ocean industries concept lab

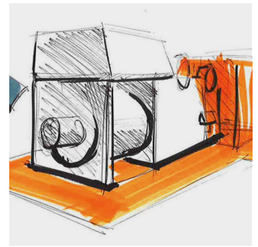
ONSITE

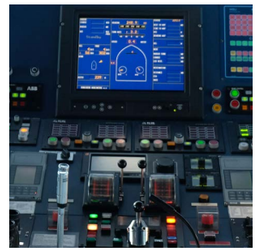
Design-driven field studies for safer demanding marine operations

Project report

Arkitektur- og designhøgskolen i Oslo
The Oslo School of Architecture and Design

Contents





Introduction

ONSITE is a research project that builds knowledge on how to implement human-centred design processes within ship design. The project focuses specifically on a field study methodology and the transfer of knowledge between human-centred design and engineering disciplines.

ONSITE WAS STARTED in 2014 after an initiative by Ulstein International and the Ocean Industries Concept Lab (OICL) at the Oslo School of Architecture and Design (AHO). After having collaborated with AHO on the Ulstein Bridge Vision (UBV) project, Ulstein saw the potential for including design methods from human-centred design within ship design processes. The UBV project had extensively used field studies to inform the design of a ground-breaking ship bridge design. Ulstein saw that this methodology might have an impact on the entire ship design process. Consequently, ONSITE was established to focus on developing knowledge that can secure an efficient feedback loop between field studies carried out during maritime operations and design processes onshore.

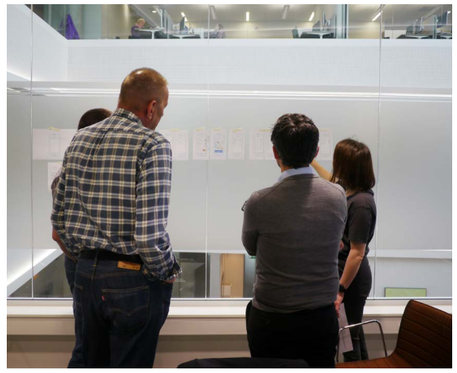
To realise the idea, Ulstein enrolled PON Power and DNV GL as industry partners and the Norwegian University of Science and Technology (NTNU) as an additional research partner for the project. The project was established as a competence project for industry (kompetanseprosjekt for næringslivet), co-financed by the Norwegian Research Council through the MAROFF program. Over the last four years, the project has developed frameworks, methods and software tools that link field studies in demanding marine operations and the onshore ship design process. It has focused on a practice-driven approach where field studies (carried out by designers trained in both marine design and field study methods) have been integrated into industry-driven maritime design processes.

The project has improved how field knowledge can be efficiently applied in design processes as a platform for better marine design. This involves the capability of undertaking field studies within short time frames, effectively organising the data in line with other existing studies, transferring the knowledge to the design team, nurturing a culture of long-term knowledge building and investigating how digital tools can support field study processes.

Key topic areas of the project included:

1. What data is needed for ship design processes?
2. How can field data be effectively captured and annotated for design purposes?
3. How can field data be shared effectively in ship design processes?
4. How can a systemic understanding of operations be captured by efficiently combining the results from multiple field studies?
5. How can software make field studies more effective by facilitating and partly automating data harvesting, sharing and retrieval?

This publication offers a brief insight into some of the results that have been produced by the project. For further, more detailed information, there is a complete list of research publications at the end of this report.



Project partners

To strengthen multidisciplinary innovation processes in ship design, the project group gathered together researchers from both the humanistic and technical disciplines alongside three industry partners representing ship design, equipment manufacturing and regulation.

ONSITE IS LED BY OICL at AHO. The project group includes NTNU, Ulstein International, DNV GL and PON Power.

Dr. Kjetil Nordby and Etienne Gernez were the principal researchers from OICL. In addition, Sigrun Lurås, Snorre Hjelseth, Marianne Støren Berg and Henry Mainsah from OICL participated. Kjetil Nordby was the project leader and Etienne was a PhD candidate with a background in the maritime industry.

Four design students from AHO were hired for short missions to help out with visualisation and prototyping. The whole class of third-year design students took the field study course at AHO each year between 2016 and 2019.

From NTNU, Hans Georg Schaathun and Aya Saad were the principal researchers. Hans Georg and Aya are Professor and Postdoc in Computer Science at NTNU Ålesund, respectively. Several students contributed to the software development.

From Ulstein, Per Olaf Brett and José Jorge Argis were the principal researchers. Per Olaf is Deputy Managing Director, Vice President and Professor II at NTNU in Management of Marine Design. José Jorge is a PhD fellow (attached to NTNU). André Keane, Ali Ebrahimi and Berit Cecilie Skeide joined Etienne for a field study on a fishing vessel. Additional independent field studies were carried out by Ulstein designers.

From DNV GL, Øystein Goksøyr and Fenna Van de Merwe were the principal researchers. Øystein is Head of the Safety Advisory Department and Fenna is Principal Consultant in the same department. Several ship surveyors from DNV GL collaborated as informants to one field study carried out by Kjetil Nordby and Etienne Gernez. Several DNV GL consultants from the Innovation and Digitalisation Department carried out independent field studies.

From PON Power, Øystein Skår and Øyvind Seim were the principal researchers. Øystein is Technical Director and Øyvind is Project Manager. Several service technicians from PON Power contributed as informants to a field study carried out by Etienne Gernez.

Finally, Margareta Lützhöft from the Western Norway University of Applied Sciences and Steven Mallam from the University of South Eastern Norway contributed as external research consultants.

Altogether, the participants covered the following disciplines: maritime engineering, human factors, industry and interaction design, design research, computer science, innovation, sales, strategy and management.

AHO
Arkitektur- og designhøgskolen i Oslo
The Oslo School of Architecture and Design

NTNU

DNV·GL

For Ulstein, the motivation to participate stems from constantly striving to innovate and design ships that are smarter, safer and more efficient to operate. Innovation comes from the development of design processes and design methods, with a specific emphasis on knowledge transfer from other design traditions.

DNV GL's motivation came from the observation that DNV GL has a large number of personnel onboard ships at regular time intervals, over the entire ship lifetime, all around the world. With, at the same time, a push from the industry to transition to more efficient processes through digitalisation, DNV GL decided to explore how the field study methodology could be applied to its own processes.

PON Power has many personnel in the field, with service technicians traveling all around the world to service ships. Its motivation is to be able to use these technicians to assemble operational knowledge from the field and share it with in-house innovation processes.

ULSTEIN®

PON CAT

Why field studies matter in maritime design

A ship's performance often relies on whether its crew are able to fully take advantage of all its capabilities. We argue that field studies are an important method that may help in the design of more user-friendly ships. However, such studies need to be well integrated into the multidisciplinary process of designing ships in order to reach their full potential.

THE HUMAN ELEMENT is the major source of risk to safe operations. Up to 80% of marine and offshore accidents are attributed to human error or to some form of human input. The resulting expenses range from the costs of large accidents, downtime, maintenance and legal fees, to loss of reputation and various matters relating to personnel. Human errors are generally caused by technologies, environments and organisations that, in some way, are incompatible with optimal human performance.

Safer, greener and more efficient marine operations are achieved through design processes that take the entire operation into account, including the human element. To achieve this, the industry needs designers who are trained in acquiring and applying field knowledge and who have easy access to shared knowledge bases from the field.

Hiring designers with maritime operational experience (e.g. captains, chief engineers) has been an approach that has been implemented to integrate experience-based operational knowledge into design. However, the increasing complexity of demanding operations makes experience competency insufficient as the main source for knowledge supporting design. In addition, the decreasing Norwegian fleet and the consequently smaller number of Norwegian personnel have led to the call for alternative approaches to securing operational competence in the design process. An increasing demand for leaner operations, improved safety and adherence to environmental regulations, as well as a greater service orientation, all serve to accentuate the need for a comprehensive understanding of operations in ship design. However, it is a challenge to fully understand demanding operations in order to change them through design, since they are complex intertwining systems of interacting people and technologies.

Field studies play a critical role in acquiring contextual, systems-oriented and human-centred knowledge from demanding marine operations. The industry acknowledges that designers need an onsite comprehension of complex operations and tasks that ranges across systems and varied conditions.

Field studies for ship design differ from traditional ones in human factors or social science disciplines in that they must take into account the domain knowledge of the design disciplines involved and their particular data needs, as well as facilitate feedback loops from the ongoing design processes.

Today, field studies are carried out sporadically, often by external consultants. These consultants are often specialists in their own fields but are not always aware of the detailed knowledge needs of the naval architect (e.g. segment understanding, arrangements), the interaction designer (e.g. readability in different light conditions, interaction, timing and task priorities) or the stability engineer (e.g. crane, tower and handling operations). The result is insufficient knowledge-building in the companies and insufficient knowledge with which to successfully model and simulate the complete ship performance when in operation. This is a problem that may lead to design proposals that do not function well during demanding operations. ONSITE has tried to overcome this problem by integrating domain experts into the field study processes themselves in either the planning, carrying out or analysis of the field study results.

Design-driven field research for Ocean Industries

User-centred design warrants a mix of analytical, creative processes with an emphasis on the user's potential needs. Field studies supporting such processes have a broad role in securing, design reflection and the designer's experiential understanding of the use context in addition to data collection.

WHEN DESIGNING for users in the maritime domain, it is necessary to develop detailed knowledge about users, their context and their activities. To do so, designers employ a range of methods such as literature reviews, interviews, focus groups, workshops and collaborative design. Common for these methods is that although they may generate useful knowledge about users, their activities and the context, they all offer indirect access to the use context. We consider such indirect access to the work context to be problematic for user-centred design processes. This is because it is easier for users to recollect and comment on their work while being present in their work context. It is also much easier for designers to understand work practices when seeing them performed in real life.

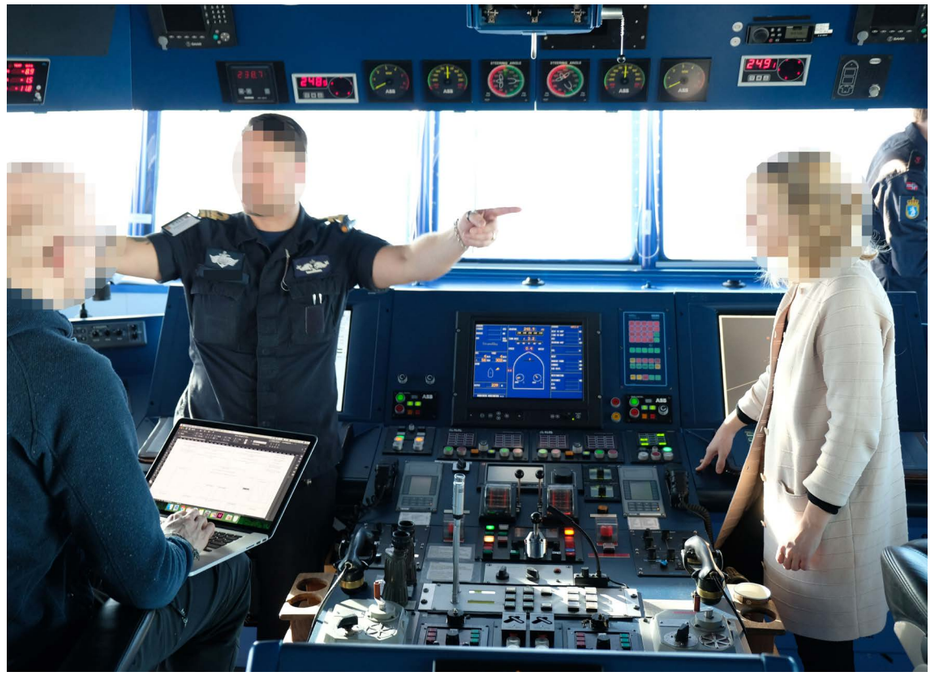
Based on experiences from undertaking field studies supporting design processes, we propose that field studies are integrated parts of design processes, that are planned and executed according to the evolving needs of design processes. We suggest three main motivations for undertaking field studies for design: data mapping, experiencing life at sea and design reflection.

Data mapping

Design processes require a wide range of information about users, their activities and the context. Each project will have different requirements in terms of what data to collect. However, since field studies are costly and an innovation process might venture into unknown territory, we recommend a broad approach to data collection in design-oriented field studies. This includes observations of and interviews with users, data capture from ship systems, as well as the comprehensive collection of media from the observation site.

Experiencing life at sea

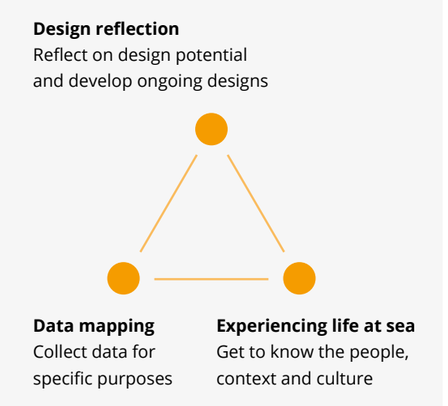
We emphasise the subjective personal experience of being on board a vessel as important for building designers' maritime competence. Consequently, we suggest an ethnographic approach to field studies where designers engage in the maritime workplace. This involves familiarisation with life on board the vessel in addition to the work activities. It also involves understanding the environmental and temporal aspects of being at sea through personal experience.



Design reflection

We suggest integrating design refection into field study processes. This includes evaluating design potential, developing ideas and concepts while in field and using the field to prepare for idea generation later in the design process. This involves bringing early-stage ideas to the field as well as including users in design processes while on board. By integrating design refection into the field study process, designers can take advantage of having the full richness of the context and the relevant users at hand when developing their design.

We see design-driven field research as closely integrated into design processes in such a way that we encourage design reflection in the field. Although field research is usually positioned early on in the design process, we encourage design reflection before, during and after the field research has been carried out.



A 10-day course in field studies

The project has developed a practice-focused course in field study methodology through three iterations. It is now a permanent course at AHO where all third-year design students are exposed to undertaking field studies on ships in operation. This is an important step in building Norwegian designers' understanding of designing for Ocean Industries.

SINCE FIELD STUDIES are costly and time-consuming, it is necessary to get as much value as possible from the studies that the company invests in. In order to improve the cost benefit of such studies, it is important to both improve the efficiency and relevance of field studies for the design projects they support.

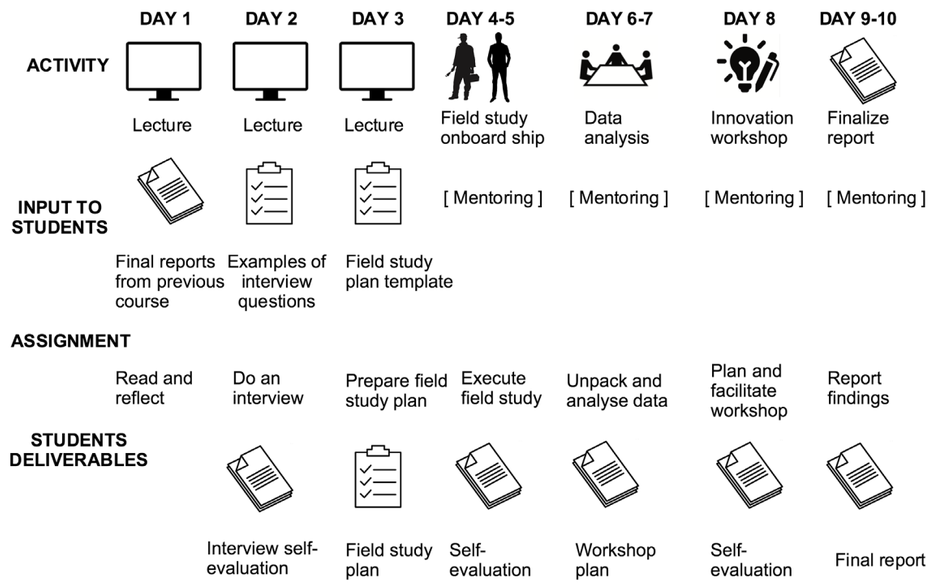
The 10-day course is designed to train the students in how to carry out a field study and be resource efficient and to ensure that the field study can translate efficiently to ongoing design processes ashore. The learning philosophy of the course is to offer learning experiences through practice followed by self-reflection on these experiences.

The students are divided in small teams and each team approaches the field study as part of a design project where they develop design concepts and present these in their final report. We emphasise reflection on the experiences of being in the field throughout the course to train the students in reflecting on their own experiences. Finally, we introduce methods and processes that aim to improve efficiency and the quality of their observations and documentation.

Over two intensive weeks, the students experience a complete field study process, including planning and undertaking a realistic field study, analysing, writing up the data, and sharing and reflecting on the data with other designers. During the course, we arrange a series of lectures and smaller tasks as well as offering templates and tools supporting each stage of the field study process.

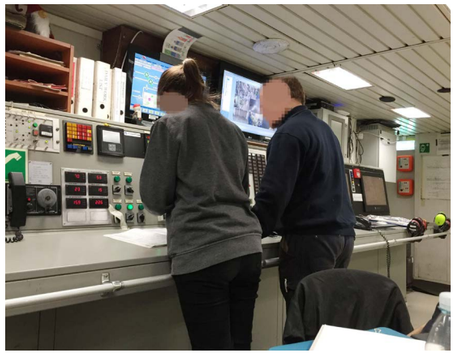
The course has the following goals:

- Understand the importance and ethical dimensions of field studies for design.
- Learn to plan effective field studies.
- Learn to use the most important observation methods.
- Learn to reflect on design processes while in the field.
- Learn to organise data from field studies.
- Learn to analyse field data, individually and as a team.
- Learn to share insights from field studies.
- Learn to write field study reports.



The course has already been fully implemented in 2016, 2017 and 2018, where 20–30 design students were trained to undertake field studies on large passenger ships in collaboration with Fjordline and Colorline. The ships were selected for three main reasons: they have regular routes, which simplifies the course's logistics; they offer a diverse set of observation sites, allowing us to undertake varied field studies, and; they are large enough so that we can distribute many students throughout the ship without interfering with the crew's operation.

Our experience of running the course is that it is an effective introduction to field research in design. It is also an important contribution to design practitioners' understanding of how to understand users and the user's context in general and in the maritime domain in particular. The course will be continued at AHO after the end of ONSITE.



Linking ship architecture and maritime operations

It is a challenge to integrate end users who can inform the ship design process with their knowledge and experience of operating a ship. The OPeration–ARchitecture (OPAR) model lays out a framework that helps to bring maritime operations naturally into the ship design process.

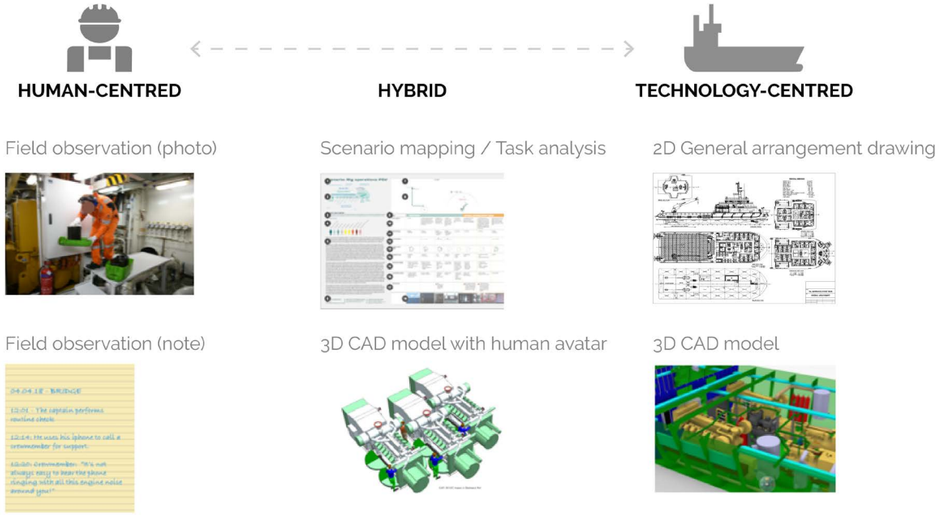
ACROSS STAKEHOLDER GROUPS involved in the ship design process such as designers (ship designers, sub-contractors, ship yards) and the end users of the design object (ship owners, ship managers and operators, the ship's crew), the involved stakeholders have different levels and directions of expertise. Consequently, frameworks for understanding the separate parts of ship design can be hard to share across disciplinary gaps. This is especially important for the gap between the technical expertise of the ship designers (design) and the operational experience of the end users (operation).

The gap between design and operation is a serious challenge, since miscommunications and non-inclusive design processes can lead to sub-optimal or even unsafe ship design solutions. Designers need to understand the tasks of the human operators during ship operations and use this understanding to create designs that are compatible with all the systems the ship users interact with.

To help bridge the gap between operations and ship design, we have developed a framework in which design activities that combine a technology-centred perspective on ship systems and a human-centred perspective on the use of ship systems can take place. We call this the OPeration-ARchitecture, or OPAR framework, where ship design is modelled as a concurrent exploration of the operation of the ship (how the ship is used) together with the architecture of the ship (what the ship is made of).

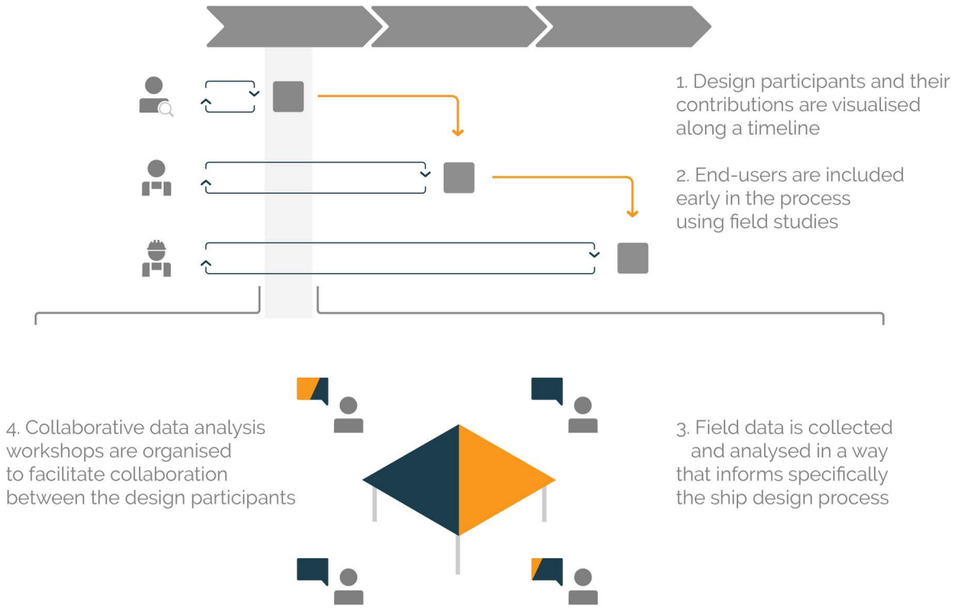
We model the ship's operations as the combination of work tasks carried out by the ship's crew when engaged in the operation of the ship. We model the ship's architecture as the combination of the systems that make up the ship. OPAR places the human-centred representation of the ship operations next to the technology-centred representation of the ship, and proposes design activities that connect these two representations. Because ship design is iterative, OPAR also includes design activities related to the generation and evaluation of concepts.

Similarly to starting a design process by looking at existing ships, we recommend starting the design process by undertaking a field study on a similar ship to map the working and living conditions of the end users of the ship, as well as how they are currently performing ship operations. Using these field insights, we then recommend analysing how the existing systems on board the ship enable its human operators to use the ship and identifying design problems that might impact the safety and efficiency of ship operations. From this analysis, we recommend sketching what architectural solutions might enable the human operators to perform their work in better conditions.



In addition, OPAR can be used in other use cases such as:

- *Retrofitting new systems* to check if the new systems require a change in their operational procedures. Conversely, the designer can start with the analysis of an operation and use it to select a specific system that allows the operation to be performed in a better way.
- *Repurposing of the ship* to check how different operations can be used with the same ship ar-



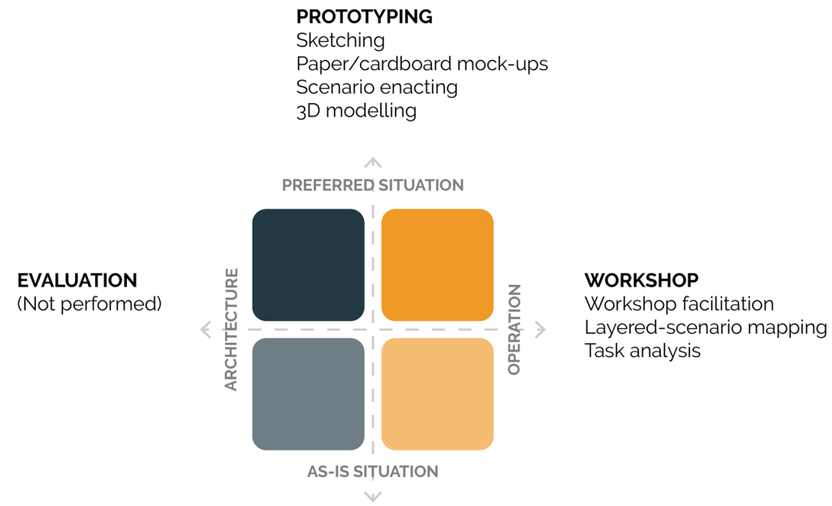
chitecture, or if the architecture needs to be modified to perform the desired new operation.

- *Designing autonomous and remote-controlled ships:* In this case, both operation and architecture can be partially unknown. The operation of the ship might not be spatially constrained to the ship, with ship control centres being placed ashore. In the case of automated systems from which humans are progressively being removed, there needs to be an analysis of what human operators do and how they do it to derive what can be automated, and how.

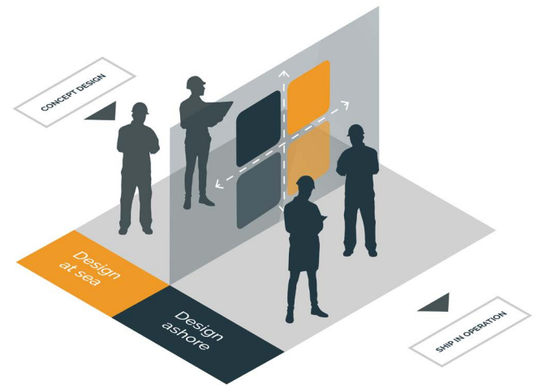
We designed OPAR so that it can enable several types of connections in the design process:

- Connecting design process steps such as early concept design and detailed engineering.
- Connecting design activities such as, for example, system mapping and task analysis.
- Connecting design activities that take place ashore with activities that take place at sea.
- Connecting human-centred, qualitative design data with technology-centred, quantitative design data.

Linking ship architecture and maritime operations



We believe that using OPAR has the potential to open up new perspectives on the design process. We observed that designers who worked with ship workplaces and end-user experiences were triggered to think about their own experience as designers and how their work might impact the experiences of the end users.



The PON–Ulstein engine room case

How can we design engine rooms that cater better to the needs of their human operators and how can we do this through a design process that involves multiple companies and competences? We facilitated a human-centred, collaborative, field-driven design process together with PON Power and Ulstein.

SHIP DESIGN IS A decision-making process and communication is one of the main design activities. As such, there is a need to secure undistorted communication and equal roles in the dialog among stakeholders of the ship design process. The facilitation of information sharing between design stakeholders is also important for exploring innovation opportunities lying at the crossover points between different design steps executed by different design stakeholders.

The traditional approach is that a subcontractor delivers a detailed design proposal that is included in the overall ship design concept by the ship design company. In terms of the design of engine rooms and engine control rooms, we uncovered the following challenges with this approach with PON Power and Ulstein:

- PON Power needs to integrate many different systems into a coherent and compact engine room without the possibility of being able to modify any of the integrated systems.
- The technical drawings need to be shared as fast as possible with Ulstein so that they can start integrating this part of the ship with the rest of the ship.
- Even when the final technical drawings are very detailed, the shipyard will need to add more systems during the construction phase, which might impact the original design quality.

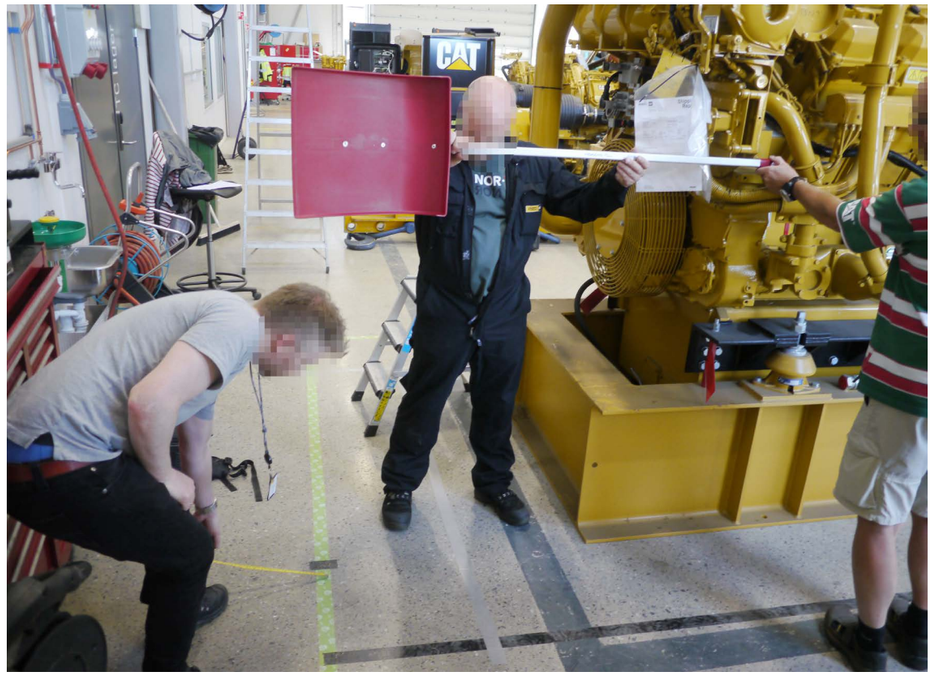
To address these challenges, we implemented a three-step process.

First, the field study focused on PON Power's part of the ship design process, with the objective being to better understand the experience of their end users working in the engine rooms: *How can we design for better experiences of ship engine rooms?*

Then, the post-field study workshop focused on how PON Power and Ulstein could collaborate when designing a ship with an engine room that would cater for the needs of the ship's crew and how they could secure the quality of the design all the way up until the delivery of the ship.

Finally, in the prototyping session, we tested a concept that was generated during the field study and the workshop that had the potential to improve the design process through the modelling of operational-use scenarios in a 3D CAD model.

We started by visiting PON Power's office and engine systems integration site. Then, one researcher from AHO spent five days on board a platform supply vessel designed by Ulstein and built in China with an engine room designed by PON Power.



The field observations focused on:

1. The tasks performed by the crew in the engine room during the supply operations of the ship.
2. The systems used to perform these tasks.
3. The experiences of the crew when using these systems.

As a result, we identified two main problem areas:

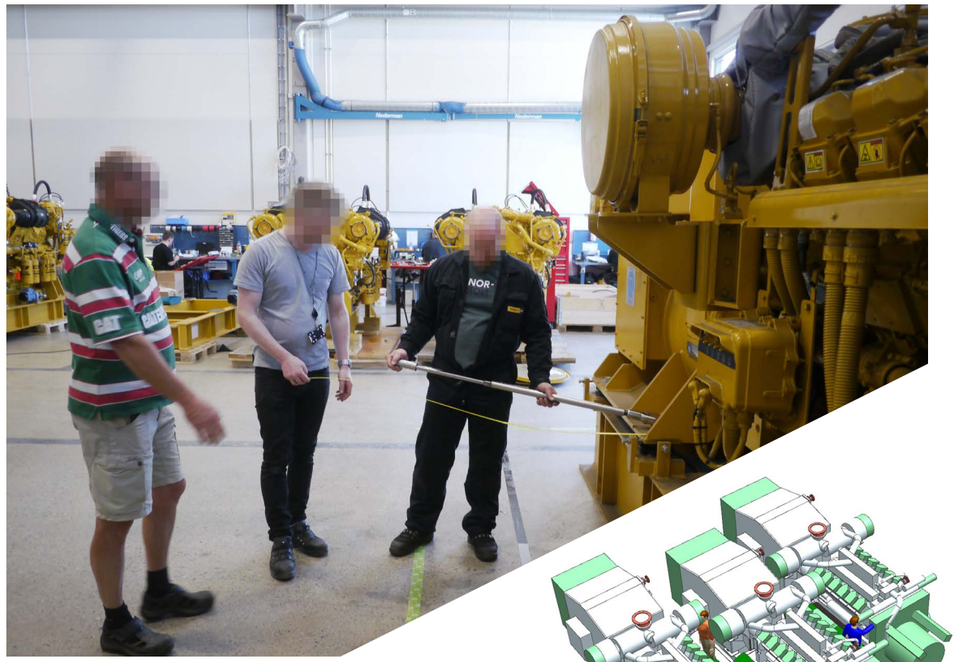
1. *The engine as a working place:* The engine needs to be seen as the central element of a working place where human operators need to carry out work tasks every day.
2. *Engine integration in the engine room:* The engine's integration into the whole engine room needs to enable the human operators to carry out their work tasks in the safest and most efficient way.

We then facilitated a workshop with PON Power and Ulstein to explore their own experience in the design of engine rooms and their integration into the overall ship design. We identified design problems that repeatedly came up during the design of engine rooms and sketched opportunities for addressing these problems.

Before the workshop, we prepared visual concepts that summarised the ideas generated during the field studies and discussed these only with PON Power. The visuals helped in facilitating the workshop conversations and triggering improvements and new ideas.

There were two main outcomes of the workshop. First, a common understanding was reached of the engine room design requirements built upon the perspective of the end users and the design stakeholders in their respective contexts of use. Second, a concept emerged for a collaborative design process and a collaborative format supporting this process.

We went back to PON Power's office to proto-



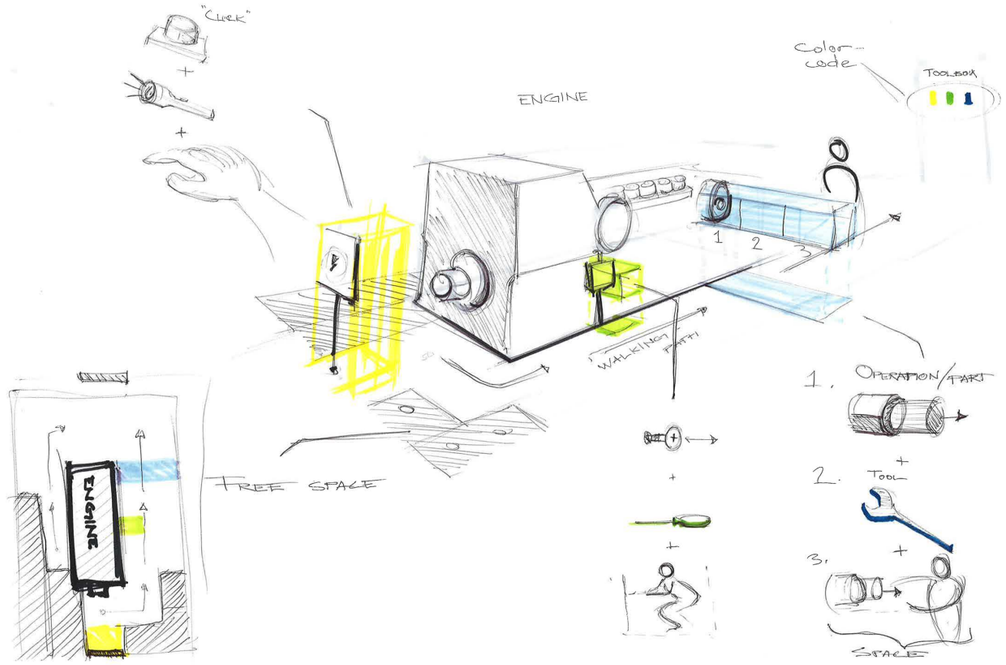
type the concept for a collaborative, human-centred design approach to engine room design. We filmed one of PON Power's service mechanics while he performed service interventions on an engine. We found and built mock-ups that reproduce the sizes and shapes of different engine parts and servicing tools. This enabled us to document in video and then transfer onto a 3D CAD model how a service intervention is done, what tools are used and what space is required around the engine for the mechanic to work under safe and optimal conditions.

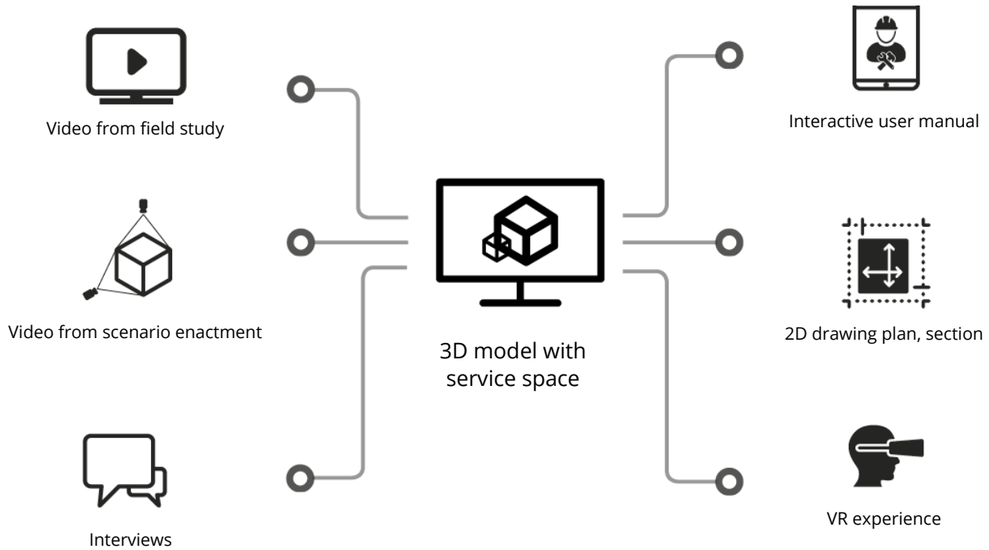
The concept of human-centred engine rooms that was developed in this case has the potential to enable more efficient maintenance and service interventions for the end users of the engine rooms, which reduces the risks of injury, system failure and operational downtime.

For the design stakeholders involved, the use of human-centred design methods has the potential to improve the detection of design flaws and, consequently, to reduce the risk of additional design iterations to correct these flaws.

The design process itself enabled each company to stimulate internal and external collaboration. With PON Power, we connected a service mechanic with a 3D modelling engineer, a yard supervision engineer and the technical director. With Ulstein, we connected concept engineers working with machinery and hull design with engineers working with detailed ship design. Last but not least, we connected all these design stakeholders together with the end users of their design artefacts.

Looking at the cost of our approach, the field study took approximately 100 hours and the workshop approximately 50 hours, including all preparatory and conclusive work. Per Olaf Brett from Ulstein explained afterwards: “Cost [of field studies] is not an issue. (...) Field studies can be very valuable for the downstream design process.”





The DNV GL ship survey case

Each one of the many DNV GL ship surveyors performs up to 200 ship surveys per year. A ship survey is actually a form of field study where the ship surveyor captures *in situ* information about the use of the ship by the crew. How can we improve the efficiency of the ship survey and its use as a knowledge base for ship design and operation?

THE SHIP SURVEY PROCESS is one element of DNV GL's Classification system. It is connected to a large database of ships, technical documents, 3D models and official documents such as quality certificates. Ship surveys take place all the time, all the over the world. As such, the process is part of a complex system that is accessed daily by many users, both DNV GL employees and their customers.
To deal with this complexity and to improve the efficiency of the system, DNV GL has been working on a large digitalisation program. Together with DNV GL, we focused on how the work of surveyors might be impacted by the digitalisation efforts, and how their work might be supported by introducing new tools and new approaches for performing ship surveys.

We focused on three questions:

- What are the activities/tasks the surveyor engages with during the ship survey?
- What activities might be performed by someone else than the surveyor? What activities might be performed by the surveyor remotely instead of him/her being physically present on the ship?
- What knowledge captured by the surveyor might be relevant for ship design and operation problems? How can we access this knowledge?

To address these challenges, we implemented a three-step process.

First, we carried out interviews ashore with DNV GL surveyors to map the process they were currently going through when performing a survey. Based on this, we designed a plan for a field study and carried it out shortly afterwards. Two researchers from ONSITE followed two DNV GL surveyors for one day when the surveyors were inspecting a ship berthed in Bergen.

Then we held a workshop with DNV GL consultants working with the digitalisation and innovation process to explore and analyse the findings of the field study.

Finally, we held another workshop with DNV GL consultants, DNV GL Class representatives and DNV GL surveyors to review the concepts developed by DNV GL consultants in parallel with the field study. We also started to plan upcoming field studies to continue working on the concepts.

The preliminary interview and the field study enabled us to map the survey step by step along a timeline, following the structure of a task analysis.

This map gave us detailed insights into how to support each task carried out by the surveyor. Specifically, it gave us an insight into whether the task could be performed by another person than the surveyor and if it could be performed remotely. Most importantly, it gave us a qualitative description of the experience of the surveyor when performing these tasks, including how current systems and tools were used and what modifications might be introduced.

During the workshop, we reviewed the task analysis used to structure the field study results in detail together with the DNV GL consultants working with the digitalisation and innovation process. For each finding, we compared our respective understanding of the needs of the surveyor and how they related to the ongoing work done by the DNV GL consultants. This enabled us to transfer our field experience to the DNV GL consultants who had not necessarily had the opportunity to follow surveyors during a survey.

After that, we had a meeting with Class representatives to share the field study findings and present our list of concepts in order to align them with their own work on the digitalisation of the process. Based on this, we updated and validated the list of prioritised concepts together with the surveyors. We all met in a final workshop where the DNV GL consultants and Class representatives presented their concepts to the surveyors and the surveyors gave feedback. We concluded by planning further field studies that DNV GL consultants could carry out on their own.

The field study confirmed several assumptions the DNV GL consultants were working on in parallel and helped them refine their concepts.

The process put surveyors, station chiefs, consultants, section managers, and innovation managers in contact and enabled them to share their respective experience.

The DNV GL consultants went on to carry out field studies on their own afterwards. Their feedback was that experiencing the life and work of surveyors was very valuable, and that compared to a traditional interview, a field study gave richer data by allowing for more spontaneity and observing actual situations.

The Ulstein fishing vessel case

When Ulstein started to work on the design of the next generation factory stern trawler, it immediately carried out a short field study. Ulstein developed a new concept and asked AHO to help in performing another field study to test this concept and help additional ship designers to gain operational experience.

WORKING WITH THE DESIGN of a new type of ship means working with limited knowledge about how this type of ship operates, what systems are installed on board and what the crucial elements are that need to be included in the new design. Undertaking a short field study at the beginning of the project helps in starting to explore these issues, but there is much ground to cover in a limited time. In spite of all the limitations and challenges, Ulstein needed to produce a balanced design as the outcome of the pre-contract phase.

AHO joined Ulstein's team towards the end of the Accelerated Business Development (ABD) process. The objective was to help Ulstein collect feedback about the concept it was working with and to gather field data that would be useful for the downstream design process. AHO worked with Ulstein to find out what critical knowledge was needed to be obtained during the field study and how to obtain it in the most efficient way.

To address these challenges, we implemented a three-step process.

First, a workshop was set up to prepare the field study. The workshop actually took place just hours before going on board the ship. We gathered as a team with one researcher from AHO and three engineers from Ulstein and went through everything we knew about this type of ship, what we did not know, what we wanted to find out and we put a plan together to do so.

Then, we went on board the ship and started to work while the crew was finishing loading up the ship. We left the harbour a couple of hours later and came back a couple of days later because the ship needed some repairs.

Finally, we analysed the field data collectively with the same team and managed to do this remotely, with one field researcher from AHO located in Oslo and the three Ulstein engineers located in Ulsteinvik.

The Ulstein team had gathered much operational data already through a preliminary field study, as well as videos filmed by ship crews on board similar ships. In addition, the team had developed a new concept for this type of ship.

To prepare for the field study, we undertook a layered scenario mapping that broke down the main operations of the ship along a timeline, with several rows of information for each time step. There we mapped what systems were most likely used by the crew, what we wanted to check out regarding these systems, how they might impact the safety and efficiency of the operations, and how they related to the new concept developed by Ulstein.

Following this workshop, the goal of the field study was then to review, step by step, the map we had produced, to update it and correct it with first-hand information from the observation of the ship operations and interaction with the ship crew.

The crew generously gave us one room on the ship where we could gather to debrief in terms of our observations and invite crew members to review our work. When Ulstein's engineers started to show sketches of their concept to the ship's captain, he started to build a model with paper and cardboard to make sure he understood correctly. As a result, we built more models and got valuable feedback about what should be improved regarding the concept.

On returning from the field study, we updated the layered scenario map with the objective of using it further in the design process. We used a spreadsheet to prototype the map and got the help of a design student from AHO to visualise the map in a clear and efficient way. We also wrote a design guideline document that summarised the most valuable teachings from the field study. The contents of the guidelines were insights that could only be obtained through field experience.

Ulstein's engineers reported that its customer was impressed by its field observations and analyses. Despite Ulstein's limited experience with this type of ship, the team had made observations and produced concepts that the customer had not thought about previously, despite the customer's lengthy experience with the matter at hand. Ulstein went on to sign a contract with this customer and produce several other design variations for this new ship segment.

The whole process enabled Ulstein to train its engineers on how to prepare for a field study, perform field observations and work with the findings in the downstream design process. Ulstein is now training more people internally at undertaking field studies and it has developed its own routines. Per Olaf Brett commented in a project seminar: "From now on, we will never undertake a new ship design project without using the field study methodology."

Undertaking field studies: The process

Undertaking field studies in a design process has the potential to improve the design data quality, the team's experience and design judgement. However, it is a method that is not common in current design processes. We created a four-step process with detailed descriptions of the tasks to be performed by the design team, the input and output data created during each step and how collaboration takes place between team members going into the field and staying ashore.

The process consists of:

- Step 1: The field study itself, with all the preparations required to enable the team to collect rich data relevant to the downstream design process in a time-efficient way.
- Steps 2 and 3: The structuring and analysis of the data through individual work (step 2) and collaborative data-analysis workshops (step 3).
- Step 4: The dissemination of the data to the right people in the right way.

The team should always keep in mind the three main outcomes the process is designed to lead to.

First, the end users of the object being designed must be placed at the centre of the design process. The designers need to focus on capturing the needs of the end users they design for and transferring these needs into the design process.

Second, to place safety and efficiency first in the decision-making process. The qualitative field observations need to be translated into operational requirements where safety and efficiency are always the priorities of the designers.

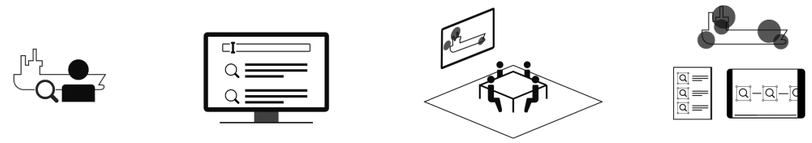
Third, a high-value delivery must be targeted. The whole process should be effective and efficient, justifying its cost and use in a design process, and it should connect with existing design processes. It should support and encourage multi-disciplinary communication and collaboration. In other words, the process should create more value than the value of its individual deliverables.

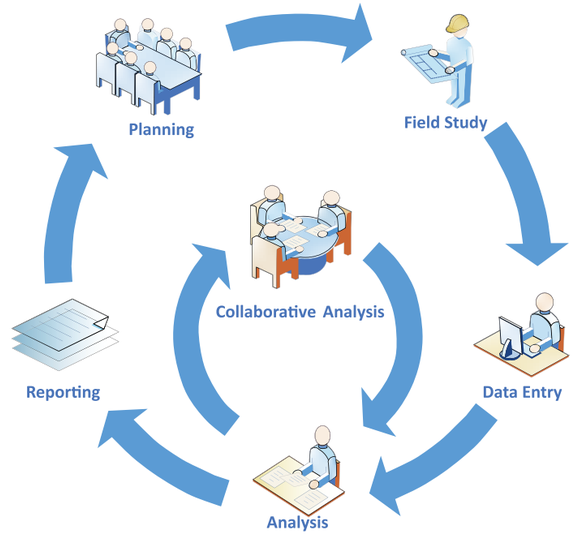
Planning field studies

The goal of this step is to design a field study that answers the needs of a specific design process. This is done in a top-down manner, starting from what information the onshore design team needs from the offshore/field team in order to infuse the downstream design process with insights about how end users currently use ships and ship systems. A field study plan is prepared to detail how to collect this information in the most efficient way and how it will be structured and used in the next phases.

Undertaking field studies

The field study plan is implemented by the team. In practice, this requires the team members to perform the three activities described by the design-driven field-research model: data collection, design reflection and simply experiencing being in the field with end users. By following this model, the field study team can combine a strict implementation of the field study plan, while at the same time allowing for the observation and capture of events that were not necessarily planned – because nothing ever goes according to plan.





Analysing field studies

During the data entry and analysis phase that takes place after the field study, the team members need to transform their hand-written notes and media collection into a structured, digital set of data. The data should be structured according to both the timeline of the field study observation, and thematically according to the field study focus areas. We recommend initially going about this process individually and then as a team in the form of a workshop. This is where individual observations are turned into team insights, and where design concepts can emerge and be criticised before further refinement. In other words, this is where field data takes on its full value.

Sharing field studies

The goal of this step is to update the reporting material produced to support the analysis phase and to turn it into the final deliverables of the field study. We recommend working on a dissemination strategy where the best-suited individual to receive the field-study results is identified and involved in the analysis of the results. The deliverables should consist of material that communicates the field study objectives alongside details of the main study findings, including opportunities for change, modification and innovation. To disseminate the deliverables, we recommend prioritising a face-to-face presentation and handover in order to possibly already plan a subsequent field study.

Managing field data

Field studies generate data that is not usual for ship designers to deal with. ONSITE has documented what type of data is created and has proposed strategies to manage it and use it in ship design processes.

WHEN FIELD RESEARCHERS come back from a field study, they bring back many observations, ideas, photos and videos that will be useful in the downstream design process. But before being usable in the design process, the data needs to be digitalised, structured and analysed. To support this process, we have built a data architecture model to help extracting the full value of the field data.

Field data produced

We analysed the field studies carried out during and before the ONSITE project and structured the produced field data into the following categories:

1. Text paragraphs describing the data and its analysis, present in field study reports.
2. Interviews. Transcripts of interviews with questions.
3. Scenarios. Linear descriptions of procedures captured from a variety of sources.
4. Timed observations. Linear descriptions of a sequence of timed activities related to a single observation.
5. Photos, videos. Digital images/video files.
6. Sketches. Digitised drawings related to, for instance, observations or concepts.
7. Maps. Overview of the physical spaces on the ship in the immediate vicinity or the large areas.

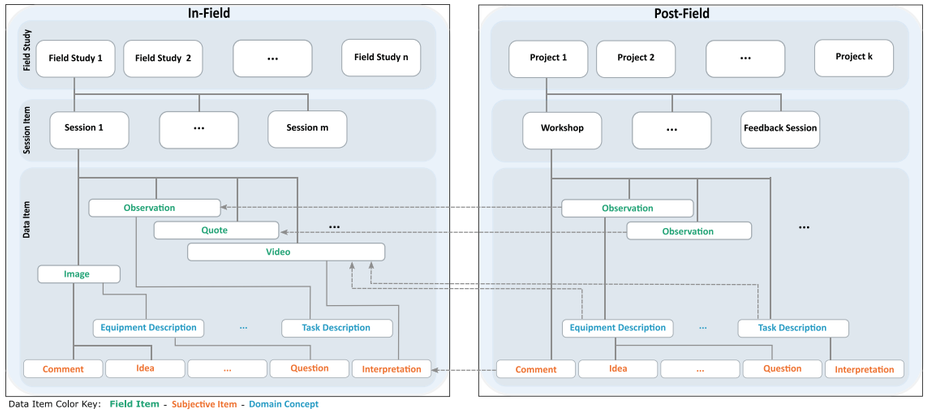
Relationship to the design data

Then we looked at how these types of data related to design processes. We proposed the following epistemological categories that also allow us to describe the degree of subjectivity of the data:

1. Descriptions (of systems, roles and so on, based on documentation, regulations etc.).
2. Observations (subjective, authored by a field researcher).
3. User input (subjective, authored by a field informant).
4. Interpretation (subjective, authored by a field researcher).
5. Design problem (subjective, authored by a field researcher).
6. Design ideas (subjective, authored by a field researcher).
7. Potential for improvement (subjective, authored by a field researcher).
8. Question (subjective, authored by a field researcher).

Atoms of data

To keep track of the field data and the metadata (when it was produced, by whom etc.) and ensure consistency in data types, we proposed elementary units of data or data atoms that all share the same attributes. Each data atom may be (for instance) a photo, a drawing, a video clip, or a piece of text (preferably a single sentence). It will typically have the following attributes:



1. A description. For a short text item, this is its actual content.
2. Event time. This is the time of the event which is described by the item, or, for an observation, the time it was made.
3. Author. This is the ID of the researcher who collected the data in the field, or if the item is a post-field comment, the author of the comment.
4. Informer. For user input, this is the user who made the statement.
5. Creation time. This is the time that the item is recorded in the computer system and it can be recorded automatically.
6. Creator. This is the ID of the user entering the item into the system and it can be recorded automatically.
7. File reference. If the item is essentially a media file (image, video, long text document), the file is referenced by a URL.
8. Epistemological type. This is used to distinguish between objective data (observations, descriptions), creative data (ideas, questions), analysis and interpretations, user input etc.

Data hierarchy

Finally, we proposed a data hierarchy that keeps track of the field studies where each data atom has been produced. Because each field study is made up of several observation and reflection sessions, we added an additional layer to gather data atoms under the specific sessions that enabled the production of the observation/reflection. The data hierarchy we proposed thus has three layers:

The root node is an item which describes the field study as a whole. It is stored as an item with a few extra attributes to record metadata about the ship and mission which was studied.

The field study is an ordered sequence of sessions, where each session has a well-defined duration and purpose. Usually there is idle time or a change of scene between the sessions, but exactly what constitutes a session is left for the users to decide. Each session contains an ordered list of data atoms.

Using the database

The fundamental idea of ONSITE is to build a database that can be used across field studies and across design projects that are informed by the field studies. The data architecture we have designed enables detailed search queries to be run in the entire database of field data gathered by a company over time. For instance, the user can search for all field data related to a specific type of ship (ex: platform supply vessel), ship operation (ex: engaging navigation in dynamic positioning or DP) or ship system (ex: DP console in the engine control room). The user can also search for data related to specific design problems (ex: ergonomy, safety, efficiency) or design ideas (ex: joystick, digital user interface).

Digital field study tools

With a data architecture backbone in place, we have explored what types of digital tools could support field-driven design processes.

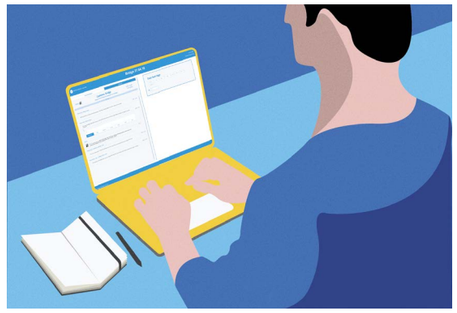
THE ANALYSIS OF our experiences when carrying out field study cases has provided us with ideas regarding how to make the process more efficient and effective. One example of a gain in efficiency is to shorten the time required to process the data. Effectiveness is related to how useful is field data and its analysis when injected into the design process. As such it is critical to ensure that all the field observations and reflections are logged in the database, and that the data most relevant to the design process at hand is properly flagged as an idea, a problem and so on. Finally, because the process involves several handovers and several disciplines, tailor-made output formats can be created to communicate field insights to the whole design team.

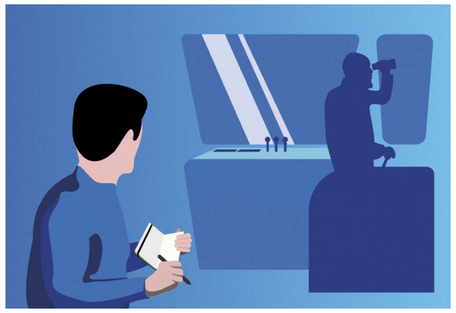
A data entry tool

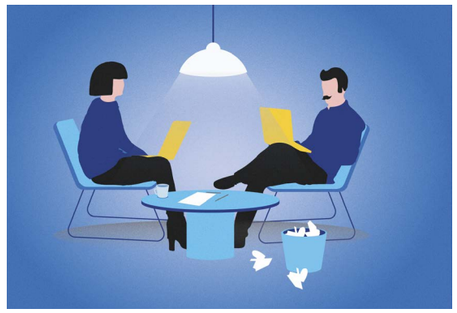
We have prototyped a user interface concept that makes it very fast for a field researcher to write up hand notes, upload the collected media, and then flag and tag the data according to its relevance for the design process. The concept uses the principle of a chat interface (like in, for example, Skype, Slack, or Facebook messenger) where the user writes short text messages. The user can either have a conversation with himself/herself or reply to the stream of data/messages typed in by another field researcher. Sometimes, long conversations between different stakeholders might arise from a particular data item, and the data model will then capture the entire conversation as data that may subsequently be analysed. The chat analogy also works when a user adds subitems to his or her own item to elaborate or exemplify, just like users sometimes reply to their own messages on social media platforms. We believe that such a user interface allows for time efficiency and a good workflow.

Analysis is data

The chat concept makes the system very versatile to use. It can be used by one or several users, at the same time or not, being present in the same physical space or not, during any step of the process. Because the length of each message is limited, the chat interface intrinsically supports the splitting of long texts into short fragments. This fragmentation helps in storing a large number of data atoms that each focus on one single aspect of the field observation or design process. Each data atom can be enriched by annotations and additional content added by multiple users at multiple times. This is what we mean by "analysis is data": Each time a data atom is commented on, its connection to ongoing and future design conversations is strengthened. The overall data quality comes from the quality of the design conversations and relies on the quantity of data atoms and their individual accuracy and their anchoring to design conversations.







A scenario editor

A scenario map is an ordered sequence of ship operation phases with a structured and detailed description of each phase. For example, the operation of engaging the Dynamic Positioning (DP) system will start with the captain calling the chief engineer in the engine control room, who will send a mechanic to check all the critical systems in the engine room, who will then report to the chief engineer, who will report to the captain, who will eventually start the DP. Each phase of the operation can be described in terms of, for example, the crew involved, the systems used by the crew and the work tasks they performed. Inputs from the crew about their experience when carrying out these tasks can be collected and added. Reflections from the designer about how to improve a system or a task can be added. The scenario is modelled as a matrix with operation phases as columns and layers of information as rows; columns and rows can be added by the user. The ONSITE tool provides a number of automatic features to generate scenario mappings quickly in a format that makes it easy to append and present. As a result, a library of maps can be progressively produced in the database.

A report generator

The most common deliverable of a field study is a field report. Depending on the need of the design team, the report can target different aspects of one field study or explore issues across field studies. The principle of the report generator is to allow the user to select the data atoms he or she wants to highlight in the report and generate a report draft that only includes these atoms. As with the scenario editor, there is a degree of automation that can be implemented. For example, the hierarchy of atoms can be reused as a hierarchy of chapters and sections in a report: one report per field study; one report chapter per field observation session. Metadata about the field study becomes an introduction. Data atoms flagged with design idea can be turned into a list of design ideas. The report is produced in an HTML format, which makes it simple to share and comment on in a web browser or import into a word processor for further editing.

Publications and further reading

Further reading per section

Design-driven field research for Ocean Industries
>> Lurås, Sigrun., Nordby, Kjetil. (2015). Shaping designers' sea sense: A Guide for design-driven field research at sea. *The International Conference on Marine Design.* London, UK: The Royal Institution of Naval Architects.

A 10-day course in field studies
>> Gernez, Etienne; Nordby, Kjetil. 2019. A 10-day course to plan and execute field studies for maritime design processes. *The International Journal of Marine Design, in press*

Linking ship architecture and maritime operations
>> Gernez, Etienne. (2019). Connecting Ship Operation and Ship Architecture in Ship Design Processes. *Journal of Ship Production and Design* 35 (1), 88–101.

The PON – Ulstein Engine room Case
>> Gernez, Etienne, Kjetil Nordby, Øyvind Seim, Per Olaf Brett, and Rune Hauge. (2018). Human-Centered, Collaborative, Field-Driven Design – a Case Study. In P. Kujala & L. Lu (Eds.), *IMDC 2018: 13th International Marine Design Conference* (Vol. 1, pp. 291–305). London, UK: CRC Press / Balkema.

Doing field studies – The process
>> Gernez, Etienne; Nordby, Kjetil. (2019). Implementing Field Research in Ship Design. *The International Journal of Marine Design, in press*

Managing field data
>> Nordby, Kjetil; Schaathun, Hans Georg; Gernez, Etienne; Lurås, Sigrun. (2019). A conceptual framework for reporting field research for design in the maritime industries. *The International Journal of Marine Design in press, in press*

>> Schaathun, Hans Georg; Tran, Que; Tollefsen, Mikael; Gernez, Etienne. (2017). Data and knowledge management in field studies: A case for semantic technologies. *NIK: Norsk Informatikkonferanse, Oslo, Norway.*

Digital field study tools
>> Schaathun, Hans Georg; Nordby, Kjetil; Saad, Aya; Gernez, Etienne. Tool-Supported Analysis Process for Field Studies. Journal article. (in progress)

>> Saad, Aya. Layered Scenario Mapping Tool for Field Studies. Journal article. (in progress)

Publications

Gernez, Etienne. Human-centred, collaborative, field-driven ship design. PhD Thesis, The Oslo School of Architecture and Design. (in review)

Ocean Industries Concept Lab. Field studies for maritime design processes. Course handbook, The Oslo School of Architecture and Design. (in progress)

Schaathun, Hans Georg; Nordby, Kjetil; Saad, Aya; Gernez, Etienne. Tool-supported analysis process for field studies. Journal article. (in progress)

Saad, Aya. Layered scenario mapping tool for field studies. Journal article. (in progress)

Gernez, Etienne. (2019). Connecting ship operation and ship architecture in ship design Processes. *Journal of Ship Production and Design* 35 (1), 88-101.

Gernez, Etienne; Nordby, Kjetil. 2019. A 10-day course to plan and execute field studies for maritime design processes. *The International Journal of Marine Design, in press*

Gernez, Etienne; Nordby, Kjetil. (2019). Implementing field research in ship design. *The International Journal of Marine Design, in press*

Nordby, Kjetil; Schaathun, Hans Georg; Gernez, Etienne; Lurås, Sigrun. (2019). A conceptual framework for reporting field research for design in the maritime industries. *The International Journal of Marine Design in press.*

Gernez, Etienne, Kjetil Nordby, Øyvind Seim, Per Olaf Brett, and Rune Hauge. (2018). Human-centered, collaborative, field-driven design – A case study. In P. Kujala & L. Lu (Eds.), *IMDC 2018: 13th International Marine Design Conference* (Vol. 1, pp. 291–305). London, UK: CRC Press / Balkema.

Schaathun, Hans Georg; Tran, Que; Tollefsen, Mikael; Gernez, Etienne. (2017). Data and knowledge management in field studies: A case for semantic technologies. *NIK: Norsk Informatikkonferanse, Oslo, Norway*.

Frydenberg, Synne Geirsdatter; Hareide, Odd Sveinung; Nordby, Kjetil. (2018). Feltstudier for design av utvidet virkelighetsteknologi i navigasjon. *Necesse* 2018 ;Volum 3.(2) s. 67-70

Lurås, Sigrun. (2016). Layered scenario mapping: A multidimensional mapping technique for collaborative design. *CoDesig*n, 12(3), 133–150.

Lurås, Sigrun., Nordby, Kjetil. (2015). Shaping designers' sea sense: A guide for design-driven field research at sea. *The International Conference on Marine Design*. London, UK: The Royal Institution of Naval Architects.

Gernez, Etienne., Nordby, Kjetil. (2015). Designing for project collaboration in the maritime industry. *The International Conference on Marine Design*. London, UK: The Royal Institution of Naval Architects.

Schaathun, Hans Georg; Rutle, Adrian. (2017). Model-driven software engineering in the resource description framework: A way to version control. *NIK: Norsk Informatikkonferanse, Oslo, Norway*.

Field study workshops and reports (per industrial partner)

Pon Power
Gernez, Etienne. Field study report. Field study report presentation workshop. 2017-01-11

Gernez, Etienne. Field study follow up workshop. Field study follow up workshop. 2017-03-30

DNV GL
Gernez, Etienne. Field study deliverable: Task analysis mapping of ship survey process. 2017-03-24

Gernez, Etienne. Field study report presentation workshop. Field study report presentation workshop. 2017-03-24

Gernez, Etienne. Field study follow up workshop. Field study follow up workshop; 2017-06-12

Ulstein
Gernez, Etienne. Field study preparation workshop. Field study preparation workshop. 2017-09-12

Gernez, Etienne. Field study deliverable: Scenario layered mapping of trawling and fish packing operations. 2018-02-22

Colorline
11 Student reports. 2016-03-24

Fjord Line
8 Student reports. 2017-03-26

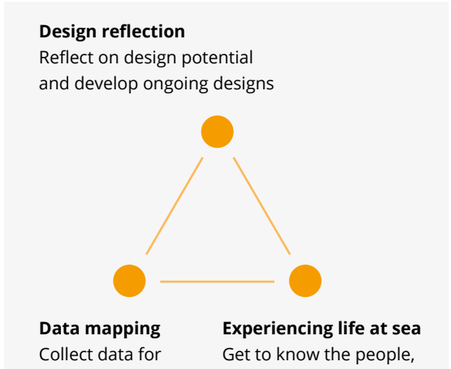
8 Student reports. 2018-03-25

DFDS
9 Student reports. 2019-03-15

Appendix:

A Guide to Design-driven field research at sea*

Design-driven field research[1] is an approach to field research specifically aimed at the needs of designers. The approach focusses on three areas:



- **Data mapping:** Collecting data for specific purposes in the design project. Examples include data related to users and their distribution of roles and responsibilities, user tasks, equipment used, and the users' information needs.

- **Experiencing life at sea:** Addressing social and cultural aspects of sea life as well as understanding its environmental, spatial, temporal and bodily aspects.

- **Design reflection:** Reflecting on design potential, developing ideas in the field, and using the field study to create a basis for generating ideas and 'aha moments' later in the design process.

These focus areas are considered throughout the planning, conducting, and analysing of the field study.

Planning and preparing the field study

It is useful to prepare as much as possible before carrying out a field study. While at sea, one gets quite tired due to the constant motion and because observing is, itself, demanding. A detailed plan can help you stay focussed and cover all that you have planned.

Familiarisation

Familiarise yourself as much as possible with the ship you will be visiting. Identify its technical outfitting and equipment. This can often be found online. Search for the ship's name at www.marinetraffic.com and in Google. Identify what kinds of operations the ship normally takes part in. Consult written documentation, such as training material, guidelines, books and online material. The Nautical Institute[2] publishes a range of specialist maritime books. gCaptain.com is a valuable online resource. There are also mariners keeping useful online blogs.

Define the study's purpose

Define the purpose of the field study. This purpose depends on your situated design work. Will it be a narrow study focusing on specific operations, user tasks or equipment, or a broad study aiming at identifying possibilities without a specific design object in mind?

Decide what to do

Decide which methods and techniques to use to achieve your purpose. Different methods are needed for different focus areas of design-driven field research. It can be helpful to consult literature on design and human factors methods to identify approaches. Methods that may prove useful include the following: shadowing,[3] hierarchical task analysis and link analysis,[4] coms usage diagrams,[5] and applied cognitive task analysis.[6] Adapt the methods to suit for your specific needs. The sources you choose will influence your choice of methods. The users are an obvious source. It may also be helpful to retrieve data from other sources, such as log data from technical systems on board.

Plan the observation sessions. Although it is useful to have a clear idea about what to observe, once in the field you should have an open mind and also consider that which is not planned for. It is useful to prepare some questions that can be used during interviews and as a starting point for discussions with users. Some type of questions, and ways of phrasing questions, are better than others. Things to consider when preparing questions:

- Using a narrative to make people start talking is a good strategy. You can, for example, use 'a day at work' as a starting point, saying, 'Tell me about a typical day at work. What do you do?' You can also use a specific operation or task as a basis for discussion: 'Think about <the operation of interest>. Can you describe what you do?' To shed light on the diversity of the task, you may ask, 'How does your task differ in different circumstances? What about at different times of year? What if the weather turns bad? What if you are chartered by a different company? What if you are performing the operation in a different country? What if you are on a different ship?' etc.

- Consider using 'how' or 'what' rather than 'why' to avoid being perceived as confrontational and making the people you ask defensive. You can ask, 'How did you end up as a mariner?' rather than 'Why did you become a mariner?' to avoid the person feeling that he must have a specific reason for his career choice. If you observed the use of a system during an operation, and you want more information on the user's actions, ask, 'What made you use this system?' rather than 'Why did you use this system?' The latter might imply that the choice of system was wrong, while the former assumes that there was a good reason for the user's action.

- To encourage the user to talk about what works well and not, you can ask, 'Are things better or worse around here than they used to be?'

- To identify what the users consider the most important information, you can ask questions like, 'If you were to go away for a minute to get a cup of coffee, and I was to keep watch for you, what should I pay attention to?' **Note:** The mariners may not accept such a question because it would be against the procedures and compromise safety, but if they accept the question, it can give valuable insight.

- If you are interested in the risk aspects of the mariners' work, you can ask 'What possible occurrence on watch do you fear the most?' to get an understanding of what is the worst event that they find plausible and 'What do you expect will be the nature of the next accident that occurs?' to gain insight on what they consider most likely.

- To elicit the users' strategies for coping with incidents, you may ask: 'If <an event> happened now, what would you do?'

* . by Sigrun Lurås. Available at: https://brage.bibsys.no/xmlui/handle/11250/294200

1. Lurås, S. & K. Nordby (2014). Field studies informing ship's bridge design at the Ocean Industries Concept Lab. In *Human Factors in Ship Design & Operation, 26-27 February 2014, London, UK* (pp. 27–35). London: RINA.
2. http://www.nautinst.org/en/shop/
3. Design Council. 2015. *Design Methods for Developing Services.* Available at: http://www.designcouncil.org.uk/resources/
4. Kirwan B. & L. K. Ainsworth (1992). *A Guide to task analysis.* London: Taylor & Francis; Stanton et. al (2005). *Human factors methods: a practical guide for engineering and design.* Aldershot: Ashgate.
5. Stanton N. A. et. al (2005). *Human factors methods: a practical guide for engineering and design.* Aldershot: Ashgate.
6. Militello L. G. & R. J. B. Hutton (1998). Applied cognitive task analysis (ACTA): a practitioner's toolkit for understanding cognitive task demands. *Ergonomics,* 41(11), 1618–1641;

Design reflection during planning

Design reflection should start before you enter the field, and you should consider making some design proposals that can be presented to the mariners on board to serve as a starting point for discussions. Presenting design ideas is a great way to involve the users in the design process as many find it easier to comment on concrete design proposals than to come up with design ideas themselves.

Decide on the format of reporting

It is a good idea to plan how to document and communicate regarding the field study even in the planning stage as this will help you to capture the data you need in the field. If you plan to make a written report, make an outline for it before entering the field. If you plan to use video, consider what to record and which views may provide useful information. If you plan to develop personas or make other types of maps or models, identify what kind of data you will need. Layered scenario mapping[7] is a technique that can be used to map out a scenario on several layers—along several dimensions and at different levels of abstraction. If you plan to make such a map, it is useful to identify the scenario to map out before going to sea.

Practical preparations

Find a shipping company and captain that will allow you on board. Note that this may be difficult and time consuming. Personal contacts are helpful. Once a shipping company has approved the field study and you know which ship you will be visiting, try to contact the captain directly to make practical arrangements.

Consider how to ensure the privacy of the crew. If you would like to take photos and video recordings, decide if you want to include identifiable people and ask for their permission; otherwise, stick to taking photos and videos where people can't be recognised or anonymise them afterwards. Consider also if the material will be used only within the design project or if you would like to use it externally as well.

Prepare information about the field study for the crew. Consider whether you need to obtain 'informed consent', which means that the crew signs off that they have been informed about the study, its purpose, and how the data collected will be used. Informed consent is normally obligatory for student and research projects. Whether informed consent is required or not, you should make a written sheet including the following: information about the project, which institution is responsible, and contact information to the project manager and/or yourself.

Develop the material necessary to carry out the planned activities, such as observation forms, inter-view guides, design proposals to discuss, a list of what to photograph, etc. Obtain the equipment you need, such as a camera, an audio recorder, and a sketchbook.

Be all set to go!

Life at sea can be unpredictable, and the opportunity to join a vessel may come suddenly. Be prepared to leave on short notice and have your bag packed with all the equipment and materials needed.

What to pack?

- Passport.
- Comfy, casual clothes. Warm clothes if it may be cold.
- Indoor shoes (sandals).
- Water bottle.
- Motion sickness pills.
- Equipment needed for the study, such as sketchbook, notebook, observation forms, camera and audio recorder.
- Chargers and/or batteries for technical equipment.
- A hard drive to make backups of digital data.

Note: Acknowledge sailor superstitions: consider not packing in a rucksack or bringing an umbrella on board.

7. Guide: Layered scenario mapping. Available at: http://hdl.handle.net/11250/294118

Conducting the field study

Signing on

When you arrive at the port, there may be a gate where you will need to identify yourself. The guard may contact the ship for you, or you may have to call the ship yourself. You may be told to walk to the quay where the ship is moored, or someone may come and collect you. Note that a port can be a hazardous area. Always do as you are told and keep within restricted zones.

Once on board, report to the bridge. Tell the captain that, as soon as is convenient for him, you would like to tell him and relevant crew members about your research. Ask when the best time for this is. During transit may be a good choice. This does not need to be a plenary session, and it need not be formal. You may also have one-on-one sessions with individual crew members at times that suit them. If you use a consent form, make sure you go through it with all relevant crew members; which crew members are relevant depends on the purpose of the study.

Before observation sessions take place, ask the captain on a general basis if it is okay to take photos and/or make video and audio recordings, if you plan to do so.

Safety is important on board. Pay attention to safety instructions, particularly location of muster stations and safety zones. During an exercise or an actual emergency, do as the captain or officer in charge tells you.

Observing

Document what you observe using notes, sketches, photos, and recordings (if relevant and allowed). Make sure to reflect on what you document, particularly on problem areas and design potential. It is a good idea to tag your notes with where they originate from.

If possible, try out what it's like to be in 'the user's shoes'. Be aware that you must be a certified seafarer to operate some of the equipment; thus, it may need to be tested while it is not 'in command', i.e., when it is not controlling the ship. Always ask before touching the equipment!

Be explorative, and see everything as interesting. Use all your senses when observing. Pay attention to details, look for patterns and make connections. Notice things that puzzle you and that are not as expected. Be conscious of what things are just as you thought they would be. Document everything, even trivial stuff. When you observe, keep as a mantra that 'something is always happening'. Look for what is happening, even when 'nothing is happening'. What are the mariners doing when it seems like they are doing nothing? What are they paying attention to?

Stick to your plan if possible, but do not let it restrict you while on board. Allow time to hang out with the crew without your notebook and with no special purpose in mind.

On-site design reflection

Work with ideas while on board. It may be difficult to conduct focussed sessions with the users for longer periods of time, however, so take advantage of periods when the crew is less busy. Present the users with design ideas developed prior to or during the field study. While on board, work on design ideas based on what you see and keep the users in the loop.

On a personal level

Always keep your social antenna up. 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 on board: for example, fixed seating arrangements 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.

Remember that your notes may be read by others—for example, over your shoulder or if you walk away and leave your book. You may even want to leave your book out intentionally to let people have a look and, thus, avoid suspicion. Notes of a more personal nature can be made on your computer or in a different book while in your cabin. Being open and telling the users why you do the things that you do is good for increased acceptance.

Beware of 'photo and documentation fatigue'. The users may find it annoying or intrusive if you are too eager, always using your camera or writing in your book. Always ask before taking photos of people or if you want to make video/audio record-

ings. If the users accept it, be clear on when you start and stop the recording. If the users say no, respect their wishes.

Be prepared for sea sickness. It can happen to anyone. Even mariners get sea sick at times. Make sure you eat and drink properly during your stay. Bring motion sickness pills, and if you know that you get sea sick easily, consider taking one before you board the ship.

Signing off

Before you depart the ship, ask the captain and the crew members if they want to be informed about how the project evolves. If so, record their contact information. You may also consider offering the captain and the shipping company a report of the field study.

Interpretation and analysis

To make the most of the field study, what you have seen must be interpreted in relation to your situated design work.

Interpretation while on board

After each observation session, do a debriefing. This implies making a summary of the most important observations and reflecting on how they are important for the study's purpose and for your design work. You may want to keep a separate account for 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. Consider using ZIP-analysis[8] as a probe for reflection on and interpretation of your observations:

- **Z = Zoom**. Used to identify areas or points where you need to do more research.
- **P = Potential.** Used to identify areas with potential for improvement.
- **I = Innovation/intervention.** Used to identify ideas or solutions to a problem.

After long hours of observing, debriefing may be tough, but it is very important to do it while the observations are fresh. Remember: You cannot rely on your memory!

Back home

After the field study, you need to finalise the analysis and document your findings and ideas. The more analysis you've been able to do on board, the easier this will be. Do this as soon as possible—it gets more difficult the longer you wait! Focus the analysis on interpreting the findings in relation to your situated design work. If others will be using the analysis, strive to communicate the experience in ways that enable others to gain the needed insight. Reflect on the field study and make notes of lessons learned.

Designing based on field study insight often leads to further questions. For this reason, it can be a good idea to plan several field studies in a given design project, if possible.

Further reading for inspiration

About observation:

- Lipshitz, R. (2005). There is more to seeing than meets the eyeball: the art and science of observation. In B. Brehmer, H. Montgomery, & R. Lipshitz (Eds.), *How professionals make decisions* (pp. 365–378). Mahwah, N.J.: Lawrence Erlbaum.
- Smith, K. (2008) *How to be an explorer of the world*. New York: Penguin Books.
- Suri, J. F. (2011). Poetic observation: what designers make of what they see. In A. J. Clarke (Ed.), *Design anthropology: object culture in the 21st Century* (pp. 16–32). Wien: Springer Verlag.

Practical advice on ethnographic field research:

- Fetterman, D. M. (1998). *Ethnography: step by step.* 2nd ed. Thousand Oaks, CA: Sage.

On going to sea to learn about the work on the ship's bridge:

- Hutchins, E. (1995). *Cognition in the wild*. Cambridge, MA: MIT Press.

8. http://www.systemsorienteddesign.net/index.php/giga-mapping/zip-analysis

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