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# **Serendipity in the Field.** Facilitating serendipity in design-driven field studies on ship bridges

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**Abstract:** Field research requires openness to unforeseen insights and opportunities, especially when designing for complex and dynamic workplaces, such as a ship bridge. In this paper, we investigate how serendipitous outcomes may be facilitated in design-driven field research. We present a case study of two field research trips onboard Arctic-going vessels, during which we investigated the premises of designing augmented reality (AR) systems for navigators. We describe how an explorative and opportunistic mixed-methods approach facilitated serendipity and analyse which specific aspects led to serendipitous outcomes in three examples. Last, we discuss how practical support for designers and design researchers conducting design-driven field research can be developed and suggest how strategies to employ approaches that facilitate serendipity can increase the likelihood and awareness of serendipitous outcomes.

**Keywords:** Design-driven field research, Ship bridges, Serendipity, Maritime design, Augmented reality

# 1. Introduction

Design for user experience is currently expanding into new, more complex domains in which safety is critical, such as ship bridge design (Lurås, Lützhöft, & Sevaldson, 2015). Since most designers and researchers are unfamiliar with ship bridges, *design-driven field research* has been proposed as a method to acquire the experience and knowledge needed to develop designs for the maritime domain (Lurås & Nordby, 2014).

When the aim of a field study is to explore and generate new ideas and solutions, designers are hoping for unexpected insights and ideas. The context, situations and findings of the field study are likely to present designers with questions, problems and design possibilities they could not envision before the field study. Planning specifically how such a field study will proceed is often impossible. More importantly, defining the outputs of such a field study too concretely before entering the field may result in overly narrow data collection.

*Serendipity* refers to approaches and activities that allow one to discover findings that are unexpected, fortunate and valuable (Carr, 2015; Halvorsen, 2016; Lunenfelt, 2003). But how can

designers facilitate serendipity in the field? In this paper, we investigate how an approach that takes serendipity into account can be valuable in design-driven field research, especially when exploring new technological solutions such as augmented reality (AR).

The EU project Safe Maritime Operations under Extreme Conditions: The Arctic Case (SEDNA) is intended to investigate how the working conditions on ship bridges in the Arctic can be improved, for example, by the use of AR. A ship bridge on an Arctic-going vessel features rapidly changing and unpredictable situations, mainly due to ice and weather conditions (Figure 1).

*Figure 1: Field research in Arctic waters (Photo: SEDNA).*

Navigators need to simultaneously maintain situational awareness of what happens outside the ship and monitor ship bridge systems on consoles inside the ship (Hareide & Ostnes, 2017). AR is an emerging technology that can be used to overlay the physical world with digital content regarding the bridge systems (Frydenberg, Nordby, & Eikenes, 2018). Thus, by using AR technology and head-mounted displays, system information can be integrated with the physical environment and adapted to specific situations and users' needs. Some research has examined how AR can meet navigators' needs for situational awareness in order to decrease human error in shipping accidents (Baldauf & Procee, 2014; Benedict et al., 2016; Hareide et al., 2017; Hareide & Ostnes, 2017; Procee, Borst, van Paassen, & Mulder, 2017; SEDNA-project.eu, 2017). However, it is yet unknown how AR can and should be designed for and used on the bridge, especially in extreme environments such as the Arctic.

In this paper, we present a case study from SEDNA and investigate how design-driven field research can be planned for and conducted to facilitate serendipitous outcomes. This work contributes to the body of knowledge about implementing serendipity in the field. Through two field studies of icebreaker vessels in Arctic waters, we investigate the premises and possibilities for designing AR systems using a broad set of mixed methods and an explorative and opportunistic approach. We analyse three examples from the field studies and describe aspects that led to relevant and unexpected outcomes. Then, we suggest four potential strategies that might support serendipity in the field.

# 2. Background

## 2.0 Serendipity – More than Happy Accidents

There are multiple definitions of the concept of serendipity, including "the art of making an unsought finding" (Rivoal & Salazar, 2013, p. 1) and "the faculty of making happy and unexpected discoveries by accident" (American Heritage Dictionary of the English Language, 2018). Serendipity is not a new concept in academic inquiry; it is part of a systematic sociological method in grounded theory for construction of theories based on gathering and analysis of data that can explain a phenomenon or situation (Strauss & Corbin, 1994), and in the field of anthropology, it is a key characteristic of the ethnographic method (Rivoal & Salazar, 2013).

Developments in the understanding of the phenomenon of serendipity and the theoretical underpinnings of unexpected and positive user experiences have triggered significant interest in digital information environments in recent years (McCay-Peet & Toms, 2017). However, the empirical underpinnings of how to identify a practical construct that could be useful for designers' needs are still poor (Makri, Blandford, Woods, Sharples, & Maxwell, 2014). Scholars exploring serendipity have attempted to capture the concept of serendipity in different ways, including serendipity models (Makri & Blandford, 2012), frameworks (Erdelez, 2005), drivers (McCay-Peet & Toms, 2017), experiences (Makri et al., 2014) or the nature of the phenomenon (Sun, Sharples, & Makri, 2011). Nevertheless, the body of work aiming to understand and conceptualise what contributes to serendipity is still in its infancy (McCay-Peet & Toms, 2017).

A practical example of an attempt to develop support for designers using qualitative methods is an interview study intended to discover how 14 creative professionals self-report the strategies they use to increase the likelihood of serendipity (Makri et al., 2014). The study suggests that such strategies can function as a framework for further exploration.

Because serendipity is interpreted and expressed in different ways in different contexts and fields, it is useful to examine the origin of the word. Reportedly, the word *serendipity* comes from a Persian fairy tale called *The Three Princes of Serendip* (now Sri Lanka). In the story, the three princes are sent into the world by their father, the king, to gain broader experience and wisdom. During their travels, they successfully find a lost camel through happy *accidents* and *sagacity*, that is, by connecting seemingly insignificant elements in such a way that leads to an unexpectedly positive (i.e. serendipitous) outcome (Merton, 2006).

The *accidental* part of serendipity requires designers to respond to opportunities while in the field (Makri et al., 2014). The likelihood of serendipity caused by an accident could be increased by situating the fieldwork within an immersive and unpredictable context. Considering only accidents may lead one to view serendipity as a phenomenon that one has no control over (Rivoal & Salazar, 2013). However, this is an incomplete understanding; it is difficult to achieve serendipity in a research process without considering *sagacity* (Fine & Deegan, 1996). According to Rivoal and Salazar (2013), the skilful synthesis of accidents and sagacity in anthropological research requires that the researcher have 1) sufficient background knowledge, 2) an inquisitive mind, 3) creative thinking and 4) good timing.

## 2.1 A Framework for Analysing Serendipity in Design

In order to develop a lens with which to analyse our design-driven field research on serendipity, we elaborate on the four aspects of serendipity suggested by Rivoal and Salazar (2013).

*Sufficient background knowledge* can be understood as having enough insight to understand what is not immediately obvious. A number of scholars have emphasised the key role of background knowledge in serendipitous discoveries. For example, the French microbiologist and chemist Louis Pasteur (1854) emphasised the importance of preparation before observation: "In the fields of observation chance favours only the prepared mind" (as cited in Vallery-Radot, 1928, p. 76). In other words, serendipity depends on one having a fundamental understanding of the domain, context and material or problem under investigation before the investigation begins. However, Mauss (2009) argued that in order to implement background knowledge in field research, sociological perception is also important: "The young ethnographer embarking upon fieldwork must be aware of what he or she knows already, in order to bring to light what is not yet known" (p. 8). This aspect is referred to as *reflexive interpretation*, and it is a hallmark of the anthropological method (Rivoal & Salazar, 2013) that may be useful for design researchers during the reflection process.

An *inquisitive mind* can be understood as one with sufficient background knowledge that optimistically reacts to unforeseen outcomes in the research. Many great discoveries within the natural sciences derive from this explorative aspect of serendipity, from Alexander Fleming's discovery of penicillin (Colman, 2006) to the development of Velcro and Viagra (Roberts, 1989). Viewing fieldwork as an iterative and elaborative process in which seemingly irrelevant elements develop into a greater body of knowledge (Crabtree, Rouncefield, & Tolmie, 2012) may support the notion of *building* serendipitous outcomes with sagacity rather than *happening upon* them.

*Creative thinking*, understood broadly as the ability to come up with new ideas, is often credited when serendipity is connected to new inventions (Kingdon, 2012). For example, radical innovations are often linked to the introduction of new technologies, such as AR, which enable designers to create new affordances or meanings through serendipitous exploration (Norman & Verganti, 2014). Creative thinking can be described as "a muscle that you can choose to work out or allow to wither" (Kingdon, 2012, p. 3). The ability to embrace serendipity in design can be compared to the ability to improvise in other creative fields, such as music and theatre, which involves not only the emotional and aesthetic personal characteristics of a person but also tacit knowledge that can be used in interactions with other persons (Alterhaug, 2004, 2010). User experience researchers must view users as humans, meaning that rich data cannot be forced (Nunnally & Farkas, 2016). Improvisational skills and the ability to creatively use unforeseen events or findings may help facilitate conversations with users in which interesting data develops naturally.

*Good timing*—and time—are required for research to facilitate serendipity (Rivoal & Salazar, 2013). The researcher's *fieldwork demeanour*, which is key for gaining acceptance in the field, should involve respect, empathy and common sense about when people will open up (Crabtree et al., 2012). Good timing can be described as being attentive to when this happens. As opposed to anthropological field research, field research on maritime design generally takes place over shorter periods, which reduces the opportunity to move back and forth between data collection and the final analysis (Lurås et al., 2015). This often results in rather intense fieldwork, as the researcher has little time to digest the information. Nevertheless, setting aside time to document, interpret, reflect and debrief between each data collection session during the field study is necessary to properly document and understand the data (Lurås & Nordby, 2015).

It might not be possible to rigorously plan for serendipity, but it is possible to manipulate the conditions that can lead to serendipitous outcomes (Rivoal & Salazar, 2013). Below, we present a case study through which we analyse how various field research techniques and methods enable serendipitous insights.

# 3. Case: AR design for ship bridges

In this paper, we use two field studies, which were conducted as part of the EU project SEDNA and examine how AR technology might improve navigators' working situations, as a case study to investigate how serendipitous outcomes may be facilitated in design-driven field studies.

AR is a rapidly developing technology (Bonetti, Warnaby, & Quinn, 2018). However, there are few practical guidelines for designers regarding how to explore and design AR systems for complex contexts, such as a ship bridge. Investigation of the parameters and possibilities of designing AR systems for ship bridges requires a certain amount of domain knowledge to understand the demanding, dynamic, high-risk working environment as a whole (Lurås et al., 2015). In addition, the use of AR on the bridge is categorised as a design problem that cannot be divided into two distinct phases—*problem definition* and *problem solution*—in a linear design process (Buchanan, 1992). This type of challenge, which is characterised by a number of issues, including the fact that it is impossible to understand until a solution is developed, is referred to as a *wicked problem* (Rittel & Webber, 1973). One cannot predict which issues and questions will arise from the research process and thus needs to constantly search for new solutions and iteratively redefine the design problem.

To better understand the potential of AR on ship bridges, we conducted two field studies in March 2018 on vessels with ice-breaking capabilities operating in two regions in the Arctic. One study was conducted by three project members onboard a Norwegian coast guard ship on a 14-day marine research expedition to the West Ice (East Greenland). The second study lasted four days and was conducted by two team members in cooperation with three researchers from a co-research institution on one of the Swedish Maritime Administration's icebreakers operating in the Bay of Bothnia.

The purposes of the field studies were to 1) explore the conditions and possibilities for designing AR systems for navigators on a ship's bridge, 2) to investigate how design researchers can methodologically approach the design of AR systems through field studies and 3) to familiarise ourselves with the context and environment of a ship bridge.

We used an explorative and opportunistic mixed-methods approach (Hanington & Martin, 2012; Nunnally & Farkas, 2016) to perform our field study. The approach for carrying out design-driven field research in the maritime domain is based on design ethnography research (Crabtree et al., 2012) and research conducted by the Ocean Industries Concept Lab at the Oslo School of Architecture and Design. This lab developed methods and models such as *design-driven field research* (Lurås & Nordby, 2014, 2015), which features the focus areas *design reflection, data mapping* and *experiencing life at sea*, specifically for the purposes of design and design research (Gernez & Norby, in press; Lurås & Nordby, 2014).

# 4. Enabling serendipity in the field

As we have argued, facilitating serendipity in a design-driven field study requires sufficient background knowledge, an inquisitive mind, creative thinking and good timing. The following section describes how we facilitated serendipity through preparation and careful selection of a method.

## 4.1 Planning for Serendipity

Exploring the design of AR systems for ship bridges in the Arctic was a complex challenge with many unknown aspects. For example, how could we ensure targeted data collection while simultaneously allowing for serendipitous outcomes, and how could we foster sagacity?

Based on the three main aims of the field studies, we acquired as much background knowledge as possible, created a comprehensive field study plan for what we wanted to understand and explore while in the field and prepared a variety of design activities.

Since we cannot predict the unexpected, we did not know in advance which methods would be use useful, realistic or suitable. Building on previous design-driven field studies, we adopted a multifaceted field study methodology that would enable us to be *explorative* (i.e. to explore and discover) and *opportunistic* (i.e. to exploit opportunities). Preparing for the unexpected not only revealed a wide range of possible approaches but also allowed us to internalise information and be mentally prepared for the field.

Our planned research was approved in advance by the Norwegian Centre for Research Data. At the beginning of the trip, we attended an information meeting to explain the purposes and approach of the field research. Then, we obtained written consent from all the involved crew members. For each new and serendipitous use of the collected data, such as the use of eye-tracking recordings for design sketching, we obtained consent again. Comprehensive reports of the collected data and plans for further use of the data were approved by the leaders of each vessel after the trip.

## 4.2 A Mixed-Methods Approach

While performing the field studies, we used a mixed-methods approach consisting of a broad set of standard methods from the fields of design, human–computer interaction (HCI), human factors (HF) and the social sciences. We aimed to continuously conduct reflection in action (Schön, 1984) and so-called *design reflections* (Lurås & Nordby, 2014) in between the planned methods and activities to iterate on design solutions in parallel to data collection. We aimed to exhibit inquisitiveness, creative thinking and correct timing by using and expanding on the methods described above. Finally, we adjusted the activity plan as we gradually achieved more insight and serendipitously uncovered new and significant aspects that needed to be incorporated into the design and research activities.

The following methods were used:

- **Participatory observation** (DeWalt & DeWalt, 2011) was used to conduct semi-structured interviews based on interview guides, informal talks, direct observation of the work on the bridge and collective discussion about users' needs and ideas.
- **Scenario mapping** (Lurås, 2016) was used to systematically gather and present data about a constructed user situation in order to design AR concepts to meet specific needs.
- **Mapping behaviour on the bridge** (Hanington & Martin, 2012) was used to determine the organisation of working stations and the workflow of actors due to the significant implications of where and how visual information can be presented to an AR user.
- **User environment design** (Beyer & Holtzblatt, 1997) was used to document all consoles on the bridge in order to understand the entire bridge system and current working situation.
- **Co-creation** (Sanders & Stappers, 2008) was used to reorganise content and functions with experienced crewmembers in a workshop to achieve more optimal working conditions on the bridge based on their experience. The implications for AR were related to existing information displays and the potential for embedding AR in suitable projection areas within the existing environment.

- **Eye-tracking** (Hareide & Ostnes, 2017) data were collected using Tobii Pro Glasses 2 to determine how long and often the navigator looks at and alternates between different points of interest in different situations.
- **Testing equipment** (Rubin, Chisnell, & Spool, 2008) included AR glasses—Microsoft HoloLens and Meta 2—which allow users to see and hear graphics and audio overlaid on the physical world. A VR headset with a conceptual model of the existing bridge design was tested by the crew. An iPhone was connected to a VR box using AR markers. The overall aim of the test was to explore the parameters for the design of AR ship bridge systems in various environmental conditions with differences of light and movement. Test logs were kept to systematise the AR tests.
- **Development of concepts for AR** (Hanington & Martin, 2012) was performed with techniques such as paper prototyping, Photoshopping and a portable mini projector to simulate AR in the environment and explore the use of AR in this context.
- **Collection of visual data for visualisations** was performed using drones, a 360-degree camera, GoPro cameras and single-lens reflex camera to capture and document various user situations, water and weather conditions and operations.

## 4.3 Data Collection

As shown in Table 1, our field research approach allowed us to collect a broad set of data (more than 2800 images and 350 video recordings) in both targeted and serendipitous ways. This involved data mapping, design reflection and the personal experiences of the design researchers. We summarised and analysed the data after the field trip, shared and discussed insights through workshops with team members and documented the insights in two field study reports validated by domain experts.

*Table 1. Overview of data collected using each method.*

| **Method** | **Data Collected** |
|---|---|
| Semi-structured interviews | Notes, audio recordings, photos, videos, sketches |
| Participatory observation | Notes, photos, videos, sketches |
| Scenario mapping | Visual diagrams, notes, photos, videos |
| Mapping behaviour on the bridge | Visual diagrams, notes, photos |
| User environment design and co-creation | Visual schemas, notes, photos, videos, sketches |
| Eye tracking | Eye-tracking record data |
| Testing AR equipment | Notes, photos, videos, test log |
| Development of concepts for AR | Photos, videos, 360-degree photos and videos, drone photos |

Before the field trip, we were not able to anticipate all the kinds of data and insights we would collect and how they would be useful both during and after the field study. For example, the eye-tracking video recordings were used not only to identify the eye-tracking patterns of the navigator, as we expected, but also as background footage that allowed us to sketch new design concepts after the trip.

During the debriefing for the field study, the participants expressed that a significant part of the insights gained in the field studies were due to serendipity, such as being present in particular situations or observing conditions develop differently than expected. They regarded much of this knowledge to be influential for further work as it enables well-founded judgements of designs for the ship bridge environment.

# 5. Examples of serendipitous outcomes

In order to specifically evaluate how serendipity occurred during the field studies, we present and analyse three situations in which we experienced serendipitous outcomes.

## 5.1 Co-creation and Design Intervention

We started by performing participatory observations on the ship's bridge to familiarise ourselves with the bridge, working situation and operations taking place. However, we found that our *background knowledge* was insufficient to understand the complexity of the various operations and working situations.

We thus improvised an unplanned research activity (*creative thinking*) to gain a better overview. This involved fully functional mapping of the ship's bridge with help from the crewmembers on duty. During the mapping process, we received unexpected and relevant insights from the users of the systems regarding optimisation of the console design. To gain deeper knowledge, we asked the users to participate in a co-creation workshop (*inquisitive mind*) to optimise the bridge console design (Figure 2). The users' different personal preferences and needs resulted in various versions of the optimal bridge console.

*Figure 2: Co-creation workshop in which system users helped determine the optimal bridge console (Photo: SEDNA).*

The serendipitous outcomes in this example include an unplanned activity (mapping the current console layout), insights into how the current system fails and succeeds in meeting users' needs in different situations, a set of co-designed concepts for new design solutions and testing and documentation of a new method for performing design-driven field studies.

## 5.2 Transitions as Information-Dense Situations

We conducted a semi-structured interview focusing on task-solving and critical points in what was categorised as a semi-intense situation due to rough ice conditions. The planned interview (Figure 4) provided us with a good overview. We stayed at the same spot after the interview and were accidently able to observe a handover between the current and new watch officers (*good timing*), which involved a two-minute briefing covering the same topics as the interview. However, the description differed in terms of specific references and pointed to different critical points.

In order to understand the dissimilar descriptions, we switched our method and asked the new watch officer if he was willing to use the eye-tracking equipment (Figure 3) we had prepared for another situation (*inquisitive mind* and *creative thinking*). The eye-tracking recordings provided a new perspective on how the watch officer worked during challenging situations.

*Figure 3: The image to the left shows an informal interview with a watch officer by the bridge console, and the image to the right shows our switch of method to eye tracking (Photos: SEDNA).*

The serendipitous outcomes include a new and unexpected perspective on a specific situation, insights into how communication conveying form and content is highly dependent on relationships, and eye-tracking data as an objective observation tool to supplement the data collection.

## 5.3 Contextual Wake-Up Call

We tested how AR graphics fixed to the user's body would be experienced on the bridge during calm conditions. Users evaluated the solutions as useful and satisfactory for the intended purpose. However, on our way back to the mainland, we decided to run another test session during demanding weather conditions with waves to see how movement would affect the AR user's experience (*inquisitive mind* and *good timing*). This time, the users experienced severe problems with the projected graphics; the conditions led to issues such as poor visibility and difficulties related to keeping the body in balance. Several of the test files that had been evaluated as functional earlier were experienced as annoying and contributed to nausea in wavy conditions.

We also conducted the tests on ourselves. We found that predicting the intensity of this effect is difficult, and it is difficult to simulate the effect with AR equipment without being in the actual context and conducting tests over a period of time. We had to be receptive to unexpected insights

and be willing to change our perspective on new design concepts, including use of a body sphere to attach most of the AR graphics to surfaces in the physical environment inside or outside out of the bridge (Figure 4).


*Figure 4: Illustration showing a design concept in which graphics are placed outside the window to accommodate the need to fix graphics to the environment instead of a body sphere (Photo: SEDNA).*

In this example, the serendipitous outcomes included new insights into how different situations and conditions affect the usability of AR and enable a new direction for design solutions.

# 6 Discussion

We argue that it is useful to support designers by helping them to build their own approaches enabling serendipity. One way of doing so is to examine cases in which these approaches are used to investigate new design problems, new contexts or new methods. We believe such cases can help designers better identify and react to serendipity in their own practice.

As described in the background section, we believe the phenomenon of serendipity consists of two factors: accidents and sagacity. We consider accidents to be something we cannot control, although we can place ourselves in unpredictable situations for long periods of time to increase the likelihood of serendipitous outcomes (Rivoal & Salazar, 2013). Based on our case study, we suggest that sagacity, also understood as *the perception aspect of serendipity* (McBirnie, 2008), can be enhanced by designers through preparation, implementation and exploration of the four aspects of sagacity (Rivoal & Salazar, 2013): *sufficient background knowledge*, *an inquisitive mind*, *creative thinking* and *good timing*. We used these aspects as lenses to analyse our own experiences of serendipitous outcomes, and next, we discuss how they helped us understand the example in our case study and how we might develop strategies to achieve serendipity in design-driven field research.

One way of developing practical design support for designers is to formulate strategies based on experiences of the attitudes and activities that may support serendipity (Makri et al., 2014).

In the first example from our case study, we learned that *allowing creative distractions* by combining an inquisitive mindset and creative thinking can lead to new methods and insights. By implementing input from users in the creative process through *co-creation*, we were exposed to knowledge, interpretations and emotions that were extremely different from our own. This instance of

serendipity allowed us to gain new knowledge and see patterns that we could not have envisioned beforehand.

In the second example, the way people view themselves was found to be highly dependent on their situation. This highlights the need to consider how we, as observers, may affect the people we investigate in different situations and thus affect the collection and interpretation of data. To increase the likelihood of serendipitous outcomes, we suggest that design-driven field research could benefit from *switching methods*, such as switching from observation to eye tracking, and seeking out information-dense situations, such as work handovers.

In the third example, we found that a field study may involve a highly dynamic research environment in which many aspects affect the situation and there are few constant factors. As a result, the assumptions, insights and findings based on the collected data had to be developed or altered based on how the situation and research environment changed. In other words, it was useful and important to *accept ambiguity*.

Based on the examples above, we suggest four potential design strategies that might support serendipity in design-driven field research:

- **Allow creative distractions**: Ideas and design reflections may emerge suddenly while conducting planned field study activities. Taking time to spontaneously elaborate on design reflections through sketching or discussion of possible design solutions can allow the creative thinking process to take new and serendipitous directions.
- **Co-create with users:** Involve users and let their engagement affect the results of the creative process in context. By implementing input from users in the creative process, designers are exposed to logics, interpretations and relations that are different from their own, and the chance of seeing new combinations and patterns increases.
- **Switch or adjust the method**: If progress is unsatisfactory, the responses of the persons involved are not useful or the situation is better suited to another way of collecting data, switching one's method can be beneficial. Customized interactions with users in which researchers improvise and adjust their field research method based on the situation might generate more useful communication.
- **Accept ambiguity**: Be open to more than one interpretation. The discomfort of ambiguity drives one to understand and find solutions. Remaining open to a variety of interpretations of assumptions and insights can lead to richer or unexpected understandings or ideas.

Further research should investigate how these strategies can be planned for and implemented in field studies and how such implementation would affect serendipity in the field.

# 7. Conclusion

We presented a case study investigating serendipitous outcomes in two design-driven field studies that explored the potential of using AR on ship bridges. Elaborating on a framework for serendipity proposed by Rivoal and Salazar (2013) for the field of social anthropology, we investigated how a mixed-methods approach to design-driven field research may facilitate serendipity. We have described three examples of serendipitous outcomes from the field research and identified aspects that led to serendipity. Based on the examples, we suggested four strategies that might support serendipity in design-driven field research: *allow creative distractions*, *co-create with users*, *switch or adjust method*, and *accept ambiguity*.

Based on our case study, we suggest that a mixed-methods approach that accounts for serendipity can be valuable for design-driven field research, especially works intended to investigate new design problems, such as the use of AR on ship bridges. We suggest that designers could benefit from practical support when building their own approaches involving serendipity.

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