Our experiences indicate that to really understand the situation on the bridge of an offshore service vessel, the individual designer benefits greatly from taking part in field studies. However, a ship is a challenging place to do field studies for a person who does not have sea legs. Many will experience motion sickness to a lesser or greater degree. Even if you are not nauseous, you may be

physically affected and become tired, get a headache and experience poor concentration. These effects from the motion will affect your ability to conduct good observational studies. Another factor influencing the designer's ability to do good field research is that being on board an offshore service vessel in the North Sea is an overwhelming experience for those unfamiliar with such settings. There is a lot to take in. We have recognised the need to compensate for these factors by doing comprehensive pre-planning for the field studies. Our guidelines for planning (Figure 4) have proved useful for this. Also, we have seen that, before going, it is important to talk to other designers who have done field studies.

We consider the observer to be an interpreter, and acknowledge that the different designers who carry out the field studies will interpret what they see in different ways, based on their previous experiences, and the focus of their design practice and research. This finding corresponds with Suri's conclusion that designers observe the world in a personal way, and that designers have a habit of paying attention to selected elements that help them generate new solutions according to their personal focus [6]. In the UBC project we have seen that different designers take different things back from their field studies, and that their insights gained may not always be relevant to the other team members from different fields of design. As an example, our sound designer placed great emphasis on the audio environment on the bridge, something which may be of lesser importance to the graphic designer. Also, product designers may not get all the information they need about the spatial environment from an interaction designer focusing on human-machine issues.

The designers of the UBC project who have been to sea stress that the field study has been vital in their understanding of the ship's bridge. We have experienced the following benefits from doing field studies:

- Getting a holistic understanding of the bridge as one system, rather than just an assembly of individual parts.
- Gaining insight into the operations, users and tasks at a level which is difficult to obtain without observing for oneself.
- Understanding how the crew communicates and interacts, both in work-related and social situations.
- Getting a spatial understanding of the bridge environment, and seeing the users' movement patterns on the bridge.
- Understanding temporal aspects of operations and tasks.
- Getting an embodied understanding of what being on board a vessel is like.
- Identifying the appropriateness of emerging designs in the context of current use.

Among these benefits the temporal and embodied aspects seem to hold a unique position. Someone can tell you about the duration of an operation and the waiting times, but the understanding you get it is very different if you have actually experienced it for yourself. Likewise, you can imagine that operating equipment in rough seas is challenging, but, if you observe it first hand, you will have a completely different insight into what rough seas really mean. Another unique insight obtained from the field studies, which is difficult to gain onshore, is getting a holistic and systemic understanding of the situation we design for. Information about the use situation as made available to designers onshore is fragmented, and it can be difficult to see how the parts are connected in the larger system without having been on the bridge.

These factors suggest that getting a personal sense of what life and work at sea is like is valuable for designers. Not only does a field study give the designer unique insights in itself, we have also experienced how the field studies have made it easier to grasp information about the use situation coming from other sources. This can be reports from other designers' field studies, spoken accounts from users or subject matter experts, and written material, e.g. manuals and accident reports. It seems that by having been at sea the designers develop a tacit understanding of the situation on the bridge, which enables them to add missing pieces of information which aid the process of making sense of new information. As Polanyi has explained it, tacit knowledge implies that we know more than we can tell [16]. Polanyi describes how tacit knowledge is an integral part of true understanding. The body plays an important part in forming this knowledge, which can only be achieved by 'indwelling'. In our case the indwelling involves going to sea. Such an understanding is particularly important in design, since it can also be used to connect field-related insight to emerging designs. However, the personal perspectives of the individual designers also introduce challenges, e.g. the designer develops biases and heuristics that are employed in making design judgements, and which may be used erroneously. Design judgements are usually made under uncertainty, i.e. we do not know how our proposed design will actually work in a future situation. In the context of probability assessments, Kahneman and Tversky have suggested three heuristics leading to biases that are employed in making judgements under uncertainty, and which sometimes lead to severe and systematic errors: 1) Representativeness, 2) Availability of instances or scenarios and 3) Adjustment from an anchor (an initial value or starting point) [17]. Referring to Kahneman and Tversky's examples, we have for example experienced biases and heuristics based on representativeness including 'insensitivity to sample size', i.e. the designer generalises, based on one field study; 'insensitivity to predictability', i.e. the designer makes predictions regarding what will or will not work; and 'illusion of validity', the designer does not critically question the representativeness of the field site visited. We have strived to address these biases and heuristics by

being aware of their potential occurrence, and by allowing several team members to do field research on different vessels, and at different times of the year.

3.2 FROM INDIVIDUAL INSIGHT TO TEAM INSIGHT

In the UBC project we have experienced that sharing individual insights with the rest of the team can be challenging. There are two main reasons for this: 1) Urgent tasks and project deadlines may keep the focus away from analysing and reporting to the rest of the project team. 2) It is difficult to share the individual's insights and to communicate the full richness of the use situation because of the tacit aspects of the insights gained.

The first challenge can be considered a project management issue. It may also be related to the fact that designers are not trained in doing observational studies and are therefore not as focused as they might be on analysing the field data. We acknowledge that interpretations are carried out in different ways, and that every field study has different needs when it comes to analysis. Still, we have experienced that sharing insights with the project team has been most successful when the designers doing the field study have set aside sufficient time to consciously analyse what they have observed in the context of the ongoing design project.

As Table 2 shows, the field studies conducted in the UBC project have been reported to the rest of the project team through a number of techniques. Written reports have proved valuable in communicating selected parts of the field studies, and project members have emphasised that they are valuable in understanding very focused topics. However, it has been difficult to convey the richness of the insights gained through text alone. The overwhelming experience of being on board an offshore service vessel can also make the designers focus more than necessary on their own experience, potentially at the expense of reporting on users' experiences.

Images have proved valuable in communicating the physical environment and the equipment used on the bridge, and to some degree, issues of the use situation. We have used images in a structured manner to help new designers in the team to quickly become familiar with the bridge environment, as reported in a previous paper [18]. However, it is difficult to convey the holistic, dynamic and interactive aspects of a situation by using still images. For this purpose video has proved more appropriate, and we have used this in different ways. In one case, the designer who had been at sea edited a film, with written explanations, of 30 minutes of a common operation. This gave the team detailed insight into what happened during this specific sequence. On another occasion, the designer who had been on the field study made a film with a high playback rate, which showed the

broader use patterns on the bridge over a longer time span. This proved to be particularly useful in assessing ergonomic issues, and informing the design of the physical working environment.

Informal spoken reports were given after all field studies, and during the design work relevant observations and design ideas emerging from the field studies were put forward. In such discussions interesting issues were raised that went beyond the photo-factual documentation. Short, formal spoken presentations proved to be an efficient way of conveying clear findings and considering patterns across the field studies carried out by different designers, while longer spoken presentations enabled deeper discussions on specific issues. The process of developing personas was valuable for those involved because it made us realise that we had met the same kind of people while at sea. However, the resulting personas have not played an important role in our design work.

To sum up, we have seen that sharing factual information about users, tasks and equipment has proved considerably easier than sharing insights on the less concrete aspects of the use situation. The issues most difficult to convey seem to be the tacit knowledge related to environmental, temporal and bodily aspects, which in our experience should be felt by designers in order to be fully understood.

3.3 FROM INSIGHT TO DESIGN

We have seen that offshore ship design processes accelerate after designers have been to sea. In particular, we noticed a change in the designers' ability to efficiently and confidently make choices in the design process, which is dependent on good design judgements. Nelson and Stolterman address the complexity of such judgements, and suggest that they involve ten different categories [9]. Since designing for the offshore ship domain differs significantly from the design situations that are familiar to designers on shore, it can be particularly challenging for designers in this domain to make efficient design judgements. Our experience suggests that designers who have been to sea acquire a more holistic and systemic understanding of use situations, which makes them better at several of Nelson and Stolterman's categories of design judgement. In particular, they improve at 'appreciative judgement', which involves determining what should be considered as the foreground of a design situation, and thus requires specific attention, and what is to be considered as the background. They also seem to be better at 'compositional judgement' and 'connective judgement'. Compositional judgement 'is about bringing things together in a rational whole', while connective judgement involves making 'binding connections and interconnections between and among things so that they form functional assemblies transmitting their influences, energy, and power to one another, creating synergies and

emergent qualities that transcend the nature of the individual things that are being connected' [9, p. 153].

As we have described in section 2.1, our field studies follow a *model for design-driven field research*, in which we focus on data mapping, experiencing life at sea and design reflection (Figure 3). Through our model, we urge designers to engage in design reflection while in the field. In our experience, it can be hard to carry out actual design production while in the moving environment at sea. However, we have found it useful to bring emerging design proposals to the field to discuss and expand on the ideas with users. Also, we have found it useful for designers to actively reflect on their current design issues while at sea.

Our model reflects the multifaceted needs of designers, and implies a view of field research in design that differs slightly from that represented in Arnold's definition [4]. We regard field research as integrated into the design process in a manner that encourages the conception of and reflection on designs while still in the field. This means that field research is not something that has to precede design, and instead suggests a more direct link between insights from the field and design.

Regarding field research as integrated into design reflection in this way builds on Schön's concept of reflection-in-action [10]. Schön's model of reflection draws on the designer's previous experience and internalised knowledge, and describes the designer's ability to reflect on new designs as they are developed. In the offshore ship industry, the field is environmentally and culturally very different from the contexts that designers normally design for. As such, we suggest that designers in offshore ship design contexts can benefit from an expansion of reflection-in-action, involving design reflection as part of field studies. We suggest that field research in design can be a means of documenting existing use situations, and can provide spaces for reflecting on possible changes in these situations through design. This makes it possible to create a better basis both for generating new designs and for assessing the appropriateness of the designs that we come up with.

4. CONCLUSIONS

In the UBC project carried out at the Ocean Industries Concept Lab, we used field research to inform multidisciplinary design processes when designing the ship's bridges of offshore service vessels. In this paper, we have described how field research was conducted for the UBC project, and have shared key lessons from our work. Our emphasis has been on the role of field studies in the context of design processes. Our main conclusion is that conducting field studies is vital when designing for a complex domain like the offshore ship industry, as this domain is normally unfamiliar to designers, and is

environmentally and culturally very different from the contexts that most designers work with onshore.

In design projects like the UBC project, which addresses several design fields, including industrial, interaction, sound and graphic design, the necessary understanding of the use situation is multifaceted and dependent on the focus of the individual designer. In our work, we have seen that designers who carry out field studies develop a personal sense of the use situation that enables them to make better design judgements. Therefore, we suggest that crucial members of design teams be allowed the possibility to conduct field research. However, we have also seen that personal understandings of use situations can lead to biases and heuristics that may be inappropriately applied in making judgements. It is thus important to be aware of these tendencies within a design team.

The multifaceted needs for insight into use situations also suggest that a versatile approach should be applied to communicating insights gained through field studies within design teams. Textual reports, images, videos and spoken accounts provide different kinds of insight and should be used in a complementary manner. We also acknowledge that generating new designs is a way of interpreting the use situations observed during field studies, and that reporting on field studies is a continuous process that occurs throughout a design project.

We propose that field research in design for the complex domains of the offshore ship industry should have three areas of focus: 1) data mapping, 2) experiencing life at sea, and 3) on-site design reflection. We refer to this as a *model for design-driven field research*. Our model explicitly encourages the designer to engage in design reflection while in the field, in order to accelerate the process of interpreting use situations and more quickly arrive at appropriate designs. In this way, the model expands on the more traditional concept of field research in design, which emphasises field studies as efforts that take place before designing. Our experiences have led us to consider whether designing for environments that designers are less familiar with can generally benefit from on-site design reflection, as a means of decreasing the contextual gap between the field and design. Our future research will involve developing a general model for design-driven field research that is applicable to other domains, in addition to the offshore and maritime industries, and investigating how this model can be used to incorporate field studies into design processes in industrial, interaction, sound and graphic design.

5. ACKNOWLEDGEMENTS

The research presented in this paper was funded by the Research Council of Norway and the Ulstein Group. We would like to thank the project team of the Ulstein Bridge Concept design research project, who provided

invaluable input into this article. We also give special thanks to the crew members who shared their insights and thoughts during our field studies, and to the shipping companies that allowed us on board their vessels.

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