Being a Reflexive Insider: The Case of Designing Maritime Technology

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***Abstract*—This article reports a long-term, multiple-site ethnographic study in which the author cooperated with a heterogeneous group in designing remote-control systems for maritime operations since 2015. The paper reports how the participants were assembled in a network that represented their interests in balancing the relationship between a design and its use. The author asserts that if Computer Supported Cooperative Work (CSCW) research aims to shed light on other disciplines, CSCW researchers should be reflexive insiders that first position themselves in such disciplines. Different from the first generation of CSCW researchers, members of the new generation are trained in multiple disciplines, and they have the ability to use their expertise in reducing the gap between CSCW research and engineering practices in various fields. Thus, through reflexive practice, CSCW researchers could connect communities of practice, thus narrowing the distance between humanity and engineering. The paper moves the historical debate on the relationship between ethnography and design toward a new focus on reflective insiders as a method used to support CSCW research outside the CSCW community.**

Keywords- CSCW; engineering design; reflectivity; practice–research gap.

I. INTRODUCTION

The literature shows that current maritime technology does not purely support cooperative work among operators on board [1]. The current design of operator–vessel interaction follows the principles of engineering design, including cognitive ergonomics and human factors [2]. The fundamental principle is to focus on the design applicability, the scope of the technical process, and the system structures to support the efficacy of machine use [3]. Operators are subjects in experimental work conducted to verify that a design is successful. However, the social aspects of human–vessel interaction have been largely dismissed. Moreover, operators are not encouraged to articulate their requirements, and the system design team is composed of a variety of specialists acting in the capacity of consultants to the project.

If the above are the facts, then how could CSCW researchers contribute to the design of maritime technology as a completely foreigner who shares few common interests with engineering designers? Shifting the focus from machines to humans challenges, the design of cooperative systems to support maritime operations, which is indeed how to position a CSCW researcher in the maritime field. However, very few previous studies have addressed how researchers could successfully conduct CSCW research outside the CSCW community. For example, scholars have tried to extend collaborative computing in a design approach to shaping the design processes to help users articulate their requirements with other specialists in systems design in both the aviation and maritime domains [4]–[6]. Thus, it was worthwhile discussing how CSCW could be extended beyond the classic discussion about the relationship between ethnography and design [7] to the collaborative effort of computer scientists and social scientists [8].

This movement in CSCW research has been debated for several years [9]. Moreover, current CSCW design has moved beyond single disciplines, such as sociology and computer science to establish itself and well in a new field. However, in the key literature on the intervention of design in CSCW [9], little attention has been paid to intervention in CSCW research [9]. Even when intervention is addressed, it is not clear that how, when and what could be intervened. Although a few studies address how CSCW research could help in design technologies, mainly in the healthcare field, the difference is that the work practices of health workers require CSCW researchers to communicate with developers who, in most cases, share similar a background, such as computer science, software engineering, and so on.

However, the story is changed if CSCW researchers work with people who have different background but focus on control engineering and automation. The priority is given to expertise outside CSCW, and interactive experiences of computation and cooperative work are less vital. Operators are affected by usefulness and usability issues in the given technology. Moreover, different priorities in the design process challenge CSCW researchers, who must design systems in cooperation with foreigners outside the CSCW world. In protecting his or her own academic interest CSCW researchers have to find ways to make sense of CSCW insights beyond their own discipline [1]. As a member of new generation of CSCW researchers, the author has multidisciplinary education, and he is interdisciplinary by training. This generation of CSCW researchers can reveal the design site and the object of study, and they play roles in supporting technology design. Thus, the research question of the present work can be formulated as: *how to shorten the distance between CSCW research and its practice in engineering design in terms of CSCW researchers' roles in engineering project?*

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This article is structured as follows: first, in Section II, the case is presented – designing remote control systems as a fundamental background of the article. In Section III, reflexivity as theoretical basis and methods used are presented. In Section IV, the article describes how participants were recruited in designing remote control with respect to CSCW insights. In Section V, the author reflects on his own experience in conducting CSCW research in the maritime domain, which is relevant for maritime studies. In doing so, the author discusses contribution to CSCW research, which moves the historical debate on the relationship between ethnography and design toward a new focus on reflexive insiders as a method used to support CSCW research. The paper concludes in Section VI.

II. THE CASE: DESIGNING REMOTE-CONTROL SYSTEMS

Traditionally, maritime technology is designed in the fields of mechanical engineering, electrical engineering, electronic engineering, and even computer engineering. In these fields, the focus is on control systems, machinery, and the automation of maritime vehicles of any kind. The design process is purposeful, systemic, and iterative. Engineering designers conduct their work in various constraint conditions to find possible solutions for problems that are usually limited to the given scenarios. Engineering designers communicate with a small group of users, for whom the design follows a positivist paradigm with the intention to test a system. Design requirements are usually based on three principles: corporate, technology, and social [10]. The primary principle is that the corporation needs to generate design requirements in line with the company's organisational structures, strategic vision, and available resources, based mainly on the knowledge and expertise of the engineering designers. This principle does not change until social aspects challenge the company's frame through markets. The second principle, which Gershenson and Stauffer [11] termed technology, is the knowledge of engineering principles, material properties, and physical laws [3]. The user's requirements are considered last. The requirements of the third principle are weighted to optimise the trade-off with the requirements of the first two principles and to align with the needs of the users, such as the "must-be need" and the "attractive need".

Thus, in line with the principles, engineering designers consider artefacts important for remote-control systems. In addition, engineering designers narrow design specifications to comply with reliability, ergonomics (i.e., human factors), manufacturability, control ability which similar to software engineers, who use models to automatically synthesise an executable code [12]. The philosophy underlying all solutions is technology-centred design. That is, using a certain algorithm to represent situational awareness [26] [29], systems are expected to represent information as accurately as possible in human decision-making [25][26]. The common sense that underpins these previous studies is the assumption that the systems will be well-designed to support human tasks, such as drawing patterns, creating models, and making sense of a machine's actions. Through a well-structured technology-centred experiment, as in most engineering design work, engineering designers expect that human factor specialists [21][22] could investigate whether or not interfaces could be built to satisfy the operators. If so, what kinds of "human error" could be investigated? Hopefully, the results could be used to reform the systems according to a better vision. As a consequence of this approach, operators are expected, oddly enough, to be re-trained in the skills needed in the autonomous future [18]. The rest, without protection against the failures, errors, and faults caused by technology, which cannot be called human errors, is treated as regulation and policy issues [24][25]. Politicians, societies and ship owners require clarification of potential liabilities introduced by autonomous technology, such as collisions [21].

However, the cost of shipping may not be reduced as expected. Instead, it might increase significantly because of infinite maintenance and change in remote-control systems, which will displease operators. When changes are introduced, people quickly learn their characteristics and discover how to get the best from them. When autonomous technology and remote control are introduced, people react the same.

III. THEORETICAL CONCEPT AND METHODS

A. Reflexivity

Calas and Smircich [27, p.240] define reflexivity as the '*constant assessment of the relationship between "knowledge" and "the ways of doing knowledge"*'. Through 'reflexivity' researchers could pay attention to '*the way different kinds of linguistic, social, political, and theoretical elements are woven together in the process of knowledge development during which empirical materials is constructed, interpreted and written (p.9)*'. In doing reflexivity study, interpretation is used as a tool to produce scientific knowledge [23]. Doing interpretation, we experience reflection '*we become observers of our own practice* [24]'. Reflexivity suggests a complexification of thinking and experience, or thinking about experience [24]. It is a process of exposing or questioning our ways of doing. In the discussion of third wave HCI, Bødker [25] calls a crucial and conventional understandings of reflexivity. Reflexivity, in her means, is unlike positivism. Instead, it is an intervention for data gathering and a chew how data gathering impacts the quality of the data itself. At the end, reflexive practices could find structural patterns in what they have observed, and in turn, to extend the theory they used. However, reflexivity has had difficulty found a place in HCI and in CSCW literature. Due to its subjectivity of the method use, it is hard for reflexivity researchers to open their work to future scrutiny. However, Geirbo [26] states reflexivity itself is important as methodological considerations which can guide researchers to entre a community, phenomenon or practice that are foreign to the researchers. In the present, it is possible for the researcher to share sensemaking between the practitioners and the ethnographer in terms of gaining performative knowledge of professional knowledge. The researcher has the capability to articulate and analyse that performative knowledge gained through an insider-role [27].

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In this effort, it is possible to bridge the practice-research gap by enacting researcher-practitioner roles across community boundaries, developing and disseminating new knowledge, and engaging field professionals outside of CSCW community.

Thus, in line with this specific theoretical concept, a CSCW researcher is able to be reflexive on how his/her ethnographic account will affect the research process. This action could help other CSCW peers gain a better understanding of the choice the researcher has made during the entire research process including the design, data collection, and interpretation phases. By reporting and discussing the theoretical struggles of interpretive empirical research could also help fulfil the principles of 'dialogue [28]' in between the fieldwork material with the reflectivity thinking and engineering design practice. As the core of 'dialogue' interpretation is relating back to the experience in terms that the CSCW peers can understand what the researcher has seen, what the researcher has been experienced, and how evaluate that work. In turn, they could sense the socio-technical gap within CSCW research itself as well as the gap between humanity and engineering in general.

B. Methods

For a long time, the role of CSCW researcher in the maritime domain is questioned. The CSCW researcher struggled to answer this question because CSCW contributions might not remain in its own area, which is *interpretive ethnography*, but might extend to in a foreign context where the CSCW researcher would have to change his/her tone and voice so those living there could understand the researcher. Although the initial question in 2015 of the author's research was "What is going on in designing maritime technology?" when he did fieldwork at sea, he asked questions about how maritime technology is produced, assembled, and maintained. Although remote-control systems are designed on land, the author sees himself not only as part of land-based maritime design teams that he observes and interviews, and then writes about. His fieldwork began from the first year when he was a doctoral student at the University of Oslo, and it continued after his doctorate degree. The author has not stayed on one site to understand the design of maritime technology. Instead, multi-sites [29] were visited both at sea and on land to observe and interview the people who will be users of remote-control systems. Importantly, seminars, workshops, and conferences were included where shipowners and their colleagues, such as engineering designers, and policymakers, as well as other relevant participants celebrate their technical achievements. Although the research project requires a long-term engagement in the maritime domain, luckily the heterogeneous group has not changed much since 2015. A group of professionals, such as operators, engineering designers, educators, and ship owners are involved in the study. The present work is a long-range project to observe and interview them in different places both at sea and on land in European countries. An online platform was established where engineering designers could share information via email and videoconferences, chat, and leave comments on documents. Those topics that the author does not understand in the hope that someone will explain were commented and observed. In addition, the author interacts with many of engineering designers through individual emails and videoconferences to construct an ethnography of their experiences in design work. A few new participants joined his study, but others have remained since the beginning. Thus, informed consent is not required but only verbally introduce the research work to newcomers when the author works with them. A few of them withdrawal their participation due to starting a new career path. However, they keep in touch from time to time in case any questions need to be followed up.

A table illustrates the research activities since 2015 (see Table I). All interviews, seminar and workshops were noted without audio-recordings due to ethical considerations. At sea and land-based simulator room the observation was recorded by videos. However, the author did not transcribe all videos. Instead, only the ones which are relevant to engineering design process were transcribed since the difference between cooperative work of seafarers at sea and on land is vital.

TABLE I. RESEARCH ACTIVITIES SINCE 2015

Settings	Methods		
	Interview[a]	***Observation***[b]	***Year***
At Sea, on board	72	1838	Autumn 2015-Spring 2016
Land-based Simulator room	18	48	Autumn 2016
Conferences on sites	4	-	Autumn 2017 – Autumn 2019
Seminar	8	-	Autumn 2016-Spring 2018
Workshops	7	63	Autumn 2016-Autumn 2019
Emails	232	-	Autumn 2015 – Spring 2020
Videoconferences	4	-	Spring 2018 – Autumn 2020

a. Number of interviews
b. Hours of observation

The data analysis has been ongoingly conducted since 2015. Thematically indexing words was conducted such as cooperative work, design, remote-control, systems collaboration, team's cooperation, remote-control and so forth. Themes were also identified. However, these themes are used to describe not only remote-control system design but also other work of the project, which is also focused on investigation and design in the maritime domain in general. The purpose in data analyses are offering an ethnographic account of the practice and associations orchestrated by crossing multiple sites both offline and online, particularly in the case of a remote-control system. Moreover, the aim is directing attention to the researcher's relf-reflectivity [30] to bridge the gulf between what Dourish [31] called the sociotechnical gap and Ackerman's definition of "the divide between what we know we must support socially and what

we can support technically" [32] without any pre-conditions. Simply put, this paper addresses the gap between CSCW research and CSCW practice in industrial contexts.

IV. The Development of CSCW Research in Designing Remote-Control Systems

In the maritime domain, operators are rarely involved in the design process. As previously mentioned, operators are used as subjects for testing purposes when a product is developed. Educators are also rarely involved because they teach operators without considering their concerns about technology. Moreover, CSCW researchers are rarely involved in a maritime design project because their expertise is invisible in the engineering field. Furthermore, shipowners are rarely consulted in design projects too for various reasons. Thus, in this study, a group of stakeholders was assembled to balance their interests in design toward a sustainable solution for all through a CSCW perspective.

A. Unheard opinions

In 2016, challenges were coming up. The operators thought the author (a CSCW researcher, and hereafter the researcher will be used) was an engineering designer. They thought that the researcher was only concerned about examining their work. However, that was untrue since a CSCW researcher who was also trained as ethnographer. The purpose of CSCW researcher to be on board was not to evaluate any work but to observe what is going on. The CSCW researcher also wanted to interview operators. Based on those findings, the CSCW researcher would work with engineering designers to design remote-control systems.

After above explanation, the operators were worried that what the researcher observed and heard would be documented as 'evidences' to change the vessel design to automatic shipping. It seems they thought the researcher was a spy who studied them and would try to create a technology that would replace human operators. Although the purpose of being on board was explained and they had given informed consent to participate the research study, the author still was misunderstood. However, later on they apologised and added that they indeed really hope someday their expertise and knowledge could be acknowledged rather than overlooked in designing remote-control. Since then, the researcher noticed that not everyone welcomes remote control.

On board, one of the operators expressed his worry that he does not believe the systems can do what he is good at. His experience at sea cannot be simply cloned into a machine. He felt anxiety that shipowners just want to save costs and do not care operators. The researcher did not know how to respond to them at that time. The researcher could not promise them that they would be assisted rather than replaced by the remote-control system. The researcher also was not able to say that their expertise would be acknowledged and used in designing maritime technology. Because the engineering designers would adopt a concept called "human-in-the-loop" anyway, which means that machines interact without human assistance. Human operators are just a backup if a problem arises.

This worry was not unique. In 2018, the same worry about remote control was expressed by maritime educators. These educators expressed their worry at a conference on upgrading the skills of maritime operators for digitalisation in the future. In a panel discussion, several educators questioned remote control operations and worried that no one knows how to teach since no one has experiences on remote-control. Although educators believe re-training themselves are needed, they do not believe simulator-based system is the best solution. In addition, although the educators said they might be re-trained, systematic training is not available. Simply put, remote-control systems have not yet been delivered to users. The work is conducted in engineering design firms. Only engineering designers run the design work. However, engineering designers assume that they have the knowledge of remote-control and that it is less important to observe current maritime operations or take into account the concerns of others. The researcher engaged with a design workshop at a company in autumn 2018, asking what was the purpose of remote control? One engineering designer replied that remote control is aiming at replacing human beings on board due to most unsafe operations are human errors. Human operators must be relocated on land to build up new abilities to control an object that they do not touch. Only one concern was given – cybersecurity issue.

The answer was not convinced the researcher since the skills the engineering designer refers to is not clear. The researcher asked the engineering designer that what are the new skills and how cybersecurity will look like and who will able to take responsibility in control vessels. A solid answer was not given. Instead, the engineering designer assumes that skills are about interaction. Operators need to take responsibility to handle any problems and make decisions if needed. In order to convince the researcher, the engineering designer guided the researcher to a lab, in which a huge screen is presented. On the screen much information was presented. An engineer sitting front of the screen brought out four small screens to simulate a case for the researcher. The case was about a vessel being remote controlled but now under attack by unknown hackers. The engineer said he would lose control of the vessel, and he was now trying to solve the problem. The solution was to protect the user interfaces through developed software. Using the mouse, the engineer opened a software application and ran it to protect his user interfaces. The engineer believed that it is a method for remote-control and such method no operators have a chance to learn it. It is not surprising that engineers expect to train everyone to use the new technology. However, it was strange for the researcher that operators need to be trained in clicking a software application to protect the safety of the vessel.

How about the weather, waves, and swimmers in the fjord? If the simulation is not real, why do educators worry about training? At least, operators could become familiar with the interaction styles in the new technology. However, although the educators were eager to welcome remote-control systems, they mentioned many times that their goal was to obtain educational funding, not the outcomes of their teaching and the students' learning. They said nothing about

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learning how to interact with computers. This was nothing new in maritime studies. When discussing this issue with an educator at another conference in 2019, the educator replied that simulator-based training is computer games. No true operations at all. The whole shipping industry misunderstand a basic question: *What learning outcome and what level we expect to achieve in simulator-based training*.

Interestingly, the educator knew it might be questionable to accept the engineer's proposal to conduct training by means of simulators. However, the entire maritime domain seems to follow the shipowners and engineering designers wishes. The educator cannot challenge that value. Although the researcher tried to play a mediating role between the engineers and operators, there were invisible hands pushing engineering work to be conducted as fast as possible.

B. Assembling participants

The above scenario indicates that intervening directly in the design process was difficult. This situation was not like an empirical study that is conducted before the actual design process is begun. In the maritime domain, engineering designers assume that software and computer systems follow mathematical models although this assumption is incorrect [33]. In 2019, by chance, the researcher engaged in observing the application process regarding innovative educational programmes for maritime studies. There was a call for applications by nautical science departments at universities to use a bottom-up approach to position students in the centre in designing new study programmes. The objective of the call was to establish an ecosystem to support lifelong relationships among technology, engineering companies, educational institutions, and, most importantly, operators. Because the CSCW researcher was engaged with the educators and invited engineering designers during the application process, the researcher wanted to contribute to making the voices of operators heard. However, it did not happen because the researcher would like to see how they would react to such a call. In CSCW research, balancing outsider–insider role and avoid inserting the researcher's biases into the project is vital. Although CSCW insights may help design technology, it is unclear that whether those insights would pose difficulties for engineering designers, challenge their professional expertise, or even interfere with their work on the ground. The same applies to working with educators. In addition to using CSCW insights to shape technology design, the intention is to scrutinise the usefulness of such insights outside the CSCW community. The power relations between different stakeholders could be balanced by their own interests rather than by an external force, such as the role of researcher in the present project. Thus, instead of interviewing the stakeholders as most ethnographers would have done, a few challenging, structured questions were asked with aim of fostering a new way of thinking about design, which is an approach sought by the researcher.

When participated in a design workshop again in 2019, the engineering designers were asked how they understand a bottom-up approach in design process. There were no clear answers. However, no one doubts that a user in engineering designers' eyes is the person who pay for the project – the shipowners. During the dialogue in the workshop, the operators were not mentioned even once. The researcher reflects that multidisciplinary design is a challenge and requires the reconciliation of diverging design perspectives [34]. Although in CSCW community, software engineers and CSCW researchers in software design projects can share and integrate their viewpoints in the design process, such design process could still miss important aspects of the design problem [35]. If that were the case in the CSCW community, it would also apply to the engineering field [36]. Engineering designers lack the ability to demonstrate the effects of their design concepts because of their insufficient thinking and reflection about such effects. In line with these arguments, in 2019, a question in a panel discussion at an academic conference on ship design was posed, addressing the overlooked operators in technology design. This time, the replies were engineering is about designing functions for the needs of products, not people who use it. In most cases, training is even important because engineers believe people need to be taught in order for properly using a product.

For the researcher, it is a circular relationship: "shipowner–engineering designer–shipowner". Similar to the article, "Located accountabilities in technology production", Suchman reflected on her experience in addressing a similar problem as "a central dilemma of CSCW researchers' participation in increasingly complex divisions of labour and professional specialisation were the layers of mediation between each of us and the consequences of our work" [37]. Although it is the responsibility of the researcher to the process of technology production, his/her participation, of course, broke the relationship into pieces. The question to the engineering designer was about investigating whether they wanted to take the responsibility to trace the usefulness of the production. However, they simply handed off the production after delivery, and they might have never revisited it until someone requested updates or changes. In the present study, one of the engineering designers discussed the following with the CSCW researcher privately after the conference: *The whole industry works in a mechanism like a design-test-deliver-maintenance loop. It is about business. Our motto is that users know very little about what they do and what they want.* The researcher cannot agree with this statement. Bannon [38] warned that users are as professional as anyone else about their workplace and tasks in designing computer systems. They have an insiders' overview of their work and the tools (including technology) that assist them.

The researcher is challenged in thinking about how to assemble different insights to propose a balance of design and use. According to Suchman, she dwelt uncomfortably in the distance between design and use for many years in the 1980s. The balance between design and use forced her to think about her role in technology design projects. She concluded that she, as an anthropologist of technology, could only translate her practice into design terms. However, because of the division of professional labour, the problem was caused by neither her ability nor the design team [37].

After studying the maritime domain for several years, the researcher felt differently. As a member of new generation in

CSCW research, the origin of the problem is known: the mismatch of design problems across multiple disciplines, such as design, science, and engineering. The researcher also knew where, when, and how to contribute to the project to benefit everyone. However, he could not. The reason was not the capability but the role of the researcher in the project. There was simply no chance to intervene in the design process from the very beginning. Because of rapid marketing changes in the shipping industry and technological development, technology companies would like to respond quickly to the expectations of shipowners. Thus, the researcher will always intervene late in the project. The researcher is expected to focus on how their studies could be used in future projects based on the results of investigating current technology.

However, the situation was changed on this occasion. Although no one has actually developed remote control, for various reasons, the researcher could intervene in an early stage to learn how to position themselves in potential projects. In this case, the researcher must be sensitive about the ongoing discussion in the industry as well as the intersection between engineering departments at research institutions and project funding organisations.

Thus, when continually asking if engineering designers can predict the future of remote control, none of them could reply. Instead, the chief engineering designer said it is sadly too few chances for them to learn from the operators. They know where to gain knowledge, however, they choose to ignore the chance. When continually asking and inviting operators to design workshops, however, actually getting even one participant is challenge due to various reasons. Although the operators did not accept the invitation, they seemed happy that their messages were delivered through the study. In mail inbox of the researcher, there was an email from one of the operators, saying that if the researcher would like to ask any questions, please contact the operator in Sep 2017. The operator would love to share his ideas and opinions. In addition, the operator told the researcher that he had started a land-based job and had continued his academic path, seeking a master's degree in computer science. He wanted to work in an engineering company in the future to design systems for vessels. This sounded like an extra bonus. At least, the researcher did not expect the research work to influence others' lives. However, to some degree, it seems the researcher not only managed to get engineering designers to accept that other opinions are also important in technology design. The researcher also inspired operators to share their experience and expertise with others. The researcher unconsciously stepped in the project to play both roles of designer (i.e., in guiding engineering designers) and user (i.e., in inspiring operators). On several occasions, the researcher formatted and reformatted the ideas and opinions of operators, educators, engineering designers, and even his own reflections into a dialogue between investigation and design [28].

C. Reflexivity as an intervention tools in assembling shipowners

Including only operators, educators, and engineering designers in this study was not enough. As previously mentioned, design requirements are given by shipowners. Without their participation, design work is unrealistic, and there would be problems if requirement conflicts arose between operators, educators, and shipowners. Indeed, the researcher has documented results in various formats. However, considering the differences between traditions in CSCW research across the Atlantic, it is notable that a few previous studies concentrated on how cooperative technologies could be created with a focus on articulation work of users [39], as in the European CSCW tradition. Some studies focused on how to intervene in the design process and how intervention is implemented in design [9]. In interviews with Volker Wulf and Myriam, Lewkowicz, Richter and Koch [40] observed that the term practice-based CSCW was descriptive. Although Lewkowicz argued that the importance of CSCW was that it enabled designers and social scientists to use same communication channel. The CSCW researcher of the present work does not fully agree because according to many CSCW studies, at least in European CSCW research, the true design process is conducted by engineering designers. It is questionable how intervention could be implemented realistically without a monitor. Moreover, most CSCW research has evaluated the outcome of design, and there are few studies on the subsequent effects on organizational changes in connection with CSCW research.

Bratteteig and Wagner [41] in the field of participatory design asked the following question: What is a result of participatory design? They argued, "Ideally, a project outcome should be evaluated in a real-use situation when users have had a chance to integrate it into whatever they are doing and (eventually) develop a new form of practice". As a participant in designing remote control systems, did the researcher improves the knowledge of the systems that are supposed to be designed? Through his activities to assemble participants, did he introduce a better "tool" for all stakeholders in the projects, inspiring them to understand that all their voices were important, but no one had a priority. Like the reply by the chief engineering designer, they acknowledged that without information from operators, it was impossible to ensure the quality of remote-control systems in the future. The educators replied similarly. The researcher therefore interviewed three shipowners at their offices at different times from August 2019 to February 2020. The aim was to enable shipowners to develop a realistic expectation of remote control. In doing so, several cases in video format based on the fieldwork in 2015 and 2018 both at sea and in simulators were showed. The shipowners expressed their astonishment after they watched those videos. They saw a great difference between realistic operations and training using simulators. Although they all invest money on training courses for the operators, after the videos they expressed their uncertainties when they addressed the usefulness of the training programmes. It seems no one was

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sure that there was a link between training and real work in ensuring safer operation. However, everyone wanted to hear from the operators, at least the most experienced ones, and recognise their voices in decision-making about technology design, including decisions about material artefacts on board (e.g., dynamic positioning systems).

In February 2020, when talking with the operators and the educator in a seminar at Athens, both were offered a chance to participate in the design of remote control. A positive answer was given this time: '*if that could happen, it would be great that we were not just treated as tools. We do not need to bind ourselves to the terms and conditions offered by engineering designers through their productions. We will not outsource our decision-making and capabilities to someone who has no knowledge of our business. We are the core elements of technology.*'

Now operators, educators, and shipowners gather in public and in private to discuss their opinions regarding design. One example is the joint calls for proposals funded by the Education, Audio-Visual and Culture Executive Agency (EACEA) of the European Commission, the European Shipowner Association and the European Transportation Workers' Foundation. The calls are for a bottom-up approach, learner-centred, lifelong action plan involving education, research, shipping, and maritime technology, which are addressed as vital and mandatory [42] [43]. It seems timely for the maritime domain to respond to such calls rather than me working to re-assemble them.

V. BEING A REFLEXIVE INSIDER

The researcher continues to be active in the maritime domain. The researcher values making changes according to the feedback on what have been seen and where he must intervene to improve maritime technology. The intention of this value is twofold: 1) deploy useful CSCW research in an engineering-oriented field; 2) contributing CSCW research with practical feedback from the front line in engineering work. If the CSCW work on assembling participation and mediating outcomes between social and engineering phrases is a practical activity, then the reflection on the role and the contribution of the researcher to the CSCW community is the highest achievement.

A. Interest-driven CSCW research in maritime design

Nygaard and Bergo [44] suggested that designers, particularly participatory designers, take sides in considering the following: 1) improving the knowledge on which systems are built while aiming to build a better "tool" for users [45]; 2) enabling people to develop realistic expectations and reducing resistance to change [46]; 3) increasing workplace democracy by giving the members of an organization the right to participate in decisions that are likely to affect their work [47]. Differing from their wishes, the researcher does not taken side with the operators, educators, shipowners, or engineering designers. However, the first two suggestions are firmly followed.

Eyal [48] warned that researchers must consider carefully who are experts and lay experts. As an outsider in the maritime domain, the judgement of experts is made by the researcher might not be convincing. Although all stakeholders have an interest in improving maritime technology, "better" is understood differently. For example, operators and educators believe that their experience and expertise are vital in remote control. Engineering designers strongly rely on their procedure-based design process. Shipowners seek to effectively invest in a project and reap the benefits. All these interests involve few or no political conflicts. How could the researcher dare to say who is a better participant in designing remote control systems? The only thing for sure is that the researcher can balance these interests and explore a design point that involves all stakeholders, such as designing organizational frameworks for actions and designing industrial relations context [41]. However, differ from participatory designers who discuss political and policy contexts in design projects, the researcher is particularly interested in collaborating with engineering designers to inspire them and the researcher himself to bridge the gap between CSCW research and CSCW design practice. Some CSCW researchers focus on recognising various materials that have different qualities depending on how they are used in specific places as intervention areas. However, regardless of how the material is bounded through time and space in cooperative work among stakeholders, it is completely static, irrespective of the execution of the coordination it prescribes. CSCW researchers have to consider that materials not only stipulate articulation work (e.g., a standard operating procedure in a social order) as invention [49] but also need to think that materials can be inscribed as a result of the delegation of social roles to nonhumans [50] as well as humans. In this manner, the CSCW researchers can identify different aspects of interest in a design project and find the most appropriate way to represent it in various formats for different stakeholders without changing the meaning. Although the formats are different, the core interest of the present project is held by the researcher; thus, it is a "win-win" situation [51] rather than maximising the complexity of remote control systems. Thus, the researcher is a spokesperson who addresses interactive relations among operators, artefacts, maritime technology, engineering designers, educators, and shipowners to improve their cooperation in such actor networks.

Importantly, as maritime technology becomes increasingly computer supported, the researcher has the responsibility to ensure the final design benefits all stakeholders. By doing so, CSCW insights into designing maritime technology should be best used to change the mechanism of design in the maritime domain, including information technology [52]. That is, the insights of stakeholders do not pertain only to requirement specifications that inform design. By representing their interests, the researcher should trigger a *modus operandi* for intervening in the project by taking specific actions regarding when, where, and what forms in the design process to support interactive relationships between actors – in social-technical associations between humans and nonhumans. Such interactions are badly needed in engineering-oriented fields.

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B. Insider roles across communities

Regarding whether CSCW researchers could potentially address the sociotechnical gap, the CSCW community is divided. Some believe it is possible, but others think that it will take a long time to achieve the division of what we knew socially and what we can support technically. Although some researchers advocate intervention [9] as a solution, their peers are uncertain about how to follow the "the guidelines" [24] because of the lack of reflexivity in interpretive writing. In the present study, the researcher worked in a heterogeneous group. The work of CSCW goes beyond researcher's own accounts of epistemological and theoretical bases. It is crucial to understand not only the nature of the ethnographic encounter and its methodology but also the datasets collected in engineering design work. Instead of tending to discuss people as the objects of study through so-called participant observation, the point is that the researcher shall take his own embodied experiences in the context of personal relationships to gain and exchange knowledge with stakeholders. It is not just a matter of methodology, such as writing detailed field notes and showing videos about practices. It is also a matter of relational epistemology. If a CSCW study is inherently experiential, then it loses the voice of the author in its writing, which limits our insights into the data and our ability to use them in design. The constant assessment of the relationship between knowledge and "the ways of doing knowledge" must be undertaken.

Positioning CSCW insights in engineering projects also concerns relationships with stakeholders, which are reciprocal [53]. In Beaulieu's [53] definition, the value of relationships in different fields in ethnographic studies goes beyond the central notion of face-to-face interaction to the co-presence with the ethnographer during the research. As the present study shows, the relationships among the stakeholders and between the stakeholders and the researcher had nothing to do with negotiating conflicts of interest. The relationship among them was based on self-interest and then was extended to integrate their willingness to participate in the network of actors. They all want their interests to be traceable and consistently represented by someone. The researcher of the present study coincidentally crossed various sites and moments during the research to formulate representations that were useful to all, which was successful. Perhaps another researcher could do the same.

Thus, a few years after completing the research work, the researcher does not perceive that he has a value-neutral stance in research work in the maritime domain. The researcher would argue that CSCW researchers should make themselves explicit to stakeholders so that the latter can better understand their own interests, which, as well as their reasons and motivations, are articulated by the researcher. In this manner, the researcher makes explicit his ideological assumptions to allow other CSCW peers to see the worlds in which the researcher is embedded. Moreover, the CSCW peers could build their own interpretations of the case study of remote-control technology and the indication to reflect on their own assumptions and mindsets. The purpose is mainly to triangulate the sources of evidence with other peers although they use different contexts. Regardless of whether the context is the maritime domain or the healthcare domain, they all work with and in a heterogeneous group. How should they share their reflexive insiders' views of epistemology and methodology in deploying CSCW insights in the design process [26]? It is not a matter that only the CSCW researcher must address. It is also a matter of how CSCW researchers communicate with others. In the present study, the researcher, engineering designers, and shipowners did not share the same mindsets in learning from experience. Thus, a dialogue between the three forms of knowledge helped promote mutual improvement and anchor the relevance of the CSCW research in policy making for design projects in the maritime domain. The CSCW researcher of the present work influences epistemological assumptions and the previous experience in the field influences the dialogic process. It is likely that the best is to position people in the centre in designing the usefulness of technology. Through the dialogue between stakeholders with whom the research engaged, it was possible for peers to investigate and criticise the accounts of interventions, thereby assessing whether the interpretations were valid.

C. Connecting Communities of Practice

Because of the researcher's unique background in software engineering, CSCW, and sociology, his enrolment in a group designing maritime technology was more than seeking to improve current design practices in multidisciplinary fields. To make sense of the problems the researcher faced in the maritime domain by creating something new. As a practitioner–researcher in systems design, CSCW research is different when it is used in the engineering field not only because it was new but also because it was a foreign element that was usually rejected by a group of professionals. The nature of the work practice of a professional community is to transform the status quo by new ways of working and interacting rather than accommodate a completely new element. CSCW insights are examples in the present study.

Jackson et al. [54] proposed that CSCW has fewer concerns about translating its theoretical knowledge into forms and instruments that are useable by wider communities. The researcher of the present study faces similar challenges in working in designing maritime technology, in which remote control systems are only one of several design projects. The new generation of CSCW researchers may be different from first-generation. They know about human-centred computing, they know how to do fieldwork, and they even know how to translate their findings into special formats to communicate with systems developers [1]. However, they miss long-term engagement and design sensitive analysis in dealing with their reflections on how they connect different communities. Most CSCW research is iterative enough of its design process and does not challenge the lack of voices of confessional reflection [30] in their community. When researchers seek intervention as a bridge between research and practice, they might fall into their existing cognitive knowledge and create their own artificial worlds and seek their own language in doing

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design. They focus on exploring the inner symbolic space of a paradigm, and they try to convince others to believe that their languages are universal and useful. This might be wrong. If they do not accept procedure-oriented engineering design, is it correct to assume that CSCW can provide a solution? Suchman [55] suggested that we might need to find a customised solution rather than a universal solution. The challenge of this idea is not only the cognitive aspect of engineering design and CSCW research. It requires the development of radically new forms of scientific inquiry.

In this article, the researcher has reported and discussed his theoretical struggles in interpretive empirical research to fulfil the forms of scientific inquiry in connecting communities of practice. In a heterogeneous group, the collaboration in designing remote control is not a straightforward process. When reading the CSCW literature, the researcher always turn on his software engineer mode to review praxis [40][77]. It is a challenge. Even though the researcher holds two sets of knowledge—CSCW and software engineering—, he should have different perspectives on what he has read, and he should consider them equal contributions to his knowledge. However, in a heterogeneous group, this inner attribute of the researcher becomes both he and others. Because the designer of remote control systems is not the researcher and most work still depends on control engineering principles, inquiry requires extensive empirical data and practical concerns as well as a theoretical framework that might be perceived as disconnected from social construction [56]. Thus, as a researcher who was uniquely trained in two fields and is now working in the complete unstructured maritime domain becomes a challenge. The researcher needs to give his peers the tools to criticise his accounts of the work practice in the workplace. He also needs to engineering designers the tools to investigate the usefulness of the contribution from CSCW point of view to them. In the present work, although no one forced the researcher to make notes and work-in-progress drafts available to all members of the project, he realises that opening the datasets helped fulfil hermeneutic cycles and multiple interpretations. In interviewing the engineering designers, the CSCW perspective of maritime technology led to further discussion. Thus, multiple interpretations of the benefits and why the project should design alternatives became possible. The CSCW approach made it possible for the engineering designers to discuss the situation and to switch from a cooperative project where everyone had his own spot to engage in truly collaborative work. Moreover, both the engineering designers and the researcher recognised the value of reflectivity even though it might differ among them. However, it is important in the discipline of design between CSCW and engineering. The engineering designers found a way forward to be comfortable with the various interests and reflected on them in a dialogue to find a solution.

VI. CONCLUSION

In this article, a case study of reassembling participation to improve the design of remote-control systems with respect to all stakeholders is presented. In addition to the contribution of practical knowledge to the maritime domain, the reflective writing in this article offers a view of how CSCW insights and engineering practices were transformed during the engagement of the researcher in designing maritime technology. In the last seven years, the CSCW interpretation of designing maritime technology suffered from blind spots. However, following the interpretive research and the knowledge and experience gained in CSCW research, the reward was not effecting change. Instead, the rewards were the better understanding of the challenges and opportunities related to bridging the gaps between applying CSCW insights and conducting research in CSCW inside and outside the CSCW community to make real contributions to other fields. As a result, the article suggests that the development of CSCW insights in the engineering fields should have a strong focus on the participation of stakeholders who not only use technology but also those who fund and develop technology. Thus, CSCW researchers could learn more about self-reflection and self-revelation in the contribution to the industry and possibly positively influence policymakers to rethink framework development in the engineering field. In conducting research in the maritime domain, the researcher found that the best way is to reflect and reveal one's own research findings and activities to enable combining them in a wider scientific discourse. If intervention is an unavoidable condition of CSCW research, by being there, the researcher already connected communities of practice, thus making a difference by affecting the practice he studies. The case in this paper, the translation of the research work, the qualitative inquiry the paper developed, and the reflective materials the researcher wrote are tools that could serve both the community and the community from which CSCW insights emerge. The rest is up to others who want to confirm their own values to balance their position with the CSCW insights in their own work. As a result, the gap between research and practice both inside and outside CSCW research could be reduced.

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