DE GRUYTER

REELER

Special Issue on Ethnography in Human-Robot Interaction Research

Guest Editors: *Cathrine Hasse, Aarhus University, Denmark*
Stine Trentemøller, Aarhus University, Denmark
Jessica Sorenson, Aarhus University, Denmark

This Special Issue is devoted to the high-quality research papers presented during the Workshop "An alternative HRI methodology: The use of ethnography to identify and address Ethical, Legal, & Societal (ELS) issues: An alternative HRI methodology", held in Chicago, USA, 5th March 2018 in conjunction with the 13th ACM / IEEE International Conference on Human-Robot Interaction (HRI 2018).

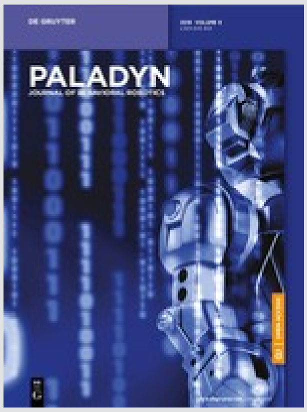
The workshop and the Special Issue were both made possible with support from the REELER project (Responsible, Ethical Learning with Robotics), which has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 731726.

Contents

DE GRUYTER

PALADYN, JOURNAL OF BEHAVIORAL ROBOTICS

Ed. by Gregor Schöner



The aim of Paladyn is to become a premier source of knowledge and a worldwide-recognized platform of exchange for scientists of different disciplinary origins and backgrounds (e.g., engineers, computer scientists, physicists, neuroscientists, psychologists, sociologists) who are inspired by the analogy between robotic autonomy and human behaviour.

Paladyn. Journal of Behavioral Robotics is a **fully peer-reviewed**, open access, electronic-only journal that publishes original, high-quality research on topics broadly related to neuronally and psychologically inspired robots and other behaving autonomous systems. The journal provides the readers with free, instant, and permanent access to all content worldwide; and the authors with extensive promotion of published articles, **long-term preservation**, no space constraints, and quick publication.

Paladyn. Journal of Behavioral Robotics is **indexed by SCOPUS**. Our standard policy requires each paper to be reviewed by at least two Referees and the peer-review process is single-blind.

The journal **does not have article processing charges** (APCs) nor article submission charges.

Editor-in-Chief
Gregor Schöner, Ruhr-Universität Bochum, Germany

Managing Editor
Justyna Zuk, De Gruyter

Publisher
DE GRUYTER Poland
Bogumila Zuga 32A Str.
01-811 Warsaw, Poland
T: +48 22 701 50 15

Online:
Open Access

Online ISSN: 2081-4836

Language of Publication: English

Subjects:
Applied Mathematics
Clinical Medicine ▸ Psychiatry, Psychotherapy
Neurobiology
Technical and Applied Physics

Of interest to: engineers, computer scientists, physicists, neuroscientists, psychologists, sociologists

Covered by SCOPUS

CiteScore 2018: 2.17

SCImago Journal Rank (SJR) 2018: 0.336
Source Normalized Impact per Paper (SNIP) 2018: 1.707

ICV 2017: 99.90

Journal

Paladyn, J. Behav. Robot. 2019; 10:180–181 DE GRUYTER

Editorial

Open Access

Cathrine Hasse*, Stine Trentemøller, and Jessica Sorenson

Special Issue on Ethnography in Human-Robot Interaction Research

https://doi.org/10.1515/pjbr-2019-0015
Received March 20, 2019; accepted March 20, 2019

This special issue builds upon the ideas raised in a workshop[1] on ethnography as an alternative methodology at the 2018 Human-Robot Interaction (HRI) conference in Chicago. We first proposed the workshop after finding that despite increasing interest in the instrumental use of ethnographic methods in technological development processes, ethnography as a research methodology remained more or less absent from the field of human-robot interaction.

The ethnographic research presented at the 2018 HRI workshop provided a close look at real-life experiences of human engagement with robotic technologies, in use and in design processes. Scholars presented how their use of ethnographic methods provided data that, through interdisciplinary collaboration, shed light on human needs and societal concerns surfacing in response to emerging technologies.

Organizing the workshop and putting together this Special Issue has brought us into contact with very interesting roboticists with an understanding of the importance of ethnographic approaches in HRI. Yet, in the work on this special issue we have also found some etymological and methodological differences in our understandings of ethnography.

One thing we heard when we first drafted our proposal was "We already use ethnographic methods in HRI." For some, ethnography is simply *a scientific description of people and cultures*. or descriptive of what "anyone can see". Another simplification of our work is that it is merely anecdotal, and that a single study is not sufficient to support scientific conclusions.

This may come down to a failure in interdisciplinary translations – how different disciplines develop different methods and have a hard time communicating them. Ethnographic methods are not cookbook recipes for research, but are embedded in a methodology with theoretical grounding.

Ethnographic methods are not easily or effectively extracted and used instrumentally, because they are tied to the theories that frame the researcher's choices in the field, and the ethnographic gaze developed in fieldwork over time.

For anthropologists, and those who utilize an ethnographic methodology to conduct research, ethnography is much, much more than 'just looking'. No anthropologically-based ethnography is ever merely descriptive. We study with people, not of people, on people, outside of people – *with people*. This implies learning how to see the world from a new perspective, learning to share values with the people we study, and relating all of this to the 'outside' world in order to analyze the (social, cultural, and material) complexity of their practices, as interpreted through our own experiences. Through the research process, our analytical objects and graphic descriptions change in accordance with our deeper learning of what matters to people.

Even if ethnography were as simple as anecdotal description, the term 'ethnography' (and the inclusion of its methods and/or methodology) is nearly absent from the HRI literature we examined in a comprehensive review. In this Special Issue, we try to demonstrate both the importance and the validity of ethnographic approaches to research in the HRI research.

***Corresponding Author: Cathrine Hasse:** Program for Future Technology, Culture & Learning Department of Education, Aarhus University, Tuborgvej 164, 2400 Copenhagen, Denmark; E-mail: caha@edu.au.dk
Stine Trentemøller: Program for Future Technology, Culture & Learning Department of Education, Aarhus University, Tuborgvej 164, 2400 Copenhagen, Denmark; E-mail: stinet@edu.au.dk
Jessica Sorenson: Program for Future Technology, Culture & Learning Department of Education, Aarhus University, Tuborgvej 164, 2400 Copenhagen, Denmark; E-mail: jeso@edu.au.dk

1 Cathrine Hasse, Stine Trentemøller, and Jessica Sorenson. 2018. The use of ethnography to identify and address Ethical, Legal, and Societal (ELS) issues: An alternative HRI methodology. In *HRI '18 Companion: 2018 ACM/IEEE International Conference on Human-Robot Interaction Companion, March 5-8, 2018, Chicago, IL, USA*. ACM, New York, NY, USA
https://doi.org/10.1145/3173386.3173560

Nevertheless, we acknowledge that there are different interpretations of ethnography (even within anthropology) and different levels of engagement with ethnographic theories, methods, and approaches, and have included such variation in this Special Issue – showing what each offers to the field of HRI.

Boh Chun makes a strong argument for an ethnographic methodology as particularly suitable for studying robot sociability in social robotics research.

Cathrine Hasse points out the benefits of the multivariation approach to cross-case ethnographic studies, in the context of technological literacy and ethical robotic design.

Leon Bodenhagen et al. combine quantitative methods with large-scale ethnographic observations to identify opportunities for the integration of robotic technologies in hospital workflows.

Jessica Sorenson's study of industrial robotics argues for ethnographic interventions as a bridge between theoretical engineering ethics and pragmatic design activities.

Jamie Wallace's visual ethnography points to the significance of the images created and shared in HRI studies – and the ethical implications of these decisions.

Niels Christian Mossfeldt Nickelsen calls forth a classic discrepancy in ethnography, between perceptions and practice, highlighting the user's key role in realizing a robot's promised performance.

Lasse Blond's comparative ethnographic study of a South Korean Robot rejected in Finland and accepted in Denmark, shows how culture and context matter in both design *and* implementation.

In all of these papers, we can see that ethnography can complement the type of work already being done in HRI, to give more varied and intimate data on the how and why behind the phenomena studied more quantitatively or experimentally in HRI, *and* to bring forward new research foci that emerge only from *studying with people*.

We would like to thank the authors and the reviewers for collaborating with us to produce this exciting Special Issue on ethnography as a methodology for more *human-centric* human-robot interaction research.

Research Article Open Access

Bohkyung Chun*

Doing autoethnography of social robots: Ethnographic reflexivity in HRI

https://doi.org/10.1515/pjbr-2019-0019
Received September 5, 2018; accepted May 8, 2019

Abstract: Originating from anthropology, ethnographic reflexivity refers to ethnographers' understanding and articulation of their own intervention to participants' activities as innate study opportunities which affect quality of the ethnographic data. Despite of its methodological discordance with scientific methods which minimize researchers' effects on the data, validity and effectiveness of reflexive ethnography have newly been claimed in technology studies. Inspired by the shift, I suggest potential ways of incorporating ethnographic reflexivity into studies of human-robot social interaction including ethnographic participant observation, collaborative autoethnography and hybrid autoethnography. I presume such approaches would facilitate roboticists' access to human conditions where robots' daily operation occurs. A primary aim here is to fill the field's current methodological gap between needs for better-examining robots' social functioning and a lack of insights from ethnography, prominent socio-technical methods. Supplementary goals are to yield a nuanced understanding of ethnography in HRI and to suggest embracement of reflexive ethnographies for future innovations.

Keywords: ethnography in HRI; ethnographic reflexivity in HRI; human-in-the-loop methods in HRI; autoethnography in HRI; the Wizard of Oz testing; participatory design in HRI; human-robot social interaction; robot sociability; digital anthropology; social robotics

1 Introduction

A social robot refers to a robot that is designated to autonomously carry out specific tasks alongside people and to interact socially with them [1]. Based upon the assumption of robot sociability, the primary goal of HRI research in social robotics is to improve the robot's everyday social functioning. Because roboticists' focus has long been the robot working far away from people [2], the study of human-robot social interaction requires to further explore a variety of techno-social methods that have seldom been appreciated in traditional robotics.

A barrier in such methodological innovations may be involved in the use of relevant methods which conflict with traditional robotics' methodological stance, called positivism in social science theories. The application of ethnographic methods in general is often the case due to their qualitative approach. Especially, ethnographies drawing on the idea of reflexivity entail an extra-difficulty in their incorporation. As I further elaborate in a later section, reflexivity refers to ethnographic researchers' self-awareness and writing of their personal impacts on the quality of the ethnographic data as quintessential study opportunities of ethnographic methods. Reflexive ethnography has widely been appreciated as a productive social method in anthropological technology studies for decades. In addition, despite of its common discordant relationships with scientific methods, its relevance and contribution to understanding advanced human-technology social networks have newly been established over the last decade in the technology field as well, Human-Computer Interaction (HCI) in particular [3, 4].

Inspired by the growing appreciation of reflexivity in ethnographic technology studies, this paper particularly concerns potential implications of ethnographic reflexivity for studies of human-robot social interaction if applied. In HRI, not only is there a lack of ethnography in general, but also there is no ethnography actively embracing reflexivity to date. Thus, a primary aim of this paper is to fill the field's current methodological gap between common needs for better-examining the robot's sociability and a lack of insights from ethnography, widely known as a prominent techno-social method. Supplementary intentions are to develop a nuanced understanding of ethnography as a set of epistemologies rather than simple research techniques and to encourage the field's methodological embracement of ethnographies typically perform-

***Corresponding Author: Bohkyung Chun:** Department of Anthropology, Oregon State University, USA;
E-mail: chunb@oregonstate.edu

ing reflexivity. To achieve these goals, I unfold potential ways and implications of incorporating ethnographic reflexivity into the field by suggesting three paths to applying autoethnography, a typical mode of reflexive ethnography, to studies of human-robot social interaction in a productive manner.

In the following two sections, I first describe ethnography and its reflexivity drawing on anthropological ethnographic theories followed by an outline of both traditional technological ethnography and emerging reflexive ethnography (i.e. autoethnography). Since ethnographic theories are scarce in the current HRI field, I refer to trajectories of technological ethnography found in HCI. Then, I present how performance of reflexivity could generate insights into the development of socially-adaptable robots by suggesting three potential ways of its productive application to studies of human-robot social interaction: participant observation, collaborative autoethnography and hybrid autoethnography. I also discuss the importance of accepting a particular writing style in publishing such autoethnographic studies in the field.

2 Ethnography and reflexivity

2.1 Ethnography

Ethnography has been used in the technology field for over three decades [5]. Ethnography is, however, still a new method for many roboticists. As someone who has been working in the field with an anthropology background, I begin with a general description of ethnography. I only focus on qualitative ethnography here, because ethnographic studies are predominantly qualitative even though there also are "mixed-method" ethnographies using both the quantitative and the qualitative data [6].

What is ethnography? Ethnography is a primary method of cultural anthropology, which is used to study on social systems and processes shared among specific groups of people [7]. By "social systems," I mean sociocultural and historical circumstances surrounding people which influence the construction of their behaviors, beliefs, self-identities and ideas about others. Meanwhile, by "social processes," I mean ways in which people adjust their behaviors and thoughts in their everyday social lives in relation to social systems. In this sense, a central tenet of ethnography is that human social behaviors and perceptions cannot be understood without the information of their own contexts [8].

In a strategic or technical level, a single ethnographic project always contains two or more data sources to let them validate one another (i.e., triangulation [9]). Hence, ethnography is known as a holistic approach to people and the society. During the period of ethnographic data collection, uniquely called fieldwork, ethnographic researchers directly participate in social groups under study and conduct a series of activities including in-depth interviews, participant observation and visual and textual documentation. In the process of conducting such activities, ethnographic researchers also write and collect their own journals, called fieldnotes, regarding what they learn and think about participants' behaviors and cultures on a daily basis. Simply put, an idea underneath the ethnographic data collection is that the best ways to learn what others do and why is to directly experience their daily lives by interacting with them.

There are some distinctions between traditional and modern ethnography since ethnography dates back hundreds of years. Conventionally, ethnography was assumed to be only used for studying on "far-away" cultures, and fieldwork referred to an ethnographer's physical presence in a culture under study for years. Whereas, in modern ethnography including ethnographic technology studies, ethnographic field sites are not limited to "strangers' worlds" anymore. Ethnographic researchers commonly study on social arenas familiar to themselves such as workplaces, homes, community centers and online social worlds with a shorter duration of fieldwork, e.g., from several weeks to years; it is usual that ethnographers travel to multiple field sites for a single project [10]. In addition, instead of literally moving into a culture under study and staying there for a long period of time, today's ethnographic researchers are more likely to frequently visit participants' mundane lives on a regular basis. Finally, in modern ethnography, it is also common to actively use digital technologies for data collection and rapport creation: participants' activities are photographed and filmed, interviews are conducted via phone and video chat, and social media services are used to develop rapports and to learn participants' updates.

The description of ethnography I made above mostly informs of ethnography as a set of data collection strategies and techniques. Ethnography as a data collection method has been known as being effective and relevant in discovering adaptabilities of computational technologies to everyday human conditions, i.e. how and why certain trends of human behaviors and attitudes towards technological systems occur, vary, persist or change over time [11, 12]. For example, such "in-situ" and "human-in-the-loop" attributes of ethnographic data collection have resulted in tech companies' serial employment of anthropologists and increasing "anthro-techno" collaborations in system design.

Meanwhile, there is another dimension of ethnographic methods less known in the technology field. That is, ethnography as a set of epistemologies, i.e. ideas of how we know things [13]. Ethnography does not simply indicate data gathering activities such as observation and in-depth interviews but also includes philosophies. Generally speaking, ethnography is often conducted from one of the two contrasting perspectives: positivism and constructivism, i.e. an idea that there is a univocal truth awaiting our discovery VS an idea that the reality is constructed and interpreted uniquely by each person [13]. Most of traditional technological ethnographies rely fairly on the former while ethnographic reflexivity is a concept drawn from the latter. Positivist ethnography, however, also entails reflexivity to some degree in principle. In the following subsection, I further elaborate what reflexivity is, how it is performed and why some may say that even positivist ethnographies are innately reflexive to some degree.

2.2 Ethnographic reflexivity

Ethnographic reflexivity refers to ethnographic researchers' awareness and articulation of interpersonal dynamics between researchers and participants and impacts of those subjective dynamics on the research process and outcomes. Since it is one of the core concepts constituting ethnographic methods, there are multiple works theorizing ethnographic reflexivity with distinct accents. This paper primarily borrows Burawoy [14]'s conceptual work of ethnographic reflexivity inspired by Rode [3]'s suggestion of incorporating it within technological ethnography.

First, ethnographic researchers who perform reflexivity admit that their own interventions to participants' actions and reactions create opportunities of data collection as well as impacts on the quality of knowledge produced. In scientific studies, data is collected and tested with a goal of producing unambiguous outcomes, and effects of the individual researcher's actions to the research process are avoided to increase reliability [14]. Whereas, researchers' intervention to and interaction with research participants during the period of data gathering refer to the ethnographic method itself. As long as researchers' interactivity towards studied situations and people generate study opportunities in ethnography, ethnographic researchers' own reflection and interpretation rather increase reliability of ethnographic findings.

In a similar vein, performance of reflexivity implies acknowledgement of ambivalent positional binaries between the researcher and the participant in ethnography drawing back from the position of the authoritative researcher. During fieldwork, ethnographic researchers' and participants' speech acts and experiences are always interrelated and co-created. Namely, ethnography is not simply a method of examining social process, but ethnography itself is also a social process. In many modern ethnographies embracing reflexivity, participants take subjective positions in considering certain study subjects closely related to their lives. Even positivist ethnographies at least depend on the researchers' interactive experiences and personal relationships with their participants (i.e. fieldwork and rapport). Hence, in anthropology and related fields (e.g. cultural studies, gender & ethnic studies and sociology), there has been a shared understanding that all ethnographic works are intrinsically reflexive and interpretative to some degree although they reveal different levels and styles of reflexivity [4].

Second, practice of reflexivity is closely tied with a question of "how do we tell others about others?" in addition to "how do we know what we know?" while those two questions are ultimately interrelated [15]. Hence, some say "reflexivity is the ethnographer of the text [16]." If ethnographic researchers realized and exploited their positional dynamics with participants in the process of data gathering and analysis, it should be ultimately presented in publications. Reflexive writing aims to tell audiences how the researcher's data gathering impacts the quality of the data itself; it is comparable to reciting the statistical data in quantitative publications. Thus, styles of writing matter to practice of reflexivity in a sense that representation of the reflexive data should be made up of researchers' detailed interpretation and retrospection of their own first hand experiences, interventions and relationships which occurred in the field [3].

Van Maanen [17] classifies ethnographic writing into three styles: the realist tale, the confessional tale, and the impressionist tale. The realist tale foregrounds authenticity of ethnographic representation; it is written in the third person voice as if the researcher was purely an outsider-observer of the described situation [17]. The realist tale is a style that hardly allows reflexivity since it neither admits interchangeable roles of both the researcher and the participant nor allows interpretative inferences and retrospective episodes. Meanwhile, the confessional tale prioritizes honesty of representation, and it is written in the first person voice in an interpretative manner; it aims to implicate the researcher's own perspective and inference within the account of the data [17]. Lastly, impressionists provide a detailed description of impressive episodes experienced by researchers and participants with a limited interpretation; it aims to vividly and dramatically reveal unique attributes of a culture under study by presenting the most striking stories [15, 17]. The realist tale is the one more likely to be adaptable to the technology field while the confessional and the impressionist tales are rarely found [3, 5].

Finally, the concept of reflexivity implies ethnographic researchers who perform reflexivity attempt to find structural patterns in the data, which results in theory building and extension. In other words, the concept legitimizes reflexive insights as valid academic results (i.e. ethnographic publications are neither anecdotal nor personal). It could be said that performance of reflexivity "objectifies" ethnographic insights in an ironical sense.

3 Reflexivity in technological ethnography

3.1 Positivist ethnography in HCI

It is obvious that reflexivity is an opposite idea to scientific methods. Thus, most of technological ethnography has been positivist ethnography which lacks reflexivity [3]. Such positivist technological ethnography was initiated in the 1980s speaking to the predominant tradition of cognitive science in HCI. Criticizing cognitive science's overfocus on individuals' internal decision-making process in the construction of human reactions towards computer systems, it has widely established the crucial role of contexts in shaping the particulars of human-technology interaction.

There are multiple theoretical frameworks (e.g. situated action [18], activity theory [19] and distributed cognition [19]) advocating distinct understandings of what "context" exactly means as a category of analysis in this ethnographic school [19]. Yet, an overlapped assumption is that ethnography is a method through which researchers objectively measure different contexts of actions conducted by participants who are apart from the researchers themselves. Accordingly, the realist tale is assumed as being the most relevant in conveying the knowledge produced by such ethnography.

For example, "ethnomethodologically-informed-ethnography [3, 5]" including ethnographies drawing on a concept of "situated action [18, 20]," maintains that knowledge of the society, e.g. social orders, should be discovered through investigation of people's knowledge of it, i.e. their methods of negotiating it, revealed in their everyday social interactions [21]. Situated action claims that every course of human interaction with the machine is sequentially and minutely created depending upon its situation [18, 20]. Ethnographies drawing on such concepts pay attention to opportunistic and moment-by-moment construction of human reactivity towards the machine, which is a counterpart of cognitive science's separation of the human action from the context [18, 19].

When it comes to reflexivity, positivist ethnography also contains reflexivity in a sense that it refuses cognitive science researchers' omnipotence in understanding "knowledge" as transcendental realities; instead, it gives away the authority of knowledge to people's everyday contexts [22]. Positivist ethnography's partial embracement of reflexivity in technology studies corresponds to the statement, "all ethnographies draw on researchers' reflexivity to some degree." Nevertheless, this ethnographic school rarely allows researchers' performance of reflexivity in analysis and writing. For instance, the concept of situated action over-emphasizes improvisatory human actions so that it misses opportunities for building theories regarding more durable trends [19]; it affects a pervasive misunderstanding of ethnography as being anecdotal and unreliable. As another example, a rule of ethnomethodological writing in which participants' description of their own actions can be only accepted as a valid basis forbids researchers' interpretations and inferences in ethnographic writing [5, 22].

3.2 Reflexivity and autoethnography in HCI

Not to mention HCI researchers' acknowledgement of the nature of ethnographic knowledge production, their emerging attention to ethnographic reflexivity is also involved in the rise of a new paradigm in HCI [3, 5, 23]. On the one hand, reflexive ethnography has been considered as being useful for those who concern participatory design methods [3]. In spite of its conceptual discordance with traditional scientific methods, reflexive ethnography's focus on the co-creation of both the researcher's and the participant's insights goes well with the trend of participatory design in HCI. On the other hand, a theoretical and analytical shift from "cognitive systems to emotional experiences [4]" in HCI research has also influenced the rise of reflexive ethnography in HCI [23]. When it comes to understanding emotional and experiential dimensions of human-technology interaction, traditional positivist ethnographies are more likely to lose their merits because they mainly burgeoned through a scientific dialogue regarding the construction of human cognition. Ethnographic studies of emotional experiences require more reflexivity in a sense that reflexivity values ethnographic researchers' emotional and sympathetic approach to potential users' techno-social experiences.

Autoethnography is a typical example of reflexive ethnography which has particularly been well-incorporated into HCI in the context of the field's paradigmatic transformation. Autoethnography refers to an ethnographic approach to research and writing that describe and systematically analyze (i.e., "graphy") ethnographic researchers' personal experiences (i.e. "auto") in order to understand larger cultural structures (i.e. "ethno") [24]. In other words, autoethnography is characterized by the following elements. First, it radically appropriates researchers' practice of reflexivity as a primary data resource of a study. Second, a pivot of autoethnography is an analytical connection between researchers' personal experience and social systems related to it [25]; to increase validity and representativity of the autoethnographic data, auto-ethnographers often conduct in-depth interviews with other social members and reviews of the existing data as well [26]. Lastly, it validates confessional and biographical style of writing in its publications [26].

Besides HCI's emerging focus of participatory and emotional design, another particular reason for the rise of autoethnography in HCI is the methodological efficiency of autoethnography in terms of accessibility to study resources [23]. On a practical level, autoethnography facilitates rapid recruitment of research participants and prolonged observation of participants' private routines. On more inspirational level, there has been a shared understanding that autoethnography provides technology researchers with opportunities for more relevant research design and analysis in studying on other participants' experiences [23]. As autoethnography validates researchers' dual roles as the researcher and the participant, it is no wonder that it encourages researchers' empathetic approach to study subjects. Similarly, it is also claimed that auto-ethnographers are more likely to be sensitive towards ethical issues related to the technology under study as they have a profound understanding of the technology's real-world deployment [27].

According to Rapp [23], such benefits of autoethnography to technology studies have given rise to a cluster of the autoethnographic approach to a variety of study subjects in HCI including impacts of location-based services on a bus drivers' work conditions [28], ways of learning music through listening [29], social interaction of people who do not use smartphones and social media [30], potential everyday functionalities of a wearable device originally designated to increase the awareness of time [31], reliabilities of self-tracking devices [32], the use of a wrist blood pressure among individuals with hypertension [33], early adopters' use of a smartwatch [34] and user cultures of Massively Multi Player Online Role-Playing Games (MMORPGs) [23]. Many of the studies employ autoethnography as means of including researchers as members of participants so that researchers' own interests, motivations and pain points regarding their research subjects are exploited as study resources rather than being remained hidden [35, 36]. Similarly, autoethnography also serves as a theoretical back-up for actual design practice in HCI such as designing a system aiming at supporting users' own reflection and awareness of their own emotional interaction with the system itself [37] and improving a system drawing on the creators' own experience of the system itself [38].

In sum, the growing attention to users' emotional existence in the course of human-technology interaction as well as the crucial role of user-generated insights in system design has engendered needs for alternative methods to the objective and realist approach in HCI. Hence, there has been a reflexive turn of the technological ethnography in HCI. Due to its unique methodological attributes, autoethnography has particularly shown its potential for developing researchers' experiential understanding and sympathetic account of complex techno-social experiences by re-appropriating researchers' personal positionalities as insightful resources rather than obstructive factors to the study. Inspired by such transformation of technological ethnography in HCI, I turn back my gaze upon HRI and suggest three potential paths to incorporating autoethnography into studies of human-robot social interaction in the following section.

4 Performing ethnographic reflexivity in HRI

4.1 From fly-on-the-wall to participant observation

As a path to validating autoethnography in HRI, I first suggest to broaden the field's current notion of "observation" to include ethnographic participant observation as an option of reliable observation techniques.

Although the number of existing ethnographies in HRI is few, those ethnographies [2, 39] repetitively employ the fly-on-the-wall technique as means of observing participants' reactivities towards robots. The fly-on-the-wall refers to a technique of empirical data gathering originated from psychological experimentation, through which the researcher secretly observes behaviors of the researched as if the researcher played a role of a CCTV camera on the wall. The existing ethnographies' exclusive use of fly-on-the-wall technique denotes pervasive methodological hindrance from ethnographic researchers' reflexive practice in HRI research.

A key difference of fly-on-the-wall from ethnographic participant observation is its minimalization of the researcher's involvement in occurring situations. While it is obvious that such observation techniques bring their own values to the study of human social behaviors with a strength of unobtrusiveness, participant observation can also be considered as being valid in HRI research with the concept of reflexivity. It is a basic element of ethnographic fieldwork embracing reflexivity, and even objective ethnographies include participant observation.

If applied to HRI research, participant observation allows the researcher to be physically and socially presenting in the situation of interaction alongside both the participant and the robot. It could offer opportunities for collecting participants' initial thoughts and expressions regarding their interaction with the robot. Through the conduction of participant observation, researchers can make instant conversations with participants and co-experience certain situations of interaction simultaneously with them as well. As long as participant observation is a basic level of reflexive practice in ethnography, acknowledgement of validity and values of participant observation would be a preceding path to incorporating autoethnographic approach within the field.

4.2 Social robotics teams' collaborative autoethnography

In traditional sense, autoethnography refers to a single-person ethnographic researcher's autobiographical investigation of one's own experiences. Whereas, I propose a social robotics team's collective performance of autoethnography regarding their own social interaction with their own robots as a productive way of applying autoethnography to the field; I call it collaborative autoethnography in this paper. Social robotics teams' collaborative autoethnography seems particularly useful in examining pre-released robots' social functioning in everyday laboratory settings throughout development stages. While the previous work mentions the suitability of autoethnography for system design, I suppose that autoethnography, particularly its collaborative variant, would be widely appreciated in HRI as well for the following reasons.

First of all, employment of robots as service providers and co-workers in ordinary human life spheres is still limited despite of a remarkable progress of social robotics technologies over the last decades. At least at this point of innovation, social robotics laboratory and company team members are identified as exceptional groups of people who spend a large portion of their daily lives with robots. In a similar vein, the robot's corporality, the attribute of its physical presence promotes the suitability of autoethnography for HRI even more, compared with other social technologies such as social software and devices. As robots physically hang around in robotics offices and test areas, roboticists have easy access to their own robots particularly when numerous times of testing and quality assurance occur at the early stage. Hence, they are perhaps one of the most eligible population for studies of such novel technologies.

In addition, another potential benefit of collaborative autoethnography is involved in the predominant social and emotional focus of social robotics research in HRI. As mentioned in the preceding section, the autoethnographic approach is characterized by acknowledgement and accommodation of subjectivity, emotionality, and the researcher's influence on the research rather than hiding from these matters [23]. As an intensified way of performing reflexivity, collaborative autoethnography could offer social robotics teams chances of experiential learning regarding robots' sociability. On the one hand, members of collaborative autoethnography would have opportunities for emotionally understanding the robot's social functioning in an embodied manner by reflecting how it's presence in their workplace makes changes in the quality of their everyday social lives. On the other hand, each collaborative auto-ethnographer may also be able to closely observe other co-auto-ethnographers' reactivities towards the robot one another, which preferably leads to iterative discussion of the data during the period of data collection and analysis. In other words, I presume social robotics teams' collaborative autoethnography would work as a participatory design method by identifying individual researcher-participants as sympathetic co-experiencers rather than rational bystanders throughout the process of innovations.

4.3 From Wizard of Oz to hybrid autoethnography

The last suggested path to incorporating autoethnography into HRI in this paper is hybrid autoethnography. Hybrid autoethnography refers to an advanced mode of reframing subjective positionalities in HRI research through which traditional positions of the researcher and the study object (i.e. the robot) are mediated and hybridized all together. It aligns the human researcher with the robot as a hybrid entity of observer-actors drawing on both the social robotics' assumption of the robot sociability and the anthropological idea of autoethnography.

Namely, hybrid autoethnography is a conceptual combination of the assumption of robot sociability and autoethnography. Considering that distinct roles of technologies (e.g. tools, media and social actors [40]) differently shape people's relationships and interaction with the technologies, it is inferred that the role of a technology under study constructs the technology's unique relationships with the human researcher, which affects the process of data collection and analysis. The more social robotics technologies evolve, the more positional binaries between the robot and its human counterpart will turn into a fuzzy area. From this perspective, the current positivist approach in HRI seems to contain a methodological inconsistency as it frames the robot as an object in the research process while assuming its subjective social abilities. Here, hybrid autoethnography could offer an alternative framework. Drawing on the autoethnographic idea which metaphorically legitimizes all the research stakeholders' simultaneous performance of dual roles of being the observer and the actor, it methodologically hybridizes the researcher and the robot as mediated observer-actors.

I suppose that hybrid autoethnography would facilitate the advanced application of the Wizard of Oz technique to the study of robot-prototypes. In the existing ethnography, teleoperation of the robot prototype is conceptualized as wizarding through which teleoperators hide themselves and secretly observe human participants' reactions as a mode of the fly-on-the-wall technique [39]. The Wizard of Oz approach identifies teleoperating researchers as omnipotent third-person experimenters rather than integral actors. While the technique has many advantages such as facilitating low-cost evaluation of the technology at an early-development stage and providing teleoperating researchers with insights into technologies' real-world adaptability, it also has disadvantages such as difficulties in faking technologies, playing consistent wizarding skills and pursuing transparency of the data gathering process.

Hybrid autoethnography would transform such shortcomings into methodological strengths in teleoperation of the robot prototype. Unlike the Wizard of Oz's prohibition of reflexivity, hybrid autoethnography allows a researcher's autoethnographic performance of reflexivity legitimizing the researcher (i.e. teleoperator) "to become a robot (i.e. a social actor in the field)" rather than to control the robot. For example, teleoperators' failure of wizarding robot-like behaviors or their own improvised wizarding is not a risk but an opportunity in hybrid ethnography because such incidents become a part of experiential learning process of hybrid auto-ethnographers who play a role of the social actor (i.e. the robot) in the situation of interaction. Even if teleoperation guidelines are given, individual operators' personal effects and opportunistic teleoperating behaviors still serve as the valid data supposed to be reflected and critically analyzed by the hybrid autoethnographer. Plus, the social presence of the researcher in the situation of interaction increases the research transparency. In this sense, I suppose that hybrid autoethnography would be a method which keeps reflexive abilities of the human researcher as well as social abilities of the robot in the loop by assigning them the hybrid positionality of observer-actors in the course of data collection and analysis.

5 Conclusion

While the positivist ethnography has long been considered as being the most appropriate for technology studies, there has also been a growing attention to the value of reflexive ethnography in the technology field. Inspired by the shift, this paper is a methodological exploration of incorporating autoethnography, a typical reflexive ethnography, within studies of human-robot social interaction. Suggesting three potential paths to the productive application of autoethnography including participant observation, collaborative autoethnography and hybrid autoethnography, I discuss that autoethnography legitimates researchers' physical and social participation in the situation of interaction so that it lowers their barrier-to-entries to everyday settings of the robot's operation and people's latent needs for the robot.

Considering the current restriction towards ethnographic reflexivity in HRI research, primary contributions of this paper could be to suggest customized paths to the incorporation of reflexive ethnography as well as nuanced understanding of it as a relevant techno-social method in the field. On the other hand, one thing that is not thoroughly suggested and articulated in this paper is the importance of incorporating autoethnographic writing styles corresponding to such paths. The incorporation of reflexive writing into the field would be more challenging than the accommodation of reflexive data gathering and analysis considering the predominant scientific standard of publications in HRI and robotics. Nevertheless, another final and primary suggestion of this paper is the field's development and embracement of its own reflexive textualization styles well-representing individual autoethnographers' retrospective, interpretative and inferential voices as well as autoethnographic research procedures and strategies used.

References

[1] T. Fong, I. Nourbakhsh, K. Dautenhahn, A survey of socially interactive robots, Robotics and Autonomous Systems, 2003, 42(3-4), 143–166
[2] A. Sauppé, B. Mutlu, The social impact of a robot co-worker in industrial settings, In: Proceedings of ACM International Conference on Human Factors in Computing Systems, 2015
[3] J. Rode, Reflexivity in digital anthropology, In: Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems, 2011
[4] S. Bødker, When second wave HCI meets third wave challenges, In: Proceedings of the 4th Nordic ACM Conference on Human-Computer Interaction: Changing roles, 2006
[5] A. Crabtree, T. Rodden, P. Tolmie, G. Button, Ethnography considered harmful, In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 2009, 879–888
[6] M. Hammersley, P. Atkinson, Ethnography: Principles in Practice, Routledge, 2007
[7] P. Atkinson, Ethnography, In: P. Atkinson (Ed.), Routledge Handbook of Qualitative Research in Sport and Exercise, Routledge, 2016, 71–83
[8] J. Boyle, Styles of ethnography, Critical Issues in Qualitative Research Methods, 1994, 2, 159–185
[9] P. Rothbauer, Triangulation, In: L. Given (Ed.), The SAGE Encyclopedia of Qualitative Research Methods, Sage Publications, 2008, 892–894
[10] U. Hannerz, Being there... and there... and there! Reflections on multi-site ethnography, Ethnography, 2003, 4(2), 201–216
[11] B. Nardi, The use of ethnographic methods in design and evaluation, In: B. Nardi (Ed.), Handbook of Human-Computer Interaction, 1997, 361–366
[12] J. Hughes, Moving out from the control room: ethnography in system design, In: Proceedings of the ACM Conference on Computer Supported Cooperative Work, 1994
[13] R. Bernard, C. Gravlee, Handbook of methods in cultural anthropology, Rowman & Littlefield, 2014
[14] M. Burawoy, The extended case method, Sociological Theory, 1998, 16(1), 4–33
[15] A. N. Markham, Ethnography in the digital Internet era: From fields to flow, descriptions to interventions, In: N. Denzin, Y. Lincoln (Eds.), The Sage Handbook of Qualitative Research, Sage Publications, 2017
[16] S. Woolgar, Reflexivity is the ethnographer of the text, In: S. Woolgar (Ed.), Knowledge and Reflexivity, New Frontiers in the Sociology of Knowledge, Sage Publications, 1988, 14–35
[17] J. Van Maanen, Tales of the Field: On Writing Ethnography, University of Chicago Press, 1988
[18] L. Suchman, Plans and Situated Actions: The Problem of Human-Machine Communication, Cambridge University Press, 1987
[19] B. Nardi, Studying context: A comparison of activity theory, situated action models, and distributed cognition, Context and Consciousness: Activity Theory and Human-Computer Interaction, 1996, 69–102
[20] L. Suchman, Lucy, Reconstructing technologies as social practice, American Behavioral Scientist, 1999, 43(3), 392–408
[21] H. Garfinkel, Studies in Ethnomethodology, Englewood Cliffs, 1984
[22] P. A. Carbó, Reflexive practice in the ethnographic text: Relations and meanings of the use of heroin and other drugs in an urban community, Forum: Qualitative Social Research, 2009, 10(2), Art. 23
[23] A. Rapp, Autoethnography in Human-Computer Interaction: Theory and Practice, In: New Directions in Third Wave Human-Computer Interaction: Volume 2 – Methodologies, Springer, 2018, 25–42
[24] P. Dourish, Implications for design, In: Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems, 2006, 541–550
[25] C. Ellis, Carolyn, The Ethnographic I: A Methodological Novel about Autoethnography, Alta Mira Press, 2004
[26] C. Ellis, T. Adams, A. Bochner, Autoethnography: An overview, Historical Social Research, 2011, 273–290
[27] L. Malinverni, N. Pares N, An autoethnographic approach to guide situated ethical decisions in participatory design with teenagers, Interact Computer, 2017, 29(3), 403–415
[28] G. Pritcherd, J. Vines, P. Briggs, L. Thomas, P. Olivier, Digitally driven: how location based services impact on the work practices of London bus drivers, In: Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems, 2014, 3617–3626
[29] X. Xiao, H. Ishii, Inspect, embody, invent: a design framework for music learning and beyond, In: Proceedings of the ACM CHI Conference on Human Factors in Computing Systems, 2016, 5397–5408
[30] L. Diaz, C. Morales, L. Gaytan-Lugo, V. Cid, L. Morales, S. Enriquez, Living without a smartphone: using autoethnography to get closer to basic phone users, Paper presented at CHI 2017 symposium on HCI across Borders Denver, 2017, 6–7
[31] D. Harrison, M. Cecchinato, Give me five minutes!" Feeling time slip by, In: Adjunct Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2015 ACM International Symposium on Wearable Computers, 2015, 45–48
[32] A. Marcengo, A. Rapp, F. Cena, M. Geymonat, The falsified self: complexities in personal data collection, In: Proceedings of the ACM HCI International Conference, 2016, 351–358
[33] A. O'Kane, Y. Rogers, A. Blandford, Gaining empathy for non-routine mobile device use through autoethnography, In: Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems, 2014, 987–990
[34] M. Cecchinato, A. Cox, J. Bird, Always on(line)? User experience of smartwatches and their role within multi-device ecologies, In: Proceedings of the 2017 ACM CHI Conference on Human Factors in Computing Systems, 2017, 3557–3568
[35] S. Ljungblad, Passive photography from a creative perspective: "if I would just shoot the same thing for seven days, it's like... what's the point?," In: Proceedings of the ACM SIGCHI Confer-

ence on Human Factors in Computing Systems, 2009, 829–838
[36] K. Williams, An anxious alliance, Aarhus Series on Human Centered Computing, 2015, 1(1), 11
[37] K. Boehner, P. Sengers, S. Warner, Interfaces with the ineffable: meeting aesthetic experience on its own terms, ACM Transaction of Computer Human Interaction, 2008, 15(3),1–29
[38] C. Neustaedter, P. Sengers, Autobiographical design: what you can learn from designing for yourself, Interactions, 2012, 19(6), 28–33
[39] A. Sabelli, A. Maria, T. Kanda, N. Hagita, A conversational robot in an elderly care center: an ethnographic study, In: Proceedings of the ACM Conference on Human-Robot Interaction, 2011
[40] B. Fogg, Persuasive computers: Perspectives and research directions, In: Proceedings of ACM CHI Conference on Human Factors in Computing Systems, 1998, 225–232

Research Article Open Access

Cathrine Hasse*

The multi-variation approach

Cross-case analysis of ethnographic fieldwork

https://doi.org/10.1515/pjbr-2019-0017
Received September 26, 2018; accepted May 7, 2019

Abstract: This article argues that a multi-variation approach can be a useful supplement to existing ethnographic studies in the field of Human-Robot Interaction (HRI). The multi-variation approach builds on classical ethnographic case studies, where a researcher studies a delimited field in a microstudy of a particular robot, its makers, users, and affected stakeholders. The approach is also inspired by multi-sited studies, where researchers move across fields, adding to the complexity of the ethnographic findings. Whereas both approaches build on analysis of microstudies, the multi-variation approach is further inspired by postphenomenology, where the main aim is to deliberately seek variation – thus again adding to the complexity of the detailed findings. Here, the multi-variation approach includes several researchers studying several types of robots across sites. The analytical approach seeks patterns across this complexity – and the claim is that a multi-variation approach has a strength in findings that are systematic and consistent across cases, sites, and variations. The article gives an example of such cross-variation findings in the robot field – namely the tendency for roboticists across cases and robot types to publicly present their robots as more finished and well-functioning than they actually are.

Keywords: ethnography, human-robot interaction, imaginaries, empirical studies, qualitative, anthropology, STS, human-technology relations

1 Introduction

In the field of Human-Robot Interaction (HRI), the term ’case studies’ often refers to experimental set-ups created by the researchers themselves, where they test some aspects of a human-robot interaction. In anthropology, ethnographic ‘case studies’ are typically delimited, but not entirely created, by the researchers themselves [1–4]. Such studies constitute bottom-up research using ethnographic methods, including analysis of observations, video-recordings, interviews, and field notes [5, 6]. These ethnographic micro-studies can go in depth into issues as they are “studying at first-hand what people do and say in particular contexts” [7, p. 4]. This article advocates a new methodology in HRI where analysis is not just made within singular cases or experimental settings but goes across several cases of ethnographic studies. Though this approach entails a loss of long-term embedded anthropological participant observations (which may result in a loss of refined ethnographic details), it opens up for a ‘multi-variation approach’ where analysis may find patterns across a multitude of bottom-up first hand studies of peoples’ values, attitudes, and concerns tied to material artefacts.

2 Ethnographic predicaments

Case studies belong to the methodology of qualitative studies. “Qualitative research involves the studied use and collection of a variety of empirical materials – case study, personal experience, introspective, life story, interview, observational, historical, interactional and visual texts – that describe routine and problematic moments and meanings in individuals’ lives,” [8, p. 3].

Qualitative studies have been praised in recent years because they give insights to what people are saying and doing beyond assumptions. “Qualitative methods can by themselves produce compelling knowledge of how and why people behave as they do, whether in organisational, family, personal, or other social roles," [9, p. 2].

In qualitative research, ethnography is often the preferred approach even if it faces accusations of being narrow and too specific when contrasted with qualitative studies. As ethnographers, we aim at understanding local contexts and the local people’s perspectives. As a result,

***Corresponding Author: Cathrine Hasse:** Aarhus University, Danish School of Education, Copenhagen, Denmark;
E-mail: caha@edu.au.dk

however interesting, it is often difficult to make any wider claims based on ethnographic studies.

In anthropology, one of the disciplines that claims to build on ethnographic studies,[1] the question of how to make local ethnographic research relevant on a larger scale has often been debated – not least in the so-called 'war' between the field of Science and Technology Studies and the natural and technical sciences [11, 12]. When social scientists study how scientific claims are made and constructed by cultural and social means, they run a risk of undermining their own position. Though ethnographers may get valuable insights through close up studies of people's everyday lives, these studies also beg some questions.

Anthropology does not always refer to case studies, though the case studies approach shares some predicaments with anthropology.

Where early anthropology was based on yearlong stays among native people (famously anthropologists like Bronislaw Malinowski, Margaret Mead, and Gregory Bateson) resulting in long monographies, much anthropology today seems to be close to a case study approach. Today the anthropological practice of ethnography is often reduced to short visits that last from a couple of days to a couple of months. At the same time 'ethno-graphy' – the written results of the ethnographic studies – has had a tendency to become more locally descriptive and less holistically analytical than the former monographies. Holism here refers to an encompassing analysis of the relation between people and the space they inhabit and (re)create. These changes have called forth issues of what status we should attribute this new kind of 'hit-and-run' ethnography in anthropology. Do we still gain insight into people's lives as a whole? Did we ever? As noted by the anthropologist Martyn Hammersley, we continue to expect ethnographic data gathered in particular places, in particular points of time to represent a general picture, even if we have gained no access to what people do when they are not visited by the ethnographers [7]. Though new methodologies have emerged, like the multi-sited approach proposed by George Marcus, where people or things are followed around across local sites and acknowledging that locations are never isolated from a larger world system [13, 14], it still may render ethnographic analysis ahistorical, a-biographical in relation to particular participants and insensitive to larger patterns of change across space and time.

Anthropology most often has a critical dimension [15] that is not always found in non-anthropological case studies. This is most likely due to the inherently contrasting approach in anthropology, which more or less explicitly builds on what the anthropologist Laura Nader termed 'implicit comparisons' in cultural analysis [16, p. 84]. We tend to see how others differ culturally from ourselves as we learn that 'they' differ from how we view ourselves in a process of culture contrast. This often-implicit juxtaposition process can be made explicit and used as a research tool [17]. These comparisons imply a kind of translation [18, p. 9], but from an ethnographic point of view that also imply a process where an ethnographer learns to align with the ethnographic subjects and their (sometimes diverse) perceptions of material artefacts [19]. Criticism is increasingly from an insider position.

Whereas this process of learning with the field does not solve the ethnographic predicaments, it makes analytical approaches less plainly descriptive from an outside perspective. Yet, in-depth anthropological case studies still demand a long time in the field to obtain the perspective of insiders that make a critical positon from within a possibility (cf. [20, 21]).

3 When anthropology goes big

As a coordinator of several big anthropological projects building on ethnographic studies in several countries, I have often had to face this problem – and sometimes defend our research methodology from accusations of being merely based on local 'anecdotes'. My first big project in this respect was a project funded by the European Commission in 2005-2008 studying differences in university cultures across five European countries (Poland, Estonia, Italy, Finland, and Denmark). In each country, local researchers visited university departments of physics. Physics as a discipline is often considered to be 'outside' of cultural influence, but in Science and Technology Studies (STS) anthropological analysis have shown that culture and physics are interwoven even in relation to what

1 Where anthropology is the discipline ethnography is often considered the methodology of anthropology. The anthropologist Tim Ingold (2011) is expanding this discussion as he points out that anthropology is what anthropologists 'live out' in the field whereas ethnography is what we choose to write about these experiences [10]. This is a novel debatable way to separate anthropology from ethnography – however in this context I stick to the understanding that ethnography is the way anthropologists and others gather data first-hand in an empirical field (which is the environment of everyday life for the ethnographic subjects), which is then put into words as analysis is formed. Often this process is taking place already in the field, and thus analysis and data gathering are inseparable.

constitutes scientific facts (e.g., [11]). These STS studies often build on directly contrasting one culture with another, as when Sharon Traweek contrasted the Japanese way of conducting particle physics with the American way [22]. Following this line of thinking, we constructed a model for studying university departments where we built on a method of 'culture-contrast' [23], holding findings from physics institutes in one country up against findings from physics institutes in four other countries. The local studies, however, were ethnographic studies as they were collections of notes from on-site visits and interview based statements on previous university careers and relations to colleagues. The focus was on human-human relations across disciplinary cultures. Other materials, such as knowledge about specific artefacts or values tied to agency and materials, were not included. This show that any large scale anthropological study necessarily already has a research ontology which sets limits for what can be studied.

In the UPGEM project (UPGEM stands for Understanding Puzzles in the Gendered European Map), 18 research assistants from Poland, Estonia, Denmark, Italy, and Finland made research at physics departments in their respective countries. This diversity added to the data analysis complexity, and eventually proved to be a strength. The culture contrast methodology built on the method of culture contrast, which was defined broader than a study of comparison – built on a 'tertium comparationis'. Though the assistants followed the same basic questionnaire, they were also asked to be open to surprises and present them in their reports.

The cross-cultural findings were not presented as 'case studies' – but had an overall objective of understanding the cultural diversity in the proportion of female physicists employed at universities across Europe. Like the few studies which have looked into this issue, the interview-based studies of UPGEM also "found that the proportion of women employed as physicists differed from country to country" [24, p. 12]. However, through contrasting the local findings in the reports, we were able to identify aspects present in one national context which we next could identify as absent in the other national reports. This led to an identification of patterns across the huge data material of *physics as culture* with intrinsic values found across national differences – and *physics in culture* informed by national histories and values. By using the culture contrast method in this way, new self-evident connections (which might otherwise not be noticed by the researcher) were revealed across the set of reports, which gave new insights into why we found differences in female career paths from country to country. An example of this was the finding (which had seemed self-evident to Italian researchers) of the importance of accepting students with a background in classical studies (Latin and Greek) in Italy, whereas this possibility was out of the question in Denmark [17]. Thus, in spite of physics being considered outside of culture [22], with an anthropological approach contrasting the individual reports across national cultures we could confirm, like Traweek, that *culture matters* for people's lives and careers – even in physics [24].

(The lessons learned from this big scale project was enhanced and refined in a subsequent study of technological literacy among teachers and nurses in Denmark (2011-2015) where teachers' technological literacy was contrasted with nurses' and engineers' [25, 26].)

4 Towards a new type of case methodology

In the ongoing REELER (Responsible and Ethical Learning with Robotics) project (2017-2020), we have materiality as the pivotal point: the robot. Robots can be defined in many ways, for instance as

> "capable of performing tasks by sensing its environment and/or interacting with external sources and adapting its behaviour. As examples, the standard gives an industrial robot with a vision sensor for picking up and positioning an object, mobile robots with collision avoidance and legged robots walking over uneven terrain." [27, p. 10]

After a review of the concept in social science and technical literature, we decided to take a point of departure in the ISO standard 8373:2012 definition:

> A robot is an actuated mechanism programmable in two or more axes with a degree of autonomy, moving within its environment, to perform intended tasks. Autonomy in this context means the ability to perform intended tasks based on current state and sensing, without human intervention.

We also decided to let the concept develop as we studied what robot designers across Europe themselves defined as robots. So when we prepared the groundwork for the project, the concept robot was included in almost all of our database searches as it frames all of our other concepts in the project, including the methodological concept of 'case study'. From these first searches (systematic EPPI-inspired database searches), it appears that studying robots as case studies *across contexts* is a novelty. As noted in a report by REELER assistant Jessica Sorenson:

> "A search of SCOPUS for robot* began with 3 hits in 1924, following the publication of Čapek's R.U.R., which coined the term. There was very little peer-reviewed literature mentioning robot until the 1980s. In the 1980s and 90s, there was a steady rise in peer-reviewed publications. Beginning in the year 2000, there was an exponential growth in mention, from under 5k texts per year to almost 25k texts per year." [28, p. 2]

However, when these references were connected to case studies the picture was as mentioned in the introduction to this contribution: Cases were largely creased by the social scientists as experiments or microstudies of a primarily local character. These studies are not the holistic anthropological studies of the past that included analysis of a larger context such as a cosmology shared by a local group of people. Hammersley has characterized this kind of studies as connected to the new possibilities for using electronic research equipment:

> "[P]artly as a result of the increasing use of audio- and video-recording devices, there has been a growing tendency for ethnographers to carry out detailed micro analysis of what was actually said and done on particular occasions." [7, p. 6]

As REELER has the general purpose of identifying and aligning gaps in how robot makers learn about people affected by their robotic creations (beyond the envisioned users), we had to think of novel ways to move beyond the close-up microstudies of robot makers testing their machines on their own choice of users. What we needed were a number of cases that could enlighten us about the many different stakeholders to be affected by robots in the future, and next to find ways to make the robot makers themselves learn about the effects of their work. The idea of making 10 separate ethnographic microstudies in robot makers' laboratories and study how they thought about users in each case was tempting, but left us with the basic question of how these cases could relate to each other. If the holistic part of the case study was not included, we ran the risk of presenting very local findings as general statements without even considering how local the studies were. If, on the other hand, we made in-depth holistic studies of ethnographic laboratories, we ran the risk of not having the time to also identify and involve the affected stakeholders we wanted the roboticists to learn about. If the robot makers were to learn to be more ethical through our research findings, by including an expanded understanding of affected stakeholders than the immediately envisioned users of robots, we had to find a way to solve this conundrum. We decided to make ten studies seeking variation in robot types spanning from industrial robots, over service robots to social robots. Here Kate Darling notes an important distinction between industrial and service robots which are not meant to be social, and social robots:

> "A social robot is a physically embodied, autonomous agent that communicates and interacts with humans on an emotional level. For the purposes of this article, it is important to distinguish social robots from inanimate computers, as well as from industrial or service robots that are not designed to elicit human feelings and mimic social cues. Social robots also follow social behavior patterns, have various 'states of mind', and adapt to what they learn through their interactions." [40, p. 4]

We were well aware of the huge differences between types of robots – which all come with their own kind of special ethical issues. One of those differences is between social robots and industrial robots. Apart from the differences between industrial robots and social robots noted by Darling, we also found it to be an important difference that industrial robots were often 'caged' in spaces especially designed for them, whereas social robots have to either adapt to existing human environments or need environments to be changed adapt to the social robots. Ethical issues change when the robots move right into people's homes. However, in spite of huge differences between robot types REELER found a number of ethical issues, which were found across cases i.e. where the same kind of ethical issue is found distributed across the robot type. We found examples where industrial robots were 'sold' in the media as autonomous and intelligent when in fact they demanded a lot of maintenance. We found industrial robots being compared to dancers, and social just like the industrial robots were presented as more capable in media versions. This 'overselling' of robot capabilities in media – and our field experiences of robots that did not live up to the media presentations – went across field studies.

At first glance, we could be seen as conducting a kind of multi-sited ethnography, where the practice of ethnographic fieldwork is pursued in more than one geographical locations. Though multi-sited is a helpful concept [13], it is important to make clear that although anthropologists may have imagined 'the field' to be one location as part of the anthropological discipline's research, anthropology has in a way always been 'multi-sited'. As already noted, Laura Nader found the multi-sited juxtaposition to be an inherent (albeit often implicit) aspect of all ethnographic fieldwork. When ethnographers cannot help contrasting what they know from their of background with a new culture – as when, for instance, white feminist American ethnographers studied the role of women in Muslim countries [16]. Even the old holistic monographies show that anthropologists always moved between a 'home' site and a new site. Even when staying in one national place,

Table 1: Example of REELER case variation.

Robot sector	Agriculture	Health	Education	Industry	Construction
Specific robot	Xi	Yi	Zi	Ni	Ti
Specific PI location	Italy	Poland	Denmark	Germany	Spain
Users	Sweden	Poland	Denmark	Germany	Spain
Affected stakeholders	Spain	Denmark	Belgium	Estonia	UK

like 'fieldwork at home', anthropologists always carried their own perspectives from their own background with them. This is the implicit comparison Laura Nader identified – and that we try to make explicit in our REELER work.

In REELER, the researchers come from Poland, Denmark, Germany, United States, UK, Italy, the Netherlands – and our research focus is on European robotics, which we soon found to be entangled with robotics in Japan and United States. Our research sites include robotic laboratories in more than 15 European countries implicated in all kinds of trade arrangements with other countries all over the globe (see Figure 1). When we (in REELER) claim to be working multi-sitedly, we acknowledge that ethnographic research is inherently embedded in a world system. Multi-sited ethnography is a fieldwork methodology emergent out of heterogeneity and globalization. Such research implies moving away from conventional ethnographic approaches that rely on single and local sites towards "the circulation of cultural meanings, objects and identities in diffuse space-time" [13, p. 96]. The goal is to investigate not only variously situated robots dispersed across Europe but also to find analytical connections among such sites. Furthermore, we expand and make use of the notion of multi-sited by going beyond what the robot makers in local laboratories themselves expect to be 'users' by identifying other subjects likely to be affected by the robots they create. We have named these 'affected stakeholders' – and ask questions about how the roboticists may or may not include considerations of affected stakeholders in their design.

In summary, we acknowledge that as researchers we are always implicitly comparative – and that whatever we follow in the world system is an effect of our own previous learning processes. That is why the main objective of REELER is not a fixed analytical object, but moves as we learn to change our own perspectives on the robotic world.

5 A new variation-based multi-sited fieldwork

Following our experiences from earlier projects, we have tried to benefit from the idea of looking across a multitude of perspectives in REELER. Instead of viewing it as a weakness that we work on very different robots, being created in very different locations, with very different envisioned users, and different affected stakeholders as well, we now look at this 'messy' amalgamation as a strength.

First a few words on how we work. In REELER, we have decided to make use of variation as a research strategy. Our research is confined to robots which are primarily made in Europe, but the robots we look at are all examples of 'robot types' which we have decided to specify from a number of variables (e.g., countries and robot types; see Table 1).

The robot names in Table 1 are made up – and the cases presented here are not real cases as we work under strict non-disclosure agreements with the companies we work with. All the robots chosen have a PI = a main project manager, but also have networks and collaborative robot maker partners all over Europe, in US, and as far as Japan. Thus, no robot is being built in one location – a robot is a *distributed* technology.

Our work on robot types can be illustrated with the following example. We have made ten case studies and in each case, we take our point of departure in a type of robot – for instance, a construction robot, *Ti*, from Spain created to help build brick houses. The users are in this case identified as 'brick workers' – and a few from the local environment in the local town of the PI are called in to test the brick laying robot. We create a case around this robot (e.g. Ti from Spain) and visit the robotics laboratories in Spain but also the partners the PI collaborate with in Germany, Italy, Sweden, Denmark, and the UK. These collaborators for instance develop the mobile base, user interface, or guidance system to be incorporated into the robotic system in Spain, where testing occurs. Thus, in a single case we may have up to 6-7 different visits and interviews with robot makers from all over Europe. Of course, we cannot explore all of the sites that contribute to the design of the robot in question for reasons of limited funding and time. Therefore, we get limited knowledge of each robot type, and even limited knowledge of the particular robot we have chosen to represent a particular robot type. In identifying affected stakeholders, we often include the users envisioned by the robot makers themselves (in this case local construction workers), but then we move to other people not tied to the project that we have identified

during fieldwork as affected stakeholders. These may include:
- People who educate construction workers – how much have they taken this new technology into account? How will it affect their work in the future?
- Unions organizing construction workers. How much have they considered this new technology? How will it affect their work in the future?
- Construction workers from other countries who may have other traditions and values tied to work.

In this way, we get 10 thorough cases that are written up as reports with a review of the robot type, descriptions of the history of the design of particular construction robot, how collaboration between partners evolved and involved users through sites and meetings – and interviews with as many as 12-25 people in a case. For an ethnographic study, 10 case studies made this way is an enormous amount of rich data material – and notoriously difficult to work with from the traditional anthropological methods of holistic analysis. The cases, however, are not just microstudies for comparison. They present us with huge *variation* where each case has some very specific issues tied to:
- The type of robots (an educational robot differ from a construction robot in particulars ways we can specify);
- The robot makers (informed by different funding schemes and national agendas);
- The users defined by the roboticists (workers and teachers differ from country to country);
- The affected stakeholders (teachers differ from union workers and construction workers).

What we have done is to look carefully at each case write-up and identify all of the issues relevant for how roboticists can make more ethically designed robots that come up in each case. Next, we have made a cross-case variation analysis through NVivo qualitative data analysis software, coding of all interview material. In all of this work, we at first deliberately seek variation – and do not work from a preselected tertium comparationis. This approach (according to our database searches) has not before been conducted anywhere in the field of HRI. It is inspired from phenomenology where the variation approach began with a Husserlian philosophical examination – for instance a human looking at an apple from many different angles to determine its essence:

> "Husserl's earlier use, variations (originally derived from mathematical variation theory) were needed to determine essential structures, or 'essences.' Variations could be used to determine what was variant, and what invariant." [29, p. 12]

Figure 1: REELER case variation across Europe.

In the new versions of postphenomenology this search for essence has for long been abandoned (e.g., [30]). The method of finding patterns across variations however is still useful. The techno-philosopher Don Ihde has expanded on the method to include how apparently 'same' objects are taking on different meaning in practice, where moving across time and space has expanded the objects' meaning:

> "I am not claiming here to have exhausted the variations, but these [examples] are enough to show that the phenomenological variations which now include considerations of the materiality of the technologies, the bodily techniques of use, and the cultural context of the practice, are all taken into account and demonstrate again the importance of variation theory with its outcome in multistability, the role of embodiment, now in trained practice, and the appearance of differently structured lifeworlds relative to historical cultures and environments." [29, pp. 18-19]

Inspired by postphenomenology and other sources of socio-cultural theory from the field of STS, we began to look for patterns across variation in and across cases and we find that the variation and the complexity of the rich dataset to be strengths of the methodology. We now make the claim that if we were to find patterns across all cases, these patterns emerge in spite of the huge variations, thus giving credit to the importance of our findings. In the preliminary cross-case variation analysis, we have indeed identified some themes that go across cases – even if each case is also rich with case-specific material. One example of this is that robot makers (across countries, robot types, and laboratory collaborations), when they present their machines to local users and to each other, have a tendency to present their unfinished robot designs as more ‘finished’ and well-functioning than is actually the case. We’ve seen this at conferences, in showrooms, and online – and contrasted these public representations with the ethnographic observations made in REELER cases. For example, a building robot, a harvesting robot, and an educational robot have been shown working side-by-side with humans in public videos (these are just examples, as we cannot disclose the actual cases studied) – whereas in all of these cases we’ve discovered that the robots in practice are far from working smoothly with humans. This tendency to enhance robots’ ability in public media could well reinforce what the robot makers themselves have termed the ‘Hollywood effect’, where humans come to expect robots to be like the ones they encounter in movies [31, p. 56]. For affected stakeholders, this means they may hold expectations for robots that are higher than what real robots can actually live up to. This is a kind of robot innovation ‘bubble’ that we may expect in the future, as we now have many (also published) examples of how robot technologies often disappoint when implemented in people’s everyday practices – and especially when the robots are expected to work closely in environments not tailored to human-robot interactions.

6 Multi-sited and multi-variation

The multi-variation approach both draws on and differs from a multi-sited approach. As discussed by Mark-Anthony Falzon and his colleagues in the anthology Multi-sited Ethnography: Theory, Praxis and Locality in Contemporary Research [32], the term multi-sited has many, sometimes contradictory, definitions. Multi-sited ethnography, however, as a whole breaks with the convention that ethnography takes place in one site where the ethnographers learn about the local people by living with them over a considerable period, and considers their local existence contextualised by a global world system. The multi-sited approach proposed by George Marcus in 1995 in Annual Review of Anthropology broke with these conventions. The ‘world-system’ would no longer be seen as outside or around the local site but an inherent feature of social phenomena that could not be explored in one site alone, but only by following people, things, metaphors, stories “across space (because they are substantially continuous but spatially non-contiguous). Research design proceeds by a series of juxtapositions in which the global is collapsed into and made an integral part of parallel, related local situations, rather than something monolithic or external to them,” [32, p. 1].

Like the multi-sited approach in terms of methods, the multi-variation approach also uses traditional methods like interviews, note-taking, etc. However, where the multi-sited approach “involves a spatially dispersed field through which the ethnographer moves – actually, via sojourns in two or more places, or conceptually, by means of techniques of juxtaposition of data” [32, p. 2], the multi-variation approach does not aim at one ethnographer following people, things, & stories across spaces. Instead, the approach involves juxtapose data collected by several researchers exploring different sites looking for variation within each case, just as the cases themselves are chosen as variations upon a common theme: in our REELER example, the design of robots.

The variation is sought for deliberately finding complexity within each case and across cases in order to make the final claim, that if some coherent relevant patterns are found across such complexity and variation, it is no longer important if each case is ‘local’ as the variation shows a pattern that only emerges in analysis *across* all of these local-global sites.

Like Ihde, we do not claim to have exhausted the variations. Therefore, our findings of patterns could also change if the number of variations were enhanced (or diminished). The phenomenological variations of robot designs and user involvements are tied to “the materiality of the technologies, the bodily techniques of use, and the cultural context of the practice” [29, p. 18]. Across this multistability, we find patterns that tie the disparate robotic lifeworlds together. However, the patterns found are most likely also both relative to history, as they point to common cultural values tied to the practices of robotic design.

Apart from the tendency to exaggerate the performance of the robots developed, we found a number of other issues across sites, such as unreflected aspects of who was included and excluded by the robots designed (e.g. taking a prototypical male size hand for robot operating systems laying bricks), or assuming a robot designed to be universal, where our research showed the robot was suitable for use only in sites close to the home environments where the robots were designed (thus ignoring differences in physical environments and/or differences in Northern and Southern European healthcare or worker policies, e.g.).

7 Conclusion

As the REELER project is ongoing, it is not possible at this stage to go more into details with our cross-case variation analysis. At this stage, we may just point the attention to the possibility of how doing ethnographic work in HRI can also work in large-scale ethnographic designs. Ethnographic case studies differ from many of the case studies presented in the field of HRI in two ways:
1) the researchers do not set up the case to be studied themselves. Even if ethnographers always influence the framing of what they study, they only rarely choose to create a new reality which they then study as a case. They are much more interested in finding out how human-robot interactions play out in everyday situations.
2) Though existing HRI studies are inherently multi-sited, the researchers are not always aware of this and sometimes make very close-up microstudies. However, in an anthropological understanding of ethnographic case studies there is always a search for a larger context. This context can include people and things present at the locations, but may also move beyond the setting.

In a multi-sited approach, the world-system is inherent in local sites. However, in the multi-variation approach, the patterns that go across the cases have to be elicited analytically. It is not so much a world-system as a pattern of values and issues that goes across even highly varied local case studies. The new methodology of finding cross-case patterns across a multitude of variations is a possibility for ethnographers to enhance the claims that can be made from ethnographic case studies. In that respect, the multi-variation approach indicates a new and important way to use ethnographic studies in HRI.

References

[1] W.-Y. Hwang, S.-Y Wu, A case study of collaboration with multi-robots and its effect on children's interaction, Interactive Learning Environments, 2014, 22(4), 429-443
[2] L. Major, T. Kyriacou, P. Brereton, The effectiveness of simulated robots for supporting the learning of introductory programming: a multi-case case study, Computer Science Education, 2014, 24(2-3), 193-228
[3] A. Ioannou, E. Andreou, M. Christofi, Pre-schoolers' interest and caring behaviour around a humanoid robot, TechTrends, 2015, 59(2), 23-26
[4] S. Somyürek, An effective educational tool: Construction kits for fun and meaningful learning, International Journal of Technology and Design Education, 2015, 25(1), 25-41
[5] M. C. Ayar, First-hand experience with engineering design and career interest in engineering: An informal STEM education case study, Educational Sciences: Theory & Practice, 2015, 15(6), 1655-1675
[6] O. G. Stewart, M. E. Jordan, "Some explanation here": a case study of learning opportunities and tensions in an informal science learning environment, Instructional Science, 2017, 45(2), 137-156
[7] M. Hammersley, Ethnography: Problems and prospects, Ethnography and Education, 2006, 1(1), 3-14
[8] N. K. Denzin, Y. S. Lincoln, Introduction: Entering the field of qualitative research, In: N. K. Denzin, Y. S. Lincoln (Eds.), The Sage Handbook of Qualitative Research, Sage, 1994, 1-17
[9] J. Hogan, P. Dolan, P. Donnelly, Introduction, In: J. Hogan, P. Dolan, P. Donnelly (Eds.), Approaches to Qualitative Research: Theory and Its Practical Application, Oak Tree Press, 2009, 1-18
[10] T. Ingold, Being alive: Essays on Movement, Knowledge and Description, Routledge, 2011
[11] S. Sismondo, An Introduction to Science and Technology Studies, Wiley-Blackwell, 2010
[12] E. J. Hackett, O. Amsterdamska, M. Lynch, J. Wajcman, The Handbook of Science and Technology Studies, The MIT Press, 2008
[13] G. E. Marcus, Ethnography in/of the world system: The emergence of multi-sited ethnography, Annual Review of Anthropology, 1995, 24, 95-117
[14] G. E. Marcus, Multi-sited ethnography: Five or six things I know about it now, Problems and Possibilities in Multi-sited Ethnography [workshop], University of Sussex, 27-28 June 2005, http://eprints.ncrm.ac.uk/64/1/georgemarcus.pdf
[15] E. F. Fischer, Cultural logic and Maya identity: Rethinking constructivism and essentialism, Current Anthropology, 1999, 40(4), 473-500
[16] L. Nader, Comparative consciousness, In: R. Borofsky (Ed.), Assessing Cultural Anthropology, McGraw-Hill, 1994
[17] C. Hasse, S. Trentemøller, The method of culture contrast, Qualitative Research in Psychology, 2009, 6(1-2), 46-66
[18] A. Gingrich, R. G. Fox (Eds.), Anthropology, By Comparison, Routledge, 2002
[19] C. Hasse, An Anthropology of Learning, Springer Verlag, 2015
[20] J. Sorenson, Decisions and values: Engineering design as a pragmatic and sociomaterial negotiation process, REELER Working Paper Series [working paper], Aarhus University, 2018
[21] S. Hansen, If we had a specific idea of the product 12 months ago, it would never be what we have today! A study in situational pragmatic actions and strategies in everyday technological development, REELER Working Paper Series [working paper], Aarhus University, 2018
[22] S. Traweek, Beamtimes and Lifetimes: The World of High Energy Physicists, Harvard University Press, 1988
[23] C. Hasse, S. Trentemøller, Cultural work place patterns in academia, Science Studies 2011, 24(1), 6-23
[24] C. Hasse, S. Trentemøller, Break the Pattern. A Critical Enquiry into Three Scientific Workplace Cultures: Hercules, Caretakers and Worker Bees, Tartu University Press, 2008
[25] C. Hasse, Technological literacy for teachers, Oxford Review of Education, 2017, 43(3), 365-378
[26] J. Wallace, C. Hasse, Situating technological literacy in the workplace, In: J. Dakers (Ed.), New Frontiers in Technological Literacy, Palgrave Macmillan, 2014, 153-164
[27] N. Nevejans, Study: European civil law rules in robotics, Policy Department for Citizens' Rights and Constitutional Affairs, European Parliament. Document PE 571.379, 2016,

http://www.europarl.europa.eu/committees/fr/supporting-analyses-search.html
[28] J. Sorenson, SEARCH REPORT: Education and Robot [internal REELER project document], 2017
[29] D. Ihde, Postphenomenology and Technoscience: The Peking University Lectures, SUNY Press, 2009
[30] J. Aagaard, J. K. B. Friis, J. Sorenson, O. A. Tafdrup, C. Hasse (Eds.), Postphenomenological Methodologies: New Ways in Mediating Techno-Human Relationships, Rowan & Littlefield International, 2018
[31] KUKA, Kuka Annual Report 2016, Making the Right Decisions at the Right Time, 2016
[32] M.-A. Falzon, Introduction, In: M.-A. Falzon (Ed.), Multi-sited Ethnography: Theory, Praxis and Locality in Contemporary Research, Ashgate, 2009, 1-23

See also:

[33] L. Blond, Technological style is history, SHOT Graduate Workshop Paper [paper presentation] presented at SHOT Annual Conference, 2016 Singapore [working paper], 2016, 1-9
[34] M. Bruun, C. Hasse, S. Hanghøj, Studying social robots in practiced places, Techne: Research in Philosophy and Technology, 2015, 19(2), 143-165
[35] K. M. Eisenhardt, M. E. Graebner, Theory building from cases: Opportunities and challenges, Academy of Management Journal, 2007, 50(1), 25-32
[36] K. M. Eisenhardt, Building theories from case study research, Academy of Management Review, 1989, 14(4), 532-550
[37] J. Gerring, The case study: what it is and what it does, In: C. Boix, S. C. Stokes (Eds.), The Oxford Handbook of Comparative Politics, Oxford University Press, 2007, 94-109
[38] J. Gerring, Case Study Research: Principles and Practices, Cambridge University Press, 2006
[39] R. K. Yin, Case Study Research: Design and Methods, Sage, 1994/2003
[40] K. Darling, Extending legal rights to social robots [paper presentation], presented at We Robot Conference, University of Miami, 23 April 2012, http://dx.doi.org/10.2139/ssrn.2044797 (accessed April 26, 2019)

Research Article Open Access

Leon Bodenhagen*, Kerstin Fischer, Trine S. Winther, Rosalyn M. Langedijk, and Mette M. Skjøth

Robot use cases for real needs: A large-scale ethnographic case study

https://doi.org/10.1515/pjbr-2019-0014
Received August 31, 2018; accepted March 29, 2019

Abstract: This article discusses the process of developing robot use cases using large-scale ethnographic observation as a starting point. In particular, during 296 hours of ethnographic observation of the workflows at seventeen departments at Odense University Hospital, 607 processes were described and subsequently annotated. The ethnographic method provided rich, contextually situated data that can be searched and categorized for use case development, which is illustrated on an example use case, describing the process and illustrating the type of data elicited, discussing the problems encountered and providing downloadable tools for other researchers interested in similar approaches to use case development.

Keywords: use case development, ethnography, health care, innovation, welfare robots

1 Introduction

Current demographic change means that the ratio between citizens above 65 years of age and those who are between 18 and 64 years old is predicted to increase from 23.6% in 2010 to 42.8% in 2040 on average across Europe [1]. In this period, the proportion of citizens aged 80+ years is expected to increase from 4.1% to 8.4%. Hence, not only will the share of elderly people increase, the share of citizens aged 80+, who have a substantially higher prevalence for multimorbidity [2], is expected to more than double. This implies that the overall demand for health-care services is likely to grow. At the same time, the health-care sector is under pressure already today, both financially in terms of limited funds but also due to a shortage of qualified staff.

Riek [3], for instance, suggests that robot technology can contribute to the mitigation of the challenges imposed by the demographic change and prove beneficial for stakeholders from various areas across the health-care domain. However, although robots are entering our daily lives in various contexts, robots are rarely utilized in the health-care domain, which might be due to the high cost for robots; it is also possible that the solutions may not be tailored sufficiently to the users' real needs [4], which hinders the adoption of robots in the health-care sector.

But how can technologies be developed that truly support caregivers or patients and help mitigate consequences of demographic change? How can this be done in socially acceptable ways that are in accordance with our social, societal, ethical and environmental values? Often, technological development is driven by what is technically possible, and ethicists and human interaction experts are only brought in to advise the process [5]. Ethnography with its holistic, socially situated approach and its focus on both emic and ethic perspectives (e.g. [6]) can contribute to the development of technologies in a value-driven manner, i.e., governed by axiological analysis and evaluation [7], by providing detailed descriptions of current workflows and of those practices by means of which people address real tasks in real-life contexts themselves. These descriptions allow us to identify repetitive and possibly strenuous tasks that can be automated and which thus might provide help where it is really needed.

In this article, we therefore argue that an ethnographic analysis is a useful perspective on use case development, i.e. a methodological approach to identifying for what purposes technologies are to be developed and how these purposes fit into general contexts of human work practices. To

***Corresponding Author: Leon Bodenhagen:** SDU Robotics, Maersk Mc-Kinney Moller Institute, University of Southern Denmark, Odense, Denmark; E-mail: lebo@mmmi.sdu.dk
Kerstin Fischer, Rosalyn M. Langedijk: Department of Design and Communication, University of Southern Denmark, Sønderborg, Denmark; E-mail: [kerstin,rla]@sdu.dk
Trine S. Winther: SDU Robotics, Maersk Mc-Kinney Moller Institute, University of Southern Denmark, Odense, Denmark; E-mail: tswi@mmmi.sdu.dk
Mette M. Skjøth: Centre for Innovative Medical Technology, Odense University Hospital, Odense, Denmark;
Danish Centre for Health Economics, Department of Public Health, University of Southern Denmark, Odense, Denmark;
E-mail: mette.maria.skjoeth@rsyd.dk

understand how robots could be utilized in the health-care domain and how technologies interact with patient care, in particular in hospitals, a large-scale ethnographic case study was conducted, which includes observation and interviews of hospital staff across departments. The observations also cover, though indirectly, interactions with patients. Based on the generated knowledge on the work flows at the hospital, an example use case for a robotic solution is synthesized. The article describes the process and illustrates the data elicited, discusses the problems encountered and provides downloadable tools developed in the project as a resource for other researchers interested in similar approaches to use case development.

2 Related work

Ethnography is a well-established method for the description of human practices [8]. The method was first applied to the analysis of human-technology interactions by Suchman [9], who analyzed interactions between two users and a photocopying machine in order to illustrate the contingent moment-by-moment situated action by humans in contrast to the fixed plans implemented into the machine. The method is now also relatively common in human-robot interaction research and robot development, for instance, to understand how robots fit into, and possibly influence, the workflow [10]. For example, Mutlu and Forlizzi [11] show that the same robot may be perceived very differently depending on contextual factors, which determine how the robot is integrated into the current workflow.

Other uses of ethnographic analysis in human robot interaction concern unconstrained interactions of robots ’in the wild’; for instance, Chang et al. [12] find that when robots are moved out of lab settings and are left for intended users to interact with in the ways they choose themselves, the results are very different from results obtained in lab studies, and robots may not elicit the same kinds of anthropomorphic, friendly behaviors. Similarly, Forlizzi [13] and Sung et al. [14] investigate how cleaning robots are used in peoples’ homes, and Sabelli et al. [15] present an ethnographic study on a conversational robot in an elderly care center.

Also in use case development, ethnographic observation may be employed [10, 16], but if so, it is usually carried out on a much smaller scale; in our own use case development in the SMOOTH project[1], for instance, we carried out a 24-hour ethnographic observation, supported by focus group and prototyping techniques [17]. For comparison, other studies using an ethnographic approach in hospital settings collected, for instance, 120 hours [18] or 148 hours [19] of observation, or they followed doctors for 32 shifts [20] and with a specific, predefined topic of interest. In contrast, in the current study, we carried out a thematically relatively open, large-scale observation comprising almost 300 hours in a large, complex and heterogeneous institution, namely the Odense University Hospital (OUH). What makes ethnography particularly suited to approach the current task is its "strong emphasis on exploring the nature of a particular social phenomenon, rather than setting out to test hypotheses about it" [21], its holistic, socio-culturally situated approach (e.g. [6]), and its focus on members’ own perspectives (e.g. [22]).

3 Case study

The study presented here aims to identify stakeholders’ real needs in their current work practices at a hospital. In particular, the project’s aim, to identify those tasks that could be taken over or supported by technology, freeing the personnel for those tasks that involve social interaction, was developed in cooperation with Odense University Hospital, which also sees a need to accommodate to demographic change in the near future, but which also generally seeks to optimize care and treatment processes and to involve patients wherever possible.

In order to carry out a large-scale ethnographic observation study, many observers are needed. Therefore, the first challenge was to train a fleet of students to carry out the observations. Furthermore, we needed to provide our observers with observation and reporting guides; our first steps taken were thus communication design tasks, which we describe in Sections 3.1.2 to 3.1.3. Other tasks were organizational and communicative in nature; for instance, the hospital departments had to be identified and contacted, the student observers’ schedules had to be managed, and questions had to be answered (see Section 3.1.4). Finally, once the data had been elicited, a coding scheme had to be developed to distill the use cases out of the many observations made. This process is described in Section 3.3. The envisioned use case development process is illustrated on an example use case, which is presented in Section 4. In the discussion, we address especially issues of the post-processing of the observations made and discuss possible alternatives to the procedure taken, as well as the next steps.

1 smooth-robot.dk

3.1 Preparing the ethnographic observation

In order to prepare the ethnographic observation, we first recruited students from various relevant disciplines, but it turned out that only students from welfare technology study programs at the University of Southern Denmark applied. We therefore developed a training session for the first six students, which we videotaped and iteratively revised during each additional training session. In total, 6 + 4 + 2 students were trained, of whom eight regularly participated in the observations. Furthermore, in order to provide students with some guidelines what to observe, we developed a booklet that they could take with them to the hospital to note down their observations. Here we adapted observation guides from previous ethnographic work (in particular, [23]) with special focus on those dimensions that are particularly relevant for the purpose of identifying repetitive and stressful activities. Moreover, we developed a reporting form for each of the processes the students encountered over the course of an observation, as well as a page to provide an overview of what was observed, who was accompanied and where the observation took place. These resources, which are described in more detail in the following subsections, can be downloaded from our website [2].

3.1.1 Designing the training

The training was designed to be doable in about a day, including four exercises in which students could practice ethnographic observation. The introduction covers methods for collecting and sharing observations, as well as what to focus on during observation, the level of detail required, the neutral, descriptive stance of the ethnographic observer and that nothing is taken to be self-explanatory or obvious. After each exercise, thoughts and problems arising were jointly discussed.

In the first exercise, students had to describe what they see, first without a focus, then with a given focus, in order for them to become aware of the role of one's own preconceptions, but also to realize that one cannot observe everything and that a particular perspective is necessary.

In a second exercise, students practiced interviewing by asking each other about their backgrounds, hobbies and favourite activities. In the discussion, we also covered how to ask politely but efficiently and how not to interrupt or disturb the professionals during their activities. Therefore, we advised the students to navigate between observer-participant and participant-observer roles, depending on the affordances of the current situation [22], aiming for a maximal understanding of what was going on while not being in the way when the situation was critical.

A third exercise addressed how clear the notes have to be in order to be understandable for others who were not present. For that purpose, two volunteers were recruited; one was blindfolded while the other had to wait outside. The blindfolded person then had to make tea using a special, non-obvious tea maker, while the others had to observe and take notes and finally use their notes to explain to the person who had waited outside what exactly had happened.

Finally, the training concluded with a video description task, for which students got detailed, individual feedback from one of the project PIs. This step served not only to provide students with helpful feedback and to ensure high quality observation, but also to make sure that we only send qualified students to the health-care institution.

The training was evaluated by gathering feedback from the students using a questionnaire, in which we asked how prepared they felt and what questions were still open. Students general felt well prepared, and most of the open issues concerned issues we could not answer ourselves at the time, such as how students would get access to the building and what they would need to wear. The training was slightly revised after analyzing the first set of observation reports; in particular, we chose videos for the exercises that were more relevant for the actual observation task, and the booklet was introduced earlier during the training and used for some of the exercises already.

Students were not informed about the main aims of the project in order not to restrict or bias what kinds of processes they would describe and report on. Furthermore, even if they had known the focus of the project, they did not bring in a solid background in robotics that would have allowed them to assess the feasibility of a potential robotic solution. We provided them with a very generic flyer, which stated as the general goal of the project to understand workflows at the hospital for identifying where help would be beneficial (to mitigate demographic change). The flyer (also downloadable from our website) was used whenever staff members or patients at the hospital asked about the purpose of the observations.

2 https://www.sdu.dk/en/om_sdu/institutter_centre/idk/projekter/human-robot+interaction/downloads/welfare

3.1.2 Designing the booklet

The aim with designing the booklet was to help observers during their observations in terms of what needs to be reported. Since the students were not completely informed about the aims of the observations, we had to guide them into reporting the right level of detail without them knowing what was going to happen with their observations afterwards.

Furthermore, the booklet needed to be practical. We thus designed a small booklet in B5-format, ideal for being carried around. Each left side of the booklet presented a schema with 14 questions to be filled out for each process observed, in particular:

- where does the observation take place?
- who is observed?
- are additional people involved, and if so, who are they?
- what kind of activity is observed?
- what is its duration?
- what are the subtasks?
- what is the context like?
- how often does this activity occur?
- how stressed (on a scale from 1-5) are the participants?
- how crowded is the space (on a scale from 1-5)?
- is it important that the task is done right now and if so, why?
- are special competences required?

On the right hand side of each double page, enough empty space for the observations was provided.

After the first observations, it became clear that we had to specify some of the questions further. Thus, we included a redesign iteration, in which we specified what we meant by the frequency question; now we ask how frequent each process is carried out by the individual observed (per shift) and how frequent the task is carried out by the department (estimation by the personnel). Furthermore, for data protection reasons, we made it explicit that students should report only the role or title of the person observed, not their name. We furthermore added explanations to the questions about stress levels and crowdedness. These additional explanations were added to the reporting template (see Section 3.1.3 below) and communicated by e-mail to the observers.

25 copies of the booklet were printed and handed to the students for their observations. The students reported the booklet to be a very helpful tool throughout their observations.

3.1.3 Designing the reporting template

The aim of the design of the reporting template was to facilitate the comparison of all the collected data and to categorize them afterwards. Furthermore, it was meant for us to be able to understand in detail what happened during the processes observed and what the circumstances were under which they were carried out. At the same time, it was meant to serve as a guideline for the students how to observe and report on the observations as clearly and as non-judgmentally as possible. After the first reports, we made a few adjustments to the reporting template: First, the template was updated to accommodate the updates in the reporting schema in the booklet. Second, we asked the students to provide one overview page in which they present the described activities and who they observed (sometimes students followed several different staff members) in temporal order. In the final version of the reporting template, the following five tasks were specified:

1. Provide an overview: name of observer, date, department and people you observed.
2. Provide a brief glossary of special terms used in the department which need clarification for laypeople.
3. Describe the observation day. In this section, describe all of the observed activities, using the questions from the booklet and making use of all of your notes; use a new schema from the booklet for each new activity. Add photographs or other materials.
4. Report on all other observations that you found relevant, yet that do not fit into the schema.
5. Optional: Describe your impression of your day, thoughts and comments.

We furthermore read through all reports closely and provided students with feedback on their reports from the perspective that we had to be able to have a detailed mental image of the process observed after reading their reports. This feedback turned out very helpful to the students and increased the quality of the reports.

The reports were anonymized by replacing staff or patient names mentioned. Furthermore, the observers' IDs were removed. Finally, the reports were labeled with a numerical ID as well as with the name of the observed department and the date of observation and saved on a certified, locally hosted server with restricted access.

3.1.4 Managing the observations

Departments at the hospital were selected and contacted in collaboration with Centre for Innovative Medical Technology at Odense University Hospital. Representative types of departments from Odense University Hospital in Odense and in Svendborg were selected in order to achieve an even distribution between wards for short and long stays, outpatients clinics and service departments, such as the pharmacy (see Table 1 for an overview on all departments involved). The heads of twenty departments were contacted with a short description of the project aim and design. Three departments were not included in the final project due to late or no response. The departments were in general not informed about the main aims of the project in order not to restrict or bias the observed work task. However, the heads of department were sometimes provided with additional information to generate interest in the project and to establish a contact to the relevant leading staff member. Occasionally, this information was passed on to the staff such that suggestions were made concerning what areas could be particularly suitable for observation.

The duration of the observations and which shifts were covered was planned with each department individually via e-mail. Since the departments found night shifts too sensitive or intense, night shifts were dropped from the investigation. The clinics operate only during the day anyway.

The observation times and dates were planned according to the wishes and requirements of the departments and the students' schedules. The students participated in the departments' work flow from the beginning of the shift to the end or when the staff assessed that observation was sufficient (and additional observation would not yield additional data except repetition).

Prior to the observations, each student signed a non-disclosure agreement and delivered it to the department.

3.2 The ethnographic observations

The students, who had been trained by means of the procedure described above, spent typically 6-8 hours per shift per department.

Prior to the observation, the students received staff clothes, name tags and an introduction to the department including instructions concerning special requirements regarding hygiene. The students primarily observed one staff member at a time, but during shift changes, the students were sometimes assigned to a different staff member. During the observations, the students acted mostly as *"fly on the wall"* and avoided interacting with patients or staff in order not to disturb the workflow. Subsequently, however, students had the possibility to ask the staff questions about the processes, stress level and so on. Occasionally, they also assisted the staff by finding equipment or with helping with minor care tasks.

Table 1: Overview of the departments involved in the study grouped by type. * indicates departments located in Svendborg, Denmark; the remaining departments are located in Odense, Denmark.

Department	Type	Hours		Processes	
		Early	Late	Early	Late
Emergency (CAP)	Ward	9.0	0.0	15	0
Haematology	Ward	5.0	5.0	11	18
Gynaecology	Ward	25.0	0.0	37	0
Nephrology	Ward	11.0	10.0	35	22
Gastrointestinal*	Ward	14.0	4.5	28	8
Geriatric*	Ward	9.0	8.0	29	17
Otorhinology	Clinic	17.5	0.0	22	0
Radiology	Clinic	12.0	0.0	19	0
Hemodialyse	Clinic	15.5	4.5	24	12
Geriatric*	Clinic	3.0	0.0	9	0
Emergency*	Clinic	7.0	7.0	18	33
Cardiology*	Clinic	12.0	0.0	39	0
Respiratory*	Clinic	6.0	0.0	14	0
Logistic	Service	27.0	0.0	49	0
Cleaning and & Hospital service	Service	21.0	18.5	38	29
Pharmacy	Service	20.0	0.0	45	0
Biochemistry & Pharmacology	Service	13.0	11.5	20	16
Total		227.0	69.0	452	155

Students were equipped with a simple digital camera, and they were encouraged to take images that did not include patients or staff. In case staff or patients were visible in the image, students were equipped with a form for declaration of consent which they then asked the respective person to sign.

Seventeen departments at Odense University Hospital in Odense and in Svendborg allowed our students to observe their daily routines; Table 1 provides an overview of the departments involved in the study, the accumulated number of hours of observation during early and the late shifts, and how many processes were identified in each department. In sum, the observations lasted for 296 hours and yielded 607 described processes.

The students were introduced to the relevant staff by the heads of department, who in a few cases also provided information about the purpose of the observations (see Section 5 for discussion). The processes identified make up approximately 210 hours of the 296 hours of observation reported. Potential explanations of this discrepancy include transition times between processes or short breaks. Furthermore, if several very short processes occurred consecutively, it is possible that students may not have been

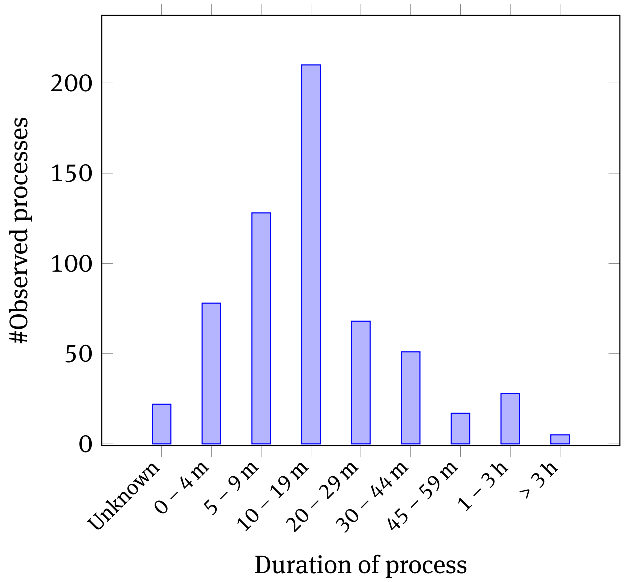


Figure 1: The distribution of the reported processes with respect to their duration. For 22 processes, the duration was not reported, and five processes had a duration exceeding three hours.

able to cover all processes in the necessary detail and thus left some out.

The distribution of the processes with respect to their duration is illustrated in Figure 1. The majority of the processes reported was found to have a duration of 10-19 minutes. However, 28% of the processes have a duration of 20 minutes or more, suggesting that some of the processes may be rather complex.

Three example of process descriptions can be found in Appendix A; they illustrate the categories we had provided the observers with and how the observers have addressed them, how the observers chose themselves to define the processes, and that some processes may consist of several subprocesses or involve different activities.

3.3 Data analysis

The purpose of this study was to identify similar or repetitive processes in a complex working environment; thus, the aim of the data analysis is not to arrive at a synthesis or to condensate the multitude of complex processes observed at Odense University Hospital, but rather to be able to retrieve and organize processes with shared features. Consequently, we decided against a data driven, bottom-up categorization process (e.g. grounded theory or affinity diagrams [24, 25]) and went for data annotation instead so that it will be possible to retrieve the complete, contextualized process descriptions by searching for particular features.

The coding scheme was iteratively developed after the first observations had come in. We annotated for recurrent patterns that have some significance for the development of use cases (see also [10]); here, our background knowledge about important distinctions in robotics (for instance, manipulation requires very different robot hardware and scene understanding than transport) informed the category development. The data analysis consequently consists of the development of a mark-up to retrieve repetitive processes with similar requirements for potential automation.

We therefore pre-sorted the processes observed according to the kinds of tasks they involve, in particular, whether they are logistic, administrative or communicational in nature or involve manipulation of any kind. These were then subdivided further; for instance, logistic processes were subdivided concerning what was moved, for example, food and beverages, critical items, like blood or medicine that require special handling and have to be moved under special constraints, clean goods versus goods that may invoke special hygienic considerations, and those that involve patients themselves. Furthermore, for each process, we thought it useful to know the temporal and spatial constraints under which they take place (stress level and crowdedness of the environment, see [11]). Furthermore, we coded how many people were involved in the process (primary and secondary) and what level of expertise these brought in.

We also coded how often each process was observed and how long it lasted. In general, the index was heavily based on the questions addressed in the booklet and the reports; some categories were added, for instance, information on privacy and data handling requirements (sensitive data, non-sensitive data, no need of information), and current challenges, such as whether the current way in which the processes are carried out causes physical/ergonomic, psychological, organizational, documentational or other challenges for the personnel. The full coding scheme applied is provided in Figure 2.

After a first round of encoding during which multiple project members encoded the same reports, we compared our results, discussed whether everyone understood the categories in the same way and identified ambiguous categories. This lead to changes in the categorization of the handling of equipment; here we distinguish now between large equipment (on wheels) and small equipment (handheld). Moreover, the category *influence on patient* was added, to indicate whether a manipulation task influ-

			Positioning patient in bed	Transport of bed with and without patient	Transport of patient in bed
ID Label		Process	14	2	12
		Report	R6	R12	R47
		Name of activity	Positioning patient in bed	Transport of bed with and without patient	Transport of patient in bed
Time		Duration [min]	10	10	5
		Frequency at department		99	4
		Frequency of observed staff	3	6	1
Nature of task (enter 1 if it applies, multiple selections are possible)	Logistics	With patients		1	1
	Logistics	Waste & Laundry			
	Logistics	Clean stuff	1	1	1
	Logistics	Critical items			
	Logistics	Food or beverages			
	Logistics – Equipment	Large (on wheels)		1	1
	Logistics – Equipment	Small (Handheld)	1		
	Manipulation – Patient-related	Nursing and care	1		
	Manipulation – Patient-related	Medical treatment or examination			
	Manipulation – Patient-related	Handling patients	1	1	
	Manipulation – Patient-related	Other			
	Manipulation – Non patient-related	Cleaning			
	Manipulation – Non patient-related	Manipulation (dosage medicin)			
	Manipulation – Non patient-related	Other			
	Manipulation – Equipment	Large (on wheels)		1	
	Manipulation – Equipment	Small (Handheld)	1		
	Communication – Face2face	Patient	1		1
	Communication – Face2face	Internal communication		1	
	Communication	Remote (phone call)			
	Communication	App. (for requesting a service)		1	
	Admin	GUI for handling patient data			
	Admin	Documentation (paperwork)			
		Number of different subtasks	7	1	2
Specify the expertise	Observed staff (enter 1 if applicable)	Long education			
	Observed staff (enter 1 if applicable)	Medium Education	1		1
	Observed staff (enter 1 if applicable)	Short Education		1	
	Observed staff (enter 1 if applicable)	No Education			
	Collaborating person(s) (enter number of persons if > 0)	Long education			
	Collaborating person(s) (enter number of persons if > 0)	Medium Education	1		
	Collaborating person(s) (enter number of persons if > 0)	Short Education			
	Collaborating person(s) (enter number of persons if > 0)	No Education			
	Collaborating person(s) (enter number of persons if > 0)	Patient or relatives	1	1	1
Privacy	(select one)	Sensitive data (e.g. CPR)	1	1	1
	(select one)	Needs non-sensitive data			
	(select one)	No need of information			
Current challenges	(enter 1 if applicable)	Ergonomically/physically	1	1	1
	(enter 1 if applicable)	Psychologically			
	(enter 1 if applicable)	Organizational			
	(enter 1 if applicable)	Documentational			
	(enter 1 if applicable)	Other challenges		1	
		Crowdedness [1-5]	3	4	4
		Stress [1-5]	2	3	1

Figure 2: Semantically grouped categories used to label the processes based on information in the reports. The description corresponding to the examples are provided in Appendix A.

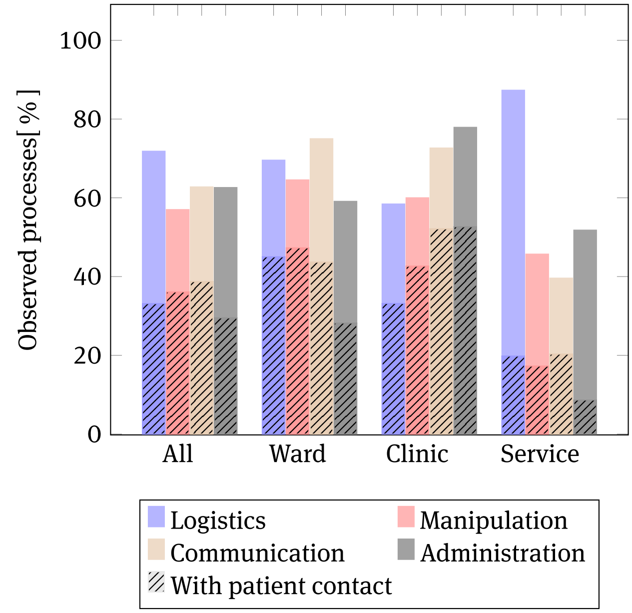


Figure 3: The distribution of the processes wrt. to type of the actions involved (indicated by the color) and whether a patient is involved or not. Since a process might be composed of multiple actions of different type, the different types sum up to >100%.

enced patients directly or not. This category is used for manipulation and logistics tasks.

However, during data analysis, it turned out that the coding is still too coarse grained to allow for the automatic extraction and grouping of all relevant processes; the different steps taken are illustrated in the example use case development in Section 4 below.

The distribution of the processes (see Figure 3) differs with respect to the type of department: For instance, unsurprisingly, in service departments, logistics tasks dominate, whereas in clinics and wards a higher share of communication tasks was observed. Furthermore, processes at the service departments involved substantially less patient contact than at the wards and clinics. Since processes may comprise multiple subtasks, such that a process involves, for instance, both logistics and manipulation, the sum of shares of all types of processes exceeds 100%. About 80% of all processes have been found to comprise multiple subtasks, indicating that additional post-processing to break down processes will be useful.

4 Example use case synthesis

In the following, a selection of the observed processes, picked based on the categorization, will be presented, briefly characterized and then used to synthesize one example use case. In particular, the procedure for us researchers was to go through all observation reports and to code each process according to the developed schema (see Figure 2). We then grouped the processes coded according to various parameters. In this way, several use cases have already been determined, an example of which is presented below in Section 4.1, but we assume that a plethora of different use cases, for robotic applications as much as for other technology development, will emerge over time.

4.1 Analysis of processes

Based on the categorized processes, a small batch of processes with similar properties was selected, analyzed and used to derive a first use case, i.e. to identify a situation in which a robot may successfully support the current work.

One task emerged to be relevant in various departments, namely the transportation of patients, of which N=69 logistic processes involving patients were identified. We furthermore distinguished those logistics tasks in which patients were the object of transportation (N=38) from those in which patients were involved in other roles.

The majority (N=16) of the remaining processes involved the transportation of patients lying in beds, but also the transportation of beds without patients. Since the beds are heavy and can be difficult to maneuver, a motorized device can be used for support (see Figure 4). However, the usage of this device is restricted to the basement since this area is inaccessible to the public, and thus potentially dangerous contacts with patients or relatives are minimized. Common to most of these processes is that also communication plays a role, in particular between the service assistant who transports the bed and the patient, for instance, by greeting and informing about the planned journey. Furthermore, communication with staff at the pick-up or target location was observed, mostly for organizational purposes, yet sometimes also waiting times occur if the patient is not ready yet or is expected to be transported back soon.

Guidance of walking patients, for instance, when they are being discharged, was observed in N=7 processes. In addition to guiding the patients to the right location, the observed personnel were typically required to find and identify the patient and to support him or her both physically while walking as well as on organizational matters. Helping the patient into a vehicle, for instance, was typically not part of the guiding but within the responsibility of another staff member such as the paramedic on an ambulance.

Figure 4: *MoovingBeds*, a supporting tool for the transportation of beds at Odense University Hospital.

Furthermore, N=3 processes concern service assistants transporting patients using wheelchairs, for instance to get patients to a medical examination in another department. These logistic processes included communication attempts. In particular, while walking, the assistants were observed trying to talk to the patients; however, because of the wheelchair, communication was not easy as assistant and patient could not see each other.

The remaining processes were of diverse nature, comprising actions like relocating the patient from an examination bed to an ordinary bed, and are thus not addressed further here.

The most common type of task was thus the transportation of patients using a bed, which is typically done by service staff who are called, for instance, by nurses when patients are ready to be transported. A service assistant is then assigned to the task and will pick up the bed and move it either locally at the ward or via elevators and the basement to a different department. In the basement, motorized support devices (see Figure 4) are supposed to be used for ergonomic reasons and to ensure safety since the floor has strong slopes. However, the usage of such a device was sometimes considered inconvenient and hence omitted. Furthermore, some staff members found that the dimension of the combined device and bed makes it even harder to turn. Finally, the device was often not placed where it was needed, or its battery level was too low. Thus, the device was not used as often as intended.

4.2 Potential robotic solutions

Different options for supporting the transportation of beds can be considered. A semi-autonomous solution (see [26] for an example), where the bed is motorized but still controlled by a human operator, would relieve the staff from the physically demanding work. Depending on the sensors and the kinematics, such a motorized bed might also assist the operator during complex maneuvering. However, such a solution would not address the organizational problem that assistants often had to wait for the patient to be taken back.

If also organizational aspects in the work flows should be addressed, an autonomous mobile robot for the transportation of beds could be envisioned. Even though autonomous navigation in semi-structured and known indoor environments of this type may scientifically be considered to be a largely solved problem, many capabilities besides navigation may be required in the context of patient transport. The ethnographic observation suggests that such a robot would likely be required to interact with patients, inform both patients and staff about its current mission and potentially also respond to requests from the patient, both during pick-up and delivery. Such capabilities are not trivial to achieve for interactions with healthy people and are particularly difficult for interactions with patients who are challenged by their condition. Furthermore, legal and safety aspects when transporting patients with autonomous devices may be challenging.

5 Discussion and next steps

In the following reflections on the methodology outlined above are provided and some future steps as well as potential adjustments are considered. In particular, the qualification and guidance of the observers (Section 5.1, the annotation of the data (Section 5.2) and the development of use cases (Section 5.3) are addressed below.

5.1 Reflections on the observations

It seems that the training, booklet and coding schemes served their purpose well to provide observers with enough guidance to provide rich descriptions that allow complete recollections of the observed practices without constraining them too much or biasing the observations with respect to possible preselections concerning what may be judged as potentially suited for automation. In this connection, it is relevant that in spite our efforts to keep observers and observed relatively uninformed about the exact aims of the project, during the later phases of the observations, the heads of the participating departments themselves spread the information that the aim was automation. Correspondingly, they pointed our observers to particular areas to observe and paired them up with staff involved in processes of which they thought they may be suitable for technical innovation. Some staff members also said jokingly that they were doing all those tasks they considered boring and repetitive and of which they would have liked a robot to carry them out. While this compromises slightly the unbiased observations we had aimed for, it illustrates how positive the attitude by staff and administration towards the project really was. Given the busy schedules of the personnel observed, it is in fact quite unlikely that they were able to change their schedules to accommodate the aims of the project. However, it emphasizes the importance of choosing the information shared with the involved parties carefully in order to ensure not to bias the observations.

5.2 Reflections on the data annotation

Regarding the mark-up, it has become clear that further iterations are necessary. One problem concerns the unit 'process', which we basically left our observers to define themselves. Many of the described processes are longer than 20 minutes (see Figure 1) and are thus likely to be composed of smaller subprocesses, which may be suited for automation to different degrees and should be handled separately. For instance, the process of changing a diaper can be broken down into logistics (fetching the clean and removing the used diaper) and manipulation (washing and changing the patient) processes. Our analysis indicates that only 12% of the observed processes consist of a simple task, and the average number of different tasks per observed process is 2.5. This would call for a subdivision of the processes observed that would increase the likelihood of identifying similar processes across departments and hence to develop use cases that generalize. On the other hand, a subdivision would present processes as separate although they actually occur in the context of a larger activity and depend on each other. This information may be lost if processes are decomposed. Moreover, when breaking down the processes into different components, we will lack precise information about the duration of the individual subprocesses.

Furthermore, during the analysis it became clear that many more possibilities for searching the processes would be useful. Thus, we understand the mark-up process as ongoing and will continue expanding the coding of the data, which is in line with other approaches to qualitative research (see, for instance, [24]). As a next step, all processes will be semantically annotated with a set of keywords still to be determined.

When we consider the results of the current procedure in the light of possible alternatives, one may ask, for instance, whether the process for the observers might have been sped up if we had equipped them, for example, with a tablet with pre-specified questions. This would have solved one practical problem we had not anticipated: for reasons of hygiene at the hospital, observers were not allowed to use their own watches, and the frequent use of their smartphones for measuring time was considered inappropriate; thus we only have sparse data on the duration of processes and their parts. A tablet would have facilitated the observations regarding duration, as well as with respect to digitizing the observations made. Drop-down menus, for instance, could have facilitated the reporting and even the encoding, since observers could have ticked off the respective categories already. However, such an approach comes also with several disadvantages: First, while the relevant criteria are available now, they were not in place when the observations started, and as described above, they are still under development. Second, the available options could have biased the observers, subtly guiding them into reporting on only those aspects of the processes that are relevant from the perspective of automation, thus reducing the richness and context-sensitivity of the data. Third, a tablet is hard to handle when observers are walking or standing without support of the tablet. Here, the old-fashioned booklet was much easier to work with. Moreover, a tablet may have intimidated staff or patients. Finally, creating reports that provide complete accounts of each process in a second step also forced our observers to check for completeness and consistency of their reports. Had this step been eliminated based on the fact that a digital version of the observation report was already available, this additional inspection and revision process would have been left out.

The overall process was complex and timeconsuming, but the obtained field observations provide complex insights into the workflow at a large institution and indicates the health-care personnel's needs for support in their real-life tasks. This type of information is typically not available otherwise, such that this study can provide unique insights on where and how staff and patients at hospitals can benefit from robots and other technologies.

5.3 Reflections on the use case development

While the ethnographic approach led to the identification of detailed descriptions of contextually situated practices, precautions need to be taken in the steps to come. So far, the post-processing of the data consisted entirely of marking up the data with respect to features that are relevant from an automation perspective; consequently, the richness and context-sensitivity of the data obtained in the ethnographic observation are preserved. Since also the challenges the participants themselves experienced and voiced during the execution of the practices were recorded, we have indicators for potential problems where help is really needed. However, by simply grouping the data to identify potential use cases, these challenges do not necessarily drive the use case development process. Here, participatory user-centered design will have to be used in order to ensure that the technological solutions developed really meet real needs (see [27]). Nevertheless, the ethnographic observation yields detailed information on how the technology has to fit into the workflow in order to be useful (see [11]). The very large number of observations provides a good overview of much of the work carried out at the hospital (even though night shifts, for instance, were not observed), which leads to the identification of potential overlap between processes, and thus of requirements even across departments. For robot use case development, such an overlap is very interesting because it indicates when the development of a robot may be economically feasible.

6 Conclusion

The results of the case study comprise a huge data set of current work processes marked up in computationally searchable ways to facilitate the identification of current tasks that are carried out repetitively across departments of the same large and complex institution. The results present open problem spaces for which numerous different possible solutions can be developed without having biased the data elicitation from the perspective of technical feasibility. Furthermore, the way in which needs and challenges that may be addressed by means of robots or other kinds of technology have been identified, preserves the rich social and institutional contexts in which they occur and that need to be taken into account during robot development. Use case development based on large-scale ethnographic observation thus allows a discussion of robots in health-care applications along the lines of social, societal, ethical and environmental values.

Acknowledgement
This work was partly supported by the project Health-CAT, funded by the European Regional Development Fund and by the strategic research initiative of the University of Southern Denmark.

Furthermore, we wish to thank the involved departments at Odense University Hospital for participating in the study and welcoming our students.

References

[1] G. Lanzieri, The greying of the baby boomers: A century-long view of ageing in european populations, Eurostat: Statistics in focus, Techical Report, 2011
[2] I. Kirchberger, et al., Patterns of multimorbidity in the aged population, results from the KORA-age study, PLoS ONE, 2012, 7(1):e30556, DOI:10.1371/journal.pone.0030556
[3] L. D. Riek, Healthcare robotics, Communications of the ACM, 2017, 60(11), 68–78
[4] A. O. Andrade, et al., Bridging the gap between robotic technology and health care, Biomedical Signal Processing and Control, 2014, 10, 65–78
[5] J. Seibt, "Integrative social robotics": A new method paradigm to solve the description and the regulation problem?, In: J. Seibt, M. Nørskov, S. Schack Andersen (Eds.), What Social Robots Can and Should Do, IOS Press, Amsterdam, 2016, 104–115
[6] T. L. Whitehead, Basic classical ethnographic research methods, Cultural ecology of health and change, 2005, 1
[7] J. Seibt, M. Damholdt, C. Vestergaard, Five principles of integrative social robotics, In: M. Coeckelberg, J. Loh, M. Funk, J. Seibt, M. Nørskov (Eds.), Envisioning Robots in Society – Power, Politics, and Public Space, IOS Press, Amsterdam, 2018, 28–42
[8] M. Hammersley, P. Atkinson, Ethnography: Principles in Practice, 3rd edition, Routledge, New York, 2007
[9] L. Suchman, Human-Machine Reconfigurations: Plans and Situated Actions, 2nd edition, Cambridge University Press, Cambridge, 2007
[10] J. Preece, Y. Rogers, H. Sharp, Interaction design: Beyond human-computer interaction, John Wiley and Sons, Chichester, 2015
[11] B. Mutlu, J. Forlizzi, Robots in organizations: The role of workflow, social, and environmental factors in human-robot interaction, In: International Conference on Human Robot Interaction (HRI'08), 2008, Amsterdam, Netherland, ACM, New York, 2008, 287–294
[12] W.-L. Chang, S. Sabanovic, L. Huber, Situated analysis of interactions between cognitively impaired older adults and the therapeutic robot Paro, In: G. Herrmann, M. J. Pearson, A. Lenz, P. Bremner, A. Spiers, U. Leonards (Eds.), International Conference on Social Robotics, Bristol, UK, Springer, Cham, 2013, 371–380
[13] J. Forlizzi, How robotic products become social products: an ethnographic study of cleaning in the home, In: Proceedings of the ACM/IEEE International Conference on Human Robot Interaction, Arlington, USA, 2007, ACM, New York, 2007, 129–136
[14] J. Sung, H. I. Christensen, R. E. Grinter, Robots in the wild: understanding long-term use, In: The 4th ACM/IEEE International Conference on Human Robot Interaction, La Jolla, USA, 2009, ACM, New York, 2009, 45–52
[15] A. M. Sabelli, T. Kanda, N. Hagita, A conversational robot in an elderly care center: an ethnographic study, In: 6th ACM/IEEE International Conference on Human-Robot Interaction, Lausanne, Switzerland, 2011, ACM, New York, 2011, 37–44
[16] M. Maguire, N. Bevan, User requirements analysis: A review of supporting methods, In: J. Hammond, T. Gross, J. Wessons (Eds.), IFIP 17th World Computer Congress, Montreal, Canada, 2002, Springer, Boston, 2002, 133–148
[17] W. K. Juel, et al., The SMOOTH Robot: Design for a Novel Modular Welfare Robot, In: ICRA2018 Workshop on Elderly Care Robotics – Technology and Ethics, WELCARO, 2018, https://sites.google.com/site/icra2018welcaro/home
[18] J. I. Westbrook, M. Z. Raban, S. R. Walter, H. Douglas, Task errors by emergency physicians are associated with interruptions, multitasking, fatigue and working memory capacity: a prospective, direct observation study, BMJ QUAL SAF, 2018, 27(8), 655–663, DOI:10.1136/bmjqs-2017-007333
[19] L. Kendall, S. R. Mishra, A. Pollack, B. Aaronson, W. Pratt, Making background work visible: opportunities to address patient information needs in the hospital, AMIA Annual Symposium proceedings, 2015, 1957–1966
[20] M. Weigl, A. Müller, A. Zupanc, J. Glaser, P. Angerer, Hospital doctors' workflow interruptions and activities: an observation study, BMJ QUAL SAF, 2011, 20(6), 491–497, DOI:10.1136/bmjqs.2010.043281
[21] S. Reeves, A. Kuper, B. D. Hodges, Qualitative research methodologies: ethnography, BMJ, 2008, 337:a1020, DOI: 10.1136/bmj.a1020
[22] J. Blomberg, M. Burrell, G. Guest, An ethnographic approach to design, In: J. A. Jacko, A. Sears (Eds.), The Human-Computer Interaction Handbook, L. Erlbaum Associates Inc., Hillsdale, NJ, USA, 2003, 964–986
[23] J. Spradley, Participant observation, Holt, Reinhart and Winston, New York, 1980
[24] N. Hook, Grounded theory, In: P. Lankoski, S. Björk (Eds.), Game Research Methods, ETC Press, Pittsburgh, PA, USA, 2015, 309–320
[25] K. Holtzblatt, J. B. Wendell, S. Wood, Rapid Contextual Design: A How-to Guide to Key Techniques for User-Centered Design, Morgan Kaufmann Publishers Inc., San Francisco, CA, USA, 2004
[26] Z. Guo, X. Xiao, H. Yu, Design and evaluation of a motorized robotic bed mover with omni-directional mobility for patient transportation, IEEE Journal of Biomedical and Health Informatics, 2018, 22(6), 1775–1785, DOI:10.1109/JBHI.2018.2849344
[27] C. Hasse, How robots challenge institutional practices, Learning, Culture and Social Interaction, 2018, DOI: 10.1016/j.lcsi.2018.04.003

A Examples of observed workflows

In the following, we provide two concrete examples of the reports written based on the observation of work flows. The reports were originally written in Danish and were translated for the current publication. In addition to the report proper, the observers provided a general description of their day, potentially additional observations they made at the ward and technical terms that may be specific to a ward.

A.1 Observed workflow at the Department of Haematology

Table 2: Report number 14, table number 6 from evening observation at the Department of Hospital and Cleaning service. The corresponding categorization of this process is provided in Figure 2.

Table number: 14	
Where do you observe?	Patient room at the Department of Haematology
Who is observed?	Nurse
Observed activity	Change patient position
Are additional people involved	Patient and colleague
What is its duration?	2-10 min
Context	To avoid soreness, the patient is moved into a different position in the bed
Describe the activity	**Move the patient up the in the bed** With a remote control which is attached to the guard rail the bed is raised to a good working height. The headboard of the bed is lowered to be in line with the rest of the bed. The patient is asked to bend the legs and to place his heels on the mattress. Then the patient is asked to push with both legs against the bottom of the bed to move himself upwards. However, the patient does not have the strength to do so, and so the nurse leaves the scene to get a colleague. The nurses position themselves at the opposite sides of the headboard and drag the bed sheet upwards so that the patient is moved up in the bed. **Decompression of the heels** The nurse places a pillow under patient's ankles to decompress the heels. This is done by lifting the legs with one hand and placing the pillow with the other. **Side positioning** The nurse leaves to pick up a long pillow from the storage. She closes the door to the patient's room and guides the patient to hold onto the left guard rail with his right hand. The nurse pulls on the right side of the sheet close to the patient's shoulder and behind so that he rolls around. She places the pillow under the right side of the patient. She asks the patient to lean back and corrects the position of the pillow to ensure that he is lying comfortably.
Tasks made at the same time	-
When is the task accomplished?	-
Stress level? 1-5	2
Crowdedness? 1-5	3
The frequency of the activity (observed staff)?	3
The frequency of the activity (department)?	10
Is it important that the task is done now, and why?	No, but it is important that patients' positions are changed frequently
Are special competences required?	Yes, knowledge about patient positioning
Images?	None

A.2 Observed workflow at the Department for Cleaning and Hospital Service

Table 3: Report number 12, table number 2 from evening observation at the Department of Cleaning and Hospital Service. The corresponding categorization of this process is provided in Figure 2. The frequency of 99 has be used to indicate that the observer could not specify the frequency of this workflow precisely but that the workflow is performed performed at least several times per day.

	Table number: 2
Where do you observe?	Hospital corridor
Who is observed?	Service assistant
Observed activity	Transport of beds with and without patient
Are additional people involved	None
What is its duration?	10 min
Context	Bed transport from a department to the storage, a second department or to an examination room
Describe the activity	The service assistant walked over to the department. The room number had not been mentioned in the request, and thus the service assistant looked around for the bed in the department. The bed can be unlocked by stepping on a stick near the wheel. The lock can be activated completely or partly for avoiding wheel rotation, which makes it easier to move the bed straight-ahead. With the remote control, placed at the side of the bed, the bed can be moved up- and downwards. The assistant pulls the bed away from the wall holding onto the long side of the bed. On the headboard of one bed, a roll of paper had been placed to cover the bed during examinations. The paper was rolled out, so the service assistant rolled it back up and fixated it by crumpling up the end. The assistant pushes the bed by the headboard along the hospital corridor. In one instant, the remote control fell off the bed since many items were placed on both sides of the corridor, making it necessary to steer the bed from left to right and back. It was frequently necessary to move obstacle, which were placed in the corridor, away. The service assistant also stopped repeatedly for oncoming traffic. Narrow corners at departments caused the service assistant to turn the bed by significantly pushing more with one arm and by moving the bed back and forth. To slow down the bed, the service assistant leaned backwards and pulled on the headboard. Normally the service assistant orients herself at the department-dependent wall color in the basement to find the way. Once she lost her way and walked in circles. When a patient is transported to an examination, the service assistance asks the staff how long the examination will take. If the examination is completed within 10 minutes, she waits in the department and returns the patient right away. Once a patient was returned without an examination due to the condition of the patient, this was noted as an unsuccessful transport.
Tasks made at the same time	None
When is the task accomplished?	During the shift
Stress level? 1-5	3
Crowdedness? 1-5	4 (some corridors was more packed than others)
The frequency of the activity (observed staff)?	6
The frequency of the activity (department)?	99
Is it important that the task is done now, and why?	No
Are special competences required?	No
Images?	-

A.3 Observed workflow at the Department of Cardiology

Table 4: Report number 47, table number 12 from evening observation at the Department of Cardiology. The corresponding categorization of this process is provided in Figure 2.

	Table number: 12
Where do you observe?	between the hall and the examination room
Who is observed?	Nurse
Observed activity	Transport of patient in bed
Are additional people involved	A nurse, the patient and a relative
What is its duration?	5 min
Context	The patient is admitted to a different department, and the nurse wants to avoid moving her to the examination table.
Describe the activity	– The patient lays in a hospital bed in the corridor, and the relative sits near the patient's head. – The nurse moves an examination table out of the examination room and into the corridor (to make space for the bed). – The nurse walks towards the bed and shakes hands with the patient and relative and informs them about the room of the examination. – Then the nurse moves the bed from the headboard of the nurse; the relative first moves the chair out of the way and thereafter controls the foot end of the bed. – To ensure that the bed is positioned correctly in the examination room, the bed is turned around in the corridor. The foot of the bed bumps against the wall since the corridor is very narrow. – The nurse stands in the examination room and pushes the bed back and forth to get it through the door. The door is narrow for this type of hospital bed. After some minutes, she manages to get the bed through the door. This type of bed is big and heavy especially in relation to the 2-meter wide corridor.
Tasks made at the same time	Talk with the relative, patient and a doctor.
When is the task accomplished?	Morning
Stress level? 1-5	1
Crowdedness? 1-5	4
The frequency of the activity (observed staff)?	1
The frequency of the activity (department)?	3-5, when a admitted bed laying patient are examined
Is it important that the task is done now, and why?	Yes
Are special competences required?	No
Images?	-

Research Article Open Access

Jessica Sorenson*

Toward a pragmatic and social engineering ethics

Ethnography as provocation

https://doi.org/10.1515/pjbr-2019-0018
Received June 30, 2018; accepted May 7, 2019

Abstract: This paper centers on a five-month ethnographic field study among engineers in a Danish collaborative industrial robotics project, to examine how the everyday work of engineers intersects with existing, formally-adopted engineering ethics approaches. Methods included a literature review of engineering ethics, participant observation in a technical research institute and in machine workshops, document and visual media analysis, object elicitation, and qualitative interviews. Empirical findings from this investigation are used to evaluate existing formalized engineering ethics in relation to engineering praxis. Juxtaposed with engineers' everyday ethical decision-making practices, professional ethics approaches are shown to be based in deontological and virtue ethics, narrowly focused on the individual engineer as a professional, and thus inappropriate and insufficient for the very practical field of engineering. The author argues for an alternative direction toward a situated pragmatic and social ethics in engineering that disrupts the current social arrangement around robot development through ethnographic intervention in the engineers' negotiation of values in the design process.

Keywords: ethics, values, design, robotics, collaboration, practice, pragmatism, ethnography, technoanthropology

Author note: This paper expands upon ideas developed in the author's Master's thesis, submitted to Aarhus University on June 1st, 2018 [1]. Pseudonyms are used throughout.

In February 2017, the European Parliament adopted a resolution [2] proposing civil law rules governing robotics and the makers of robot technologies. Years of research and debate preceded the resolution which proposed an insurance or taxation plan for robots, assigned liability to robot makers, and suggested a new code of ethics for robot engineers. During this same period, the European Commission dedicated 700 million euros to robotics research and development projects [3]. With such economic and political interest in robotics and relatively high stakes, the moment is right for a reevaluation of engineering ethics approaches.

This paper is not a critique of engineering education, nor of engineers' own practices, but of the political and regulatory efforts that inappropriately impose a philosophical ethics on robotics and engineering practitioners.

I propose a transition from engineering ethics rooted in professional ethics traditions to a practicable social ethics rooted in shared values and critically dependent on collaboration between engineers and ethnographers. Through an assessment of the social arrangements of decision-making in design processes, and disrupting this social arrangement through provocative ethnographic inquiry, it might be possible to bring diverse groups into dialogue, to blend disciplinary understandings, and to spark ethical reflection and the integration of human values into everyday design activities – thus bringing about more ethical realities.

1 Historical approaches

Contemporary professional ethics in engineering hark back to the earliest codes of ethics, established in the beginning of the twentieth century [4]. In the decades that followed, there was a long slow process of revision as engineering associations sought to establish engineering as a profession rather than a trade [4, 5]. By the 1970s, engineering ethics had emerged as a field [6], but was criticized already in the early 1980s for being too oriented toward philosophy and morals and not sufficiently oriented toward engineering practice. Philosopher and STS (Science and Technology Studies) scholar Heinz Luegenbiehl (1983) argued that the narrow focus on engineers as *professionals* neglected to consider engineers as *practitioners*:

***Corresponding Author: Jessica Sorenson:** Aarhus University, Danish School of Education, Copenhagen, Denmark; E-mail: jeso@edu.au.dk

> Underlying the numerous attempts to develop an adequate code of ethics for the engineering profession, however, has been an idea that has become almost an article of faith, namely, that engineering, in order to be considered a profession, must have a code of ethics very much in line with the format of the early codes. It would thus appear that, in the quest for unification and refinement of the codes, a more fundamental concern is being widely overlooked, that being the issue of whether or not a code of ethics is appropriate for the engineering profession at all. [5]

Luegenbiehl was perhaps ahead of his time. A new conversation around ethics in engineering burst onto the scene in the mid-1980s after the Challenger disaster, a case which remains a pet example in engineering ethics today [7]. The Challenger space shuttle, launched in the United States in 1986, exploded before even leaving the stratosphere, due to a known engineering vulnerability and the decision to proceed with the launch despite engineers' objections. The explosion, televised live, caused a devastating loss of life and was a national disaster in the United States, resulting in multiple investigations, public hearings, and a broad call for attention to ethics in engineering. In the years leading up to the Challenger disaster, Luegenbiehl had taken up the case against engineering codes of ethics, suggesting instead that codes of ethics be replaced with guides for ethical engineering decision-making [5]. This was a departure from the traditional codes and oaths which targeted the individual engineer's moral compass and attempted to affect a person's ethical thinking or orientation rather than their everyday practices and the structures in which they're embedded.

From the ashes of the Challenger rose a renewed interest in professional codes of ethics, oaths, edicts, filled with principles, canons, and the like targeted at the engineer's professional conduct [8], which caused the pragmatist movement by Luegenbiehl and others to lose traction. These codes of conduct were (and continue to be) based in part on situations like the Challenger, in which there occurs a conflict between an engineer's personal morality and structural elements, such as cultural pressures or hierarchical decisions – what Ronald Lynch and William Kline (2000) term "whistle-blowing" cases [8, 9]. These approaches, with an overly narrow focus on such David-and-Goliath, make-or-break situations overemphasize big decisions, major risks, and – most importantly – the onus on the individual engineer. Such an engineering ethics combines aspects of deontological, consequential, and virtue ethics, wherein the engineers' adherence is dependent on rules, consequences, and moral character, respectively [10].

For example, the Institute of Electrical and Electronics Engineers (IEEE), a major international professional association for robotics engineers, has the following canon under its code of ethics:

> We, the members of the IEEE [. . .] agree: to hold paramount the safety, health, and welfare of the public, to strive to comply with ethical design and sustainable development practices, and to disclose promptly factors that might endanger the public or the environment. [11]

The American Society of Civil Engineers' (ASCE) nearly identical canon reads:

> Engineers shall hold paramount the safety, health and welfare of the public and shall strive to comply with the principles of sustainable development in the performance of their professional duties. [12]

Again, the canon is found, simplified, in the National Society of Professional Engineers' (NSPE) code:

> Engineers shall hold paramount the safety, health, and welfare of the public. [13]

These aims are not all that actionable. Holding something paramount amounts to a feeling or an orientation – there is no reference to concrete practices or the social arrangement in which engineering work is situated. The ASCE code of ethics, however, also contains "guidelines to practice under the fundamental canons of ethics," which seem to be the operational principles for each moral canon. For the aforementioned ASCE canon, one guideline reads:

> Engineers shall recognize that the lives, safety, health and welfare of the general public are dependent upon engineering judgments, decisions and practices incorporated into structures, machines, products, processes and devices. [12]

Although intended as a practicable guideline, it seems difficult to enact the verb "recognize" – a word which points more to a mental activity than a material or practical one. The other guidelines for both the ASCE's and the IEEE's codes of ethics are directed at whistle-blowing prescriptions, declarations against fraud and discrimination, and tenets such as "be honest and realistic" [11] or "be dignified and modest" [12]. In a 2011 review of engineering organizations' codes of ethics, the American Association of Engineering Societies (AAES) found many similarities (as demonstrated above) [14].

These professional organizations have in common a focus on the *virtuous engineer* who subscribes to particular moral principles and behaves according to prescribed norms. These professional edicts have dominated engineering ethics from their inception.[1] This period has been marked by a neglect of collective decision-making processes, pragmatic everyday engineering activities, and the cultural and social factors in these processes [5, 9, 15]. Recently, there has been a new push away from normative rule-based deontological and consequential ethics [10]. Faith in such approaches has fallen, as empirical research has shown that engineers do not modify their decision-making processes when instructed to adhere to a particular code of ethics [16]. Contemporaneously, there have been arguments for a more virtue-based engineering ethics, relying more on an engineering morality rather than rules or oaths about right and wrong. However, there has been a noted failure of existing approaches to produce 'good engineers' or 'moral experts' [10, 17]. While a move away from deontology is in order, I argue that it ought to be a step toward a more pragmatic ethics, and not a step toward virtue ethics. Overall, virtue ethics relies too heavily on individual ethical thinking, and not enough on the social praxis that is engineering.

In line with this attitude, there have been calls for a professional engineering ethics that does pay attention to everyday practices, to target the ethical decision-making behaviors of engineers [5, 18–20]. These approaches recognize that engineering ethics is more than professional ethics. To move from the professional in the workplace to the practitioner in the workshop, engineering ethics ought to extend to the ethics of the design and execution itself, addressing the more mundane but still important ethical issues that occur in regular practice. Necessary to the shift from ethical orientation to ethical practice, is a shift from individual to social ethics. Social ethics is:

> ...an examination of structure and process, [which] involves social relations, their structure, and the norms and policies that characterize them. [21]

Such an approach would allow for a focus on hierarchy, power, materiality – and other aspects of situated engineering practices that might affect the end product in design (and thus the ethical impact it has in the world). Nevertheless, new and continuing efforts at formalized engineering ethics still center on the individual and their ethical orientation and professional conduct, through edicts, codes of ethics, and regulations [22]. In the recent EU parliamentary resolution to govern robotics [2], top-down measures with nondescript goals were once again proposed:

> [W]hereas the Union could play an essential role in establishing establishing basic ethical principles to be respected in the development, programming and use of robots and AI and in the incorporation of such principles into Union regulations and codes of conduct, with the aim of shaping the technological revolution so that it serves humanity and so that the benefits of advanced robotics and AI are broadly shared, while as far as possible avoiding potential pitfalls. [2]

The EU parliament further suggests the creation of:

> [a] framework in the form of a charter consisting of a code of conduct for robotics engineers, of a code for research ethics committees when reviewing robotics protocols and of model licences for designers and users...based on the principles of beneficence, non-maleficence, autonomy and justice. [2]

The European Commission has invested 700 million euros in robotics research and development under Horizon 2020 from 2014 to 2020 [23] (including a spin-off of the HECHO project described in this paper). Amid diverse concerns about the growing and rapid implementation of robotics [24], and a large portion of a total 100 billion euros expected to be invested in robotics and other digital technologies under the upcoming Horizon Europe framework programme from 2021 to 2027 [25], the impact of robotics and AI will not be insignificant. Therefore, I argue for an urgent reevaluation of the traditional deontological or virtue-based approaches which have thus far been unsuccessful [10, 17, 26]. In this paper, I suggest a departure from hypothetical, procedural frameworks that strictly target the engineers' moral reasoning, and a cultural shift toward incorporating shared human values [27] into the pragmatic and social design activities of engineers that I have observed ethnographically. One way to go about achieving this shift is through ethnographic interventions which, from a social ethics perspective, would examine and restructure the social arrangement in a particular design setting to allow for the negotiation of ethnographically identified values in everyday decision-making practices.

2 Methodology

Ethnography, in the anthropological tradition, is a research methodology consisting of theoretical approaches, research methods, and a descriptive practice of documen-

1 See, for example: ASCE www.asce.org/ethics/;
IEEE www.ieee.org/about/corporate/governance/p7-8.html;
ACM www.acm.org/code-of-ethics;
NSPE www.nspe.org/resources/ethics/code-ethics;
WFEO www.wfeo.org/ethics/. Accessed January 19, 2018.

tation. Martin Hammersly and Paul Atkinson describe how ethnography is used to study a group of people closely:

> The task is to document the culture, the perspectives and practices, of the people in these settings. The aim is to 'get inside' the way each group of people sees the world. [28]

I conducted a five-month ethnographic fieldwork in order to understand the decision-making processes and practical everyday activities of engineers, and to examine how these practices related to their ethical orientations and actions.

There exist different approaches to ethnographic research in anthropology. I worked from a sociomaterial perspective to define the empirical field, consisting of people (or actors), places, things, and practices. I used a multisited "follow the thing" approach [29] where I built my research around the 'thing' at the center of social practices – in this case, an industrial robotic cell being developed in the HECHO project in Denmark – and then traced the human activity (the engineers' practices) tied to the thing in order to construct the field of inquiry. Following the thing led me into conference rooms, electrical engineering workshops, demonstration halls, factory floors, and lunch rooms. In these places, I found mechanical and electrical engineers, programmers, software developers, system integrators, factory managers, and production engineers.

Qualitative research methods are a cornerstone of ethnography; the use of such methods provides a kind of close knowledge that is especially useful when asking questions about human behavior (ethical decision-making, for example). In this study, I relied on participant observation, visual and object elicitation, discourse and document analysis, ethnographic interviews, etc. Through participant observation, I learned about the everyday choices, interactions, and other activities at various sites tied to the collaborative robot development project. These observations brought to my attention particular questions of culture (such as jargon, dress codes, and education) which affected communication and collaboration among the robot developers. By involving the participants in a method of object elicitation, mapping the robotic cell and its components, I learned about the participants' separate object-worlds [30] – the different ways they thought about and related to the robot, viewing it simultaneously as a product, a research object, and a source of labor. These differences in motivations and interpretations of the object seemed to have an impact on their decisions in the cell's development. Through media analysis and qualitative interviews [31], I learned more about the participants' views on ethics and decision-making, which directed my attention to my main finding: the discrepancies between the way the engineers approached decision-making and ethics, and the way their design decisions actually unfolded in their everyday work, leaving ethics relatively unexplored.

Finally, the anthropologist ethnographer traditionally presents research results as detailed analytical descriptions. The ethnographer describes the human situation as situated phenomena, specific to time and place, subject to the researcher's own interpretations, and affected by the researcher's presence – as opposed to scientific truths. The researcher's own position within the field is particularly important in *critical ethnography*, an applied research methodology [32] in which the ethnographer acknowledges oneself as an actor within the field of inquiry, rather than an objective observer. The research output of this fieldwork was primarily descriptive, but I take the position of critical ethnographer in that I acknowledge my own motivations and political orientation toward the research field. The aim of this investigation was to evaluate the way decisions are made in a collaborative research and innovation project, with the hope of identifying opportunities for more ethical or value-oriented decisions in the design process, and to evaluate the potential role of the ethnographer in bringing these opportunities to fruition by challenging the social arrangement of the development through a social ethics perspective.

3 Findings: Everyday engineering ethics

In this ethnographic study, I observed engineering as a situated practice that is both pragmatic and social: it involves a process of decision-making that goes between conception and action, and processes of social negotiation mediated by design artefacts. As such, a social and pragmatic design process deserves a social and pragmatic ethics (see the full ethnographic study [1] for a discussion of engineering as pragmatic and social). From a review of engineering and design literature, including an examination of professional engineering association membership documents, I found that existing formalized attempts at engineering ethics have been neither pragmatic nor social. The canons and principles contained in the codes of conduct that professional engineering associations promote are not actionable. These formalized ethics approaches push an ethical orientation or a *way of being*, rather than a way of acting. Not surprisingly, such oaths and edicts have been ineffective and clashed with the very pragmatic nature of design activities observed in the HECHO project. Further, I have found that professional engineering ethics is prescriptive and narrowly focused on the individual engineer – not fitting the context of development, comprising dynamic and social negotiations, that I observed amongst the engineers in this study.

The HECHO engineers approached ethics abstractly, rarely (if ever) engaging with ethics in practice. In interviews, most of the participants expressed a sense of morality and empathy, but did not locate ethics within their own design practices. After sharing some narratives about ethical consequences of implementation, the engineers began to understand ethics in a new way and could identify ethical issues within their own projects. Nevertheless, they either felt it was not their responsibility to account for these ethical issues in the design process, or that their ethical decision-making agency was constrained by the design plan, by hierarchy, or by the customer. In the following section, I present empirical findings from the ethnographic study that demonstrate why existing virtue-based and individual-oriented approaches are particularly unsuitable for engineering praxis.

3.1 Ethics do not apply here

Early in the fieldwork, it became clear that social scientists were not a part of the social arrangement of the HECHO project. The project involved a diverse group of what I have collectively termed 'engineers', including those from the computer sciences (software engineers, programmers) and other engineering disciplines (mechanical, robotics, mechatronics, electrical, etc.), but also included other professionals (machinists, production engineer, factory manager). When I asked about ethics, it became clear that this was not a typical conversation the participants were used to having. My questions about ethics were a disruption to the normal social arrangement, wherein tasks are delegated by disciplinary expertise.

One robotics engineer, responsible for overseeing all robot development at his institute, did not think ethics was relevant to the design of industrial robotic cells at all.

> "If you want to look at ethics, you won't find it here [industrial robotics]. That's one of those things you mark off—not relevant [miming a checkmark]. Nobody here is working on ethics." (Robotics engineer)

He held that safety regulations and CE markings served as the markers of ethical design in industrial robotics, saying that if you design within these parameters, your machine would be ethical. Other engineers also equated ethics with physical safety, but not with other forms of well-being, like emotional or social welfare.

> "What we're considering, mainly, is: Is it safe to use? ...The one issue is safety. If there is something safety-related, we have to change it. And we do. We consider that very deeply." (Software engineer)

Many of the engineers shared the opinion that ethics was important, but that it was not a part of their work to consider the ethical aspects of the design.

> "I think things like pride and social interaction are not part of what we're considering." (Robotics engineer)

> "Funny, I never thought of these issues much before." (Software & robotics engineer)

> "Technical people are not involved in things like that." (Automation consultant)

The very nature of engineering, their problem-solving orientation, was often used against ethical thinking. This thinking presumes that the technical and the ethical aspects are separate, and that ethics is *not* a part of engineering.

> "We're just trying to solve a technical problem." (Software engineer)

> "I think, for most of those actually physically building the solutions, their motivation is the technical aspects. *We just want to make cool robots, no matter what happens with them* [emphasis added]. And cool solutions. Whereas, I think that most companies would also be run by people who just want to make cool solutions for people. . . .Yeah, so there's a difference in those making a robot, building it, and those actually using it. . . .I'm sure that those actually developing the robot would be technical people, just wanting to create a cool robot." (Mechanical engineer)

> "When you are trying to solve this problem, you're not thinking about the ethics – you're just trying to figure [out] a solution to something technical. How do I get the robot to move this part from here, to here?" (Robotics engineer)

If pressed on where in the design it would even be possible to incorporate ethical decision-making, many of the engineers thought it belonged in the beginning with the decision of whether to develop the robot or not. Indeed, some ethical problems, like job loss, *were* tied to the automation of the task itself.

> "Some of these aspects, like reducing social interaction and maybe someone losing their job, are intrinsic to these projects that we do. So if we are *doing* a project, some of these questions have already been decided. . . .[And for other types of projects], if

> you're not in on the design [planning] process, it's pretty much locked in." (Software engineer)

One reason that the engineers had trouble locating ethics within their work processes is that they held a very narrow view of ethics, built around automation and job loss (as evident in a national and industry-wide discourse about saving jobs [33]):

> "Hah! Let me just start by saying, as you are probably aware, that we are preserving jobs rather than losing jobs." (University professor)

> "An automated workplace is a competitive workplace. And a competitive workplace is a well-staffed workplace." (Technological institute website)

With this point of view, the choice to automate is *the* ethical issue. To reiterate what one software engineer pointed out: "...if we are doing a project, some of these [ethical] questions have already been decided." They also had trouble understanding the ethical implications of their work because they only thought about ethics in the hypothetical, and could not envision negative outcomes aside from job loss (which they had already dismissed as an issue) and physical safety (which is already regulated). A possible explanation for this disconnect between their work and the greater impact of their designs could be a lack of training and experience in ethical thinking. The engineers reported that while they'd had coursework on regulations, safety, and legal issues, they had not had any education in ethics. They simply lacked the language and experience for engaging with the topic.

3.2 Probing for ethics with ethnographic data

In order to bring the engineers' ethical-thinking out of the hypothetical, I had to conduct another round of interviews using narratives from other HECHO engineers and from professional literature to provoke ethical reflection about the HECHO engineers' own work. The engineers had had trouble extending their views of ethics beyond discursive issues, like replacement and safety. However, when given real-life examples of ethical issues with implementation, the engineers were able to understand ethics in a broader sense and were able to look beyond the ethical dilemma of whether to automate or not to automate. They told stories of industry workers whose work or livelihood was negatively affected by the engineers' own work.

> "Back in the shipyard, I also heard something about that. I was not directly involved in this project, so I only heard about it. But it was a robot for welding pipes together. If you have one pipe connecting to another in a T, you have a very special welding seam, which the robot was made for. However, the trouble was that the workers were paid more for doing this complicated welding than for doing the end-welding when they have the flange. So, they indeed sabotaged the robot. Only because they were paid more for doing what the robot was doing! That was completely stupid, because if the company had done something about the payment, of course there would be no problem. Only because the loss of money that was seen from the workers' side." (Robotics engineer)

Another engineer shared a story about a process he'd helped to automate, in which a small data-entry task was automated in a process of bending sheet metal from CAD drawings to create parts. Three years after implementation, the workers were still not using the software, but were instead inputting the numbers manually.

> "The people on the floor, they still wanted to use the old-fashioned way because that was what they knew, and actually they thought that they put value to the product. By doing things, they could use their skills to do it, even if it was just typing in some numbers that came from a drawing.... The leader said that he had seen that it was difficult to take off this responsibility because then they thought that their work was not as valuable. Even if they maybe could do some more metal sheets because they were not using time to enter the numbers. But it was difficult to get people to work like that. If you forced them to do it, they'd think their work was not that interesting anymore. Because putting the sheet metal in was not the interesting part. They thought it was nice when they had a new product: 'Now we have to make this work,' type in numbers, see that it actually forming some part, and say, 'Yes! *We* did this.' Instead of just starting the machine and putting in sheet metal." (Robot consultant)

Both engineers could see that their work negatively affected work processes and the lives of the workers, making their work less interesting, less valuable, or less profitable. Both engineers acknowledged that considering the effects on the workers beforehand might have prevented these outcomes. So although the engineers did not generally see a place for ethics within their practices, they were able to engage with a personal or professional ethical orientation toward design, when provoked. One young engineer, when asked whether he would feel ethical responsibility for a negative outcome resulting from his design, said that he wouldn't feel responsible, but that it would trouble him personally. He would like not to be involved in projects that might cause someone to lose their job, but he felt constrained by his position within the company.

> "[The user's] unhappiness with the machine would hurt me-hurt my pride....I can't really decide which projects I pick, I'm mostly assigned. If I had the space, I would say no— Actually, I haven't considered what would happen if I said no to a project—and I don't want to at all. They'd find some way to work around it. Maybe 'I'm not doing it'- but now my colleague is doing it. Is that so much better?" (Robot consultant)

Although the engineers typically expressed empathy for the workers, they did not feel responsible or liable for any ethical aspects or outcomes:

> "Of course I would feel bad, but I wouldn't feel responsible." (System integrator)

When as an ethnographer, I put forth ethnographic data from prior research and recalled specific scenarios in the HECHO project itself, the engineers were able to have a conversation about something previously thought to be inaccessible, lying somewhere beyond their competences. In adding my own expertise and language around ethics to the existing social arrangement, we crossed disciplinary boundaries to open for new ways of thinking about the ethical implications of ongoing design practices. Despite the significant headway made with these engineers, they still denied all ethical responsibility. A closer look at the social arrangement of HECHO showed that this was because the engineers associated ethical responsibility with decision-making power – something often formally designated in development processes (even if informally negotiated in practice).

3.3 Assessing social arrangements around decision-making

The HECHO engineers felt constrained by the social arrangements and procedural frameworks in which decisions were made. Many of the engineers subscribed to a proprietary project management framework (SCRUM, e.g.), in which particular decisions are formally assigned to certain persons, and design processes are meticulously planned, following the procedures set forth in the frameworks. Even informal decisions were delegated to particular actors – in theory. Most of the participants presented a neat design process in which the initial stages involved planning, decision-making, and sometimes ethical considerations, and later stages involved the actual execution of these decisions.

Contrary to these attitudes, observed *in-practice* decisions were continuous, shared, and negotiated throughout the design process. Components as simple as the type of LEDs used to communicate information about the cell to the operators were discussed repeatedly, changed, and then discussed again. Although the HECHO project had formally ended, the design continued to evolve as the original cell was implemented and as new processes (tasks) came up.[2] STS scholar Lucy Suchman has examined this disjunction between theory and practice in her work on situated plans and actions among engineers and designers. She writes that "plans are best viewed as a weak resource for what is primarily ad hoc activity," [34]. The dynamic and ad hoc decision-making activities observed in practice unfortunately did not explicitly involve discussions of ethics or ethical issues. When design issues came up, the discussions always pertained to the cell's function, not the effects on operators or on the work environment, for example. The engineers did not even recognize these minor social negotiations as a mode of decision-making, even while this activity was characteristic of much of the actual development activities occurring in HECHO. In a way, the engineers were constrained by their linear or schematic thinking about the design process.

The way the HECHO engineers *thought* about and approached decision-making was consistent with the squareness of prescriptive commands in the professional codes that govern engineering and with the procedural logic that permeates engineering practices. Generally, the engineers thought that ethics belonged in the very beginning of a design process, in the decision of whether to develop the robot or not (or determining whether the robot's purpose is ethical or isn't) – echoing the make-or-break thinking of existing engineering ethics frameworks [5, 8]. The engineers' exile of ethics to the hypothetical first stages of a presumed formal design process precluded space in their thinking for addressing ethics. Ethics was simply not integrated into the everyday decisions in the continuous design process. This is an essential point, because it is in the minute decisions that the opportunities to mitigate risks and consider ethical issues may occur.

3.4 Distributing ethical responsibility

Overall, the engineers did not feel that the consideration of ethics was a part of their existing practices, nor did they feel it was their responsibility to integrate it into their practices – despite having seen and sympathized with workers who were negatively affected by the engineers' designs.

2 The HECHO project eventually transformed into a new iteration funded by the EU.

One reason for denying responsibility was attributed to a lack of agency in decision-making, especially when decisions are formally assigned or limited by hierarchical, material, or structural aspects. The robot consultant whose project involved sheet-metal bending said he felt frustrated with the company for not having gathered their workers' opinions on which tasks to automate. However, he did not feel that was his decision to make and felt constrained by the agential hierarchy of commercial projects:

> "It is the customer who takes the last decision. The man with the money decides."

Other engineers felt that their ethical decision-making agency was constrained by structural elements like workplace hierarchy, as in the example above, or by budgets. As several engineers explained, everything they do in the design process has to add economic value. In the end, 'productivity' rules – the point of the robotic solution is to make the total human-machine production process more efficient and cheaper.

> "Sometimes they [operators] are annoyed with the robot, because it doesn't do it the way that they would have liked it to be done. And now they even have to provide it with resources the way that it says it wants it. So, that can sometimes give some negative reactions…'Why do we need the robot if it's slower than us?' Well, because it doesn't have lunch. Or it doesn't go for lunch breaks. It works at night as well. It doesn't complain. It just does what it's told." (System integrator)

> "That's the logic in industry. Does it make money? No, it doesn't. Then we can't." (Software engineer)

Here, where agency is limited, traditional professional ethics might suffice with moral imperatives to take a stand against one's superior, employer, or the customer; however, social ethics would instead suggest a renegotiation of agency or responsibility within the group and a restructuring of the social practices rather than placing the impetus on the already disadvantaged actor.

When asked who *did* have a responsibility to ensure an ethical product or ethical outcomes, the engineers deferred responsibility. The software developers pointed to the system integrators who pointed to the client (i.e., the factory manager) who pointed to the government.

> "We don't think about the social perspective of the operator. But that is also because we have these specifications that this machine has to perform against. And if that is causing a bad day for the operator, that responsibility lies not with us, but with the person who specifies and buys the machine – the customer." (Software engineer)

> "It's the customer's problem, whether the worker is happy or isn't happy." (Robot consultant)

> "I don't know, you can say that the government is setting the direction, saying that we should install more robots. And they know about the societal ethics, effects that it will have. So they are somehow responsible." (System integrator)

Thus, the HECHO engineers may have had an ethical orientation toward design and toward users, but felt no responsibility for the harm their designs might cause. They thought ethics was important, and came to realize that ethics was relevant to their projects, but still did not think it part of their practice to consider ethics. This is symptomatic of their individual moral orientation (their professional ethics) alongside their practical abstinence (lack of pragmatic ethics). The engineers' decision-making agency, limited by the social arrangement of the project, affected the engineers' assignment of ethical responsibility. They not only felt that they had no responsibility to consider ethics, they also felt it was not feasible.

4 Discussion: A negotiation of values

For the HECHO engineers, it was difficult to engage with ethics on a practical level. This may have something to do with how ethics has been approached within the engineering profession thus far. Devon and Van de Poel, advocates for a social ethics of engineering, argue:

> Despite the considerable recent growth in the literature and teaching of engineering ethics, it is constrained unnecessarily by focusing primarily on individual ethics using virtue, deontological, and consequentialist ethical theories. [21].

Ethnographic observations of the HECHO engineers, however, showed that it may actually be possible to bring ethics into the design practices by using ethnographic data collected in the project to bring forth existing *values*. Current engineering ethics approaches focus on ethical or moral orientations, *theoria*, rather than value-driven practices, *praxis* [17]. Engineering ethics presupposes that an orientation will effect a consideration for human needs in design. This has not been the case in this empirical study or in experimental studies of ethics in design[16]. A value-oriented engineering, however, would flip the situation, bringing human values first into practice and perhaps transforming the ethical orientation over time. Rather than aiming to produce ethical *engineers*, the aim would be on reforming practices to ensure ethical *engineering*. Therefore, I propose the use of ethnography in identifying and challenging values in development practices.

Value comes from the Latin verb *valere* ('to be able', 'to be worth') [35], denoting an ability and a quality. *Ethics*, by contrast, assumes a field of knowledge, a set of values, and perhaps a philosophical orientation toward those values [36]. Ethics and morality derive from the respective Greek and Latin terms *ethos* and *moralis* ('character', 'manner', or 'conduct'), denoting a way of being. As shown in the previous sections, a particular engineer might identify with an ethics or a moral orientation that does not necessarily effectuate the consideration of values in design practices [16]. Ethics is rather theoretical until operationalized into the values it subsumes.

Values are the practicable element of ethics. They can be tangible and specific, such as *flexibility* in modular robotics design, which describes the ability to adapt the robotic cell. Whereas ethics typically concerns just one type of value (human values, or moral rights and wrongs), there exists a plurality of value types (functional, economic, e.g.) which are *socially* and contextually determined [37–40]. Engineers often have experience incorporating some of these value types into their work, and negotiating their worth. In the HECHO project, the meaning and worth of *flexibility* was negotiated by the engineers, buyers, and funding organizations involved in the cell's development and implementation. From its introduction into the project via the HECHO work-package, with the goal to develop "hyper-flexible automation," to the selection of particular design features or components. While flexibility is a *functional value* describing the changeable configuration or applicability of a robotic cell, I argue that engineers might also incorporate flexibility's underlying *human values*. The human value inclusion, for example, underlies the functional values flexibility and accessibility; by designing the cell to be more flexible or accessible, the engineers might include SMEs or operators with less experience working with a robotic cell. Existing engineering ethics credos tend to call for *individually* internalized principles citenews-1, while values, like flexibility here, are *socially* negotiated norms. The ethnographer has the opportunity to act as a broker in these negotiations, helping to identify and communicate the values that matter to operators and to engineers. Thus, a focus on identifying and negotiating values can help in shifting toward a more pragmatic *and more social* engineering ethics.

Moreover, values are already a part of design discourses. Batya Friedman and Peter Kahn (2006) have already created a value-sensitive design framework [41]. I am not the first to suggest a pivot to a pragmatic engineering ethics [9, 18], I simply suggest a direction toward values in realizing this move. Because values and engineering are both pragmatic, and because engineers engage with functional values already – such as flexibility, agility, efficiency – the significant shift will be in expanding the *types* of values incorporated into their design processes. Here, I will suggest that ethnographers might play a role in provoking such a shift. Perhaps, ethnographers can provoke engineers to consider ethics as *human* values, rather than moral principles, alongside existing functional values as a part of their everyday design practices. If engineering ethics can be translated into human values, and then embedded in tangible design values, ethics may finally be enacted in the sociomaterial practices of design.

5 Conclusion: Ethnography as provocation

I have suggested a shift from professional engineering ethics approaches to a more pragmatic and value-oriented social ethics. I propose that by expanding the values that engineers incorporate into their everyday design practices, we might open for more ethical outcomes in engineering. One way that we might realize this shift is through ethnographic research in robotics development. Here, I suggest that ethnographers can enter the social arrangement of design to play a role in bringing forth particular human values– by bridging object-worlds (between engineer and operator), by provoking ethical reflection to identify relevant human values, and by identifying opportunities for value-oriented technical decisions.

Ethnography has been used in the past as design provocation. Jacob Buur and Larisa Sitorus (2007) have used ethnographic materials to "provoke engineers to reframe their perception of new designs," [42]. In a participatory-design project, Buur and Sitorus brought machine operators into the design process to engage in direct dialogue with engineers. This helped the engineers to better understand how the operators worked – and how the engineers' new technologies might shape or support their work. They also used ethnographic material (videos) to prompt engineers to discuss how they understand the design product itself.

> The [ethnographic] material mediates the exchanges of understanding and perspectives of various practitioners. [Eleanor] Wynn argues that by creating openings within the boundaries that form such practices, one diminishes the distance between these practices. These openings take place when designers are willing to be more sensitive towards the boundaries. Ethno-

> graphic material can help these practitioners expose, exchange and reframe their understandings. [43] (as paraphrased in [42])

As discussed further in my full account of the HECHO project [1], engineering involves a social negotiation across object-worlds. If an ethnographer were to provide ethnographic material that provoked a dialogue about ethics and human values, perhaps it would open a space where the engineers could negotiate values as part of their everyday design practices. Indeed, EunJeong Cheon and Norman Makoto Su (2018) are currently attempting to elicit values in design processes, through the use of futuristic autobiographies developed from empirical narratives [44]. While this study is a step in the right direction, it focuses on invoking values within an individual – not within the social context of design. From a sociomaterial perspective, agency (and by extension, moral agency) does not exist a priori, but is negotiated within a situated practice [34, 45]. Therefore, such a practice of ethnography as provocation or as interference, should be done with a social ethics approach – taking into account the entire assemblage.

What is the active role of the critical ethnographer [32] beyond describing the engineers, their object-worlds, and their social practices? What is their role as a participating actor in the social assemblage?

In conducting ethnographic research in the HECHO project, I entered the design process with my own *object-world* [30] about me: I came with different experiences and understandings of technologies as artefacts, as cultural products, etc. My object-world was changed significantly as I became familiar with the jargon, the parts, and the practices involved in the HECHO project. However, I too, brought with me some expertise and experiences which might have changed the engineers' own understandings. I asked questions about ethics, morals, and consequences. I drew attention to operators' experiences, societal needs, and caused the engineers to reflect on their own practices.

Whereas I had observed that the HECHO engineers' technical decision-making had been marked by social negotiations, this was not the case with ethical decision-making. The individualized ethical principles they held, however loosely, never translated to actionable values and did not come through in their work. Whatever their moral orientations, they did not discuss, share, or argue over ethical decisions. However, by having conversations around ethnographic data with the engineers, their understandings of ethics expanded and they were able to connect the ethical effects of their products to their own design processes. My ethnographic research may have altered their object-worlds: A disruption of their relatively structured approach to design might have opened the process up for new ways of understanding the operators and the robotic cells themselves.

> The contribution that ethnography may make is to enable designers to question the taken-for-granted assumptions embedded in the conventional problem-solution design framework. [46] (as cited in [42])

In this way, there was some learning occurring between the engineers and myself, signaling that ethnography itself might play a role in the design process- in defining the new realities produced when engineers and ethnographers work together.

Therefore, ethnography might be seen as a form of world-making or knowledge production [47]. John Law and John Urry (2004) suggest that social scientists create certain realities when they select particular methods, perspectives, and inquiries. Citing Donna Haraway, they call social science a *system of interference*, and argue that if our investigations build new realities, we [social scientists] can make political choices about what type of realities we want to contribute to [48]. As Lucy Suchman writes:

> The representations ethnographers create, accordingly, are as much a reflection of their own cultural positioning as they are descriptions of the positioning of others. [49]

In choosing to pay attention to ethics, and to draw attention to human values, and by writing an ethnography of ethics and decision-making in engineering, I have already instigated a new reality. Just by examining the HECHO sociomaterial assemblages through the lens of social ethics, by raising issues of values and ethics with the engineers, by drawing out ethnographic data and working together around it, I noticed an increase in their attention to ethics, their ability to locate clashes of values or interests in design, and in their orientation toward the design process.

So, if there is to be a move from *ethical engineers* to *ethical engineering*, a reform of engineering ethics from hypothetical, procedural, or moral frameworks toward ethical engineering practices, perhaps it can come through ethnographic provocation and social ethics. By examining the social arrangements and decision-making processes involved in a particular design, and by provoking engagement with human values in the design process, by crossing object-worlds and working interdisciplinarily, ethnographers might play a role in a more critical design process.

References

[1] J. Sorenson, Decisions and values: Engineering design as a pragmatic and sociomaterial negotiation process, REELER Working Paper Series [working paper], Aarhus University, 2018

[2] European Parliament, EU Parliamentary Resolution, Civil Law Rules on Robotics, 2017

[3] About euRobotics, SPARC, https://www.eu-robotics.net/sparc/about/index.html, Accessed 29 January 2018

[4] C. Didier, Engineering ethics, In: O. J. K. Berg, S. A. Pedersen, V. F. Hendricks (Eds.), A Companion to the Philosophy of Technology, Blackwell Publishing Company, 2009, 426-432

[5] H. C. Luegenbiehl, B. Puka, Codes of ethics and the moral education of engineers [with commentary], Business & Professional Ethics Journal, 1983, 2(4), 41-66

[6] V. Weil, The rise of engineering ethics, Technology in Society, 1984, 6(4), 341–345

[7] M. Rossow, Engineering ethics case study: The Challenger disaster, [manual] Continuing Education and Development, Engineering, 2012

[8] M. Davis, Thinking like an engineer: The place of a code of ethics in the practice of a profession, Philosophy & Public Affairs, 1991, 20(2), 150–167

[9] W. T. Lynch, R. Kline, Engineering practice and engineering ethics, Science, Technology, & Human Values, 2000, 25(2), 195–225

[10] H. Furey, Aristotle and autism: Reconsidering a radical shift to virtue ethics in engineering, Science & Engineering Ethics, 2017, 23(2), 469–488

[11] IEEE, IEEE Code of Ethics, Section 7, Part A, 2018

[12] ASCE, ASCE Code of Ethics, American Society of Civil Engineers, 2017

[13] NSPE, Code of Ethics for Engineers, National Society of Professional Engineers, 2007

[14] ASCE, Civil engineering, Comparison of Engineering Society Codes of Conduct, January 1, 2011, https://www.asce.org/question-of-ethics-articles/jan-2011/, Accessed 29 January 2018

[15] J. R. Herkert, Ways of thinking about and teaching ethical problem solving: Microethics and macroethics in engineering, Science & Engineering Ethics, 2005, 11(3), 373–385

[16] A. McNamara, J. Smith, E. Murphy-Hill, Does ACM's code of ethics change ethical decision making in software development?, In: Proceedings of the 2018 26th ACM Joint Meeting on European Software Engineering Conference and Symposium on the Foundations of Software Engineering - ESEC/FSE 2018, Lake Buena Vista, FL, USA, 2018, 729–733

[17] J. A. Schmidt, Changing the paradigm for engineering ethics, Science & Engineering Ethics, 2014, 20(4), 985–1010

[18] M. W. Martin, R. Schinzinger, Ethics in Engineering. 3rd ed, McGraw-Hill, 1996

[19] J. Manning, Evolution of engineering ethics over the past 150 years, Journal of Professional Issues in Engineering Education & Practice, 2003, 129(3), 136-137

[20] T. Swierstra, J. Jelsma, Responsibility without moralism in technoscientific design practice, Science, Technology, & Human Values, 2006, 31(3), 309–332

[21] R. Devon, I. Van de Poel, Design ethics: The social ethics paradigm, International Journal of Engineering Education, 2004, 20(3), 461–469

[22] J. L. Hess, G. Fore, A systematic literature review of US engineering ethics interventions, Science & Engineering Ethics, 2017, 24(2), 551-583

[23] SPARC/euRobotics website, https://www.eu-robotics.net/sparc/about/index.html, Accessed 19 January 2019

[24] Directorate-General for Communication, European Commission, TNS Opinion & Social, Public attitudes towards robots, summary, Special Eurobarometer Survey 382 / Wave EB77.1, 2012

[25] Directorate-General for Research and Innovation, European Commission, Commission proposal for Horizon Europe, 2018, https://ec.europa.eu/health/sites/health/files/non_communicable_diseases/docs/ev_20180928_co05_en.pdf, Accessed 19 January 2019

[26] B. Gert, Universal values and professional codes of ethics, Anthropology News, 1995, 36(7), 30–31

[27] European Parliament, Values and objectives, https://europarlamentti.info/en/values-and-objectives/values/, Accessed 13 April 2019

[28] M. Hammersley, P. Atkinson, Ethnography: Principles in Practice, 2nd ed, Routledge, 1995

[29] G. E. Marcus, Ethnography in/of the world system: The emergence of multi-sited ethnography, Annual Review of Anthropology, 1995, 24(1), 95–117

[30] L. L. Bucciarelli, An ethnographic perspective on engineering design, Design Studies, 1988, 9(3), 159–168

[31] S. Kvale, InterViews: An Introduction to Qualitative Research Interviewing, SAGE Publications, 1996

[32] J. W. Creswell, Qualitative Inquiry and Research Design: Choosing Among Five Approaches, 3rd ed, SAGE Publications, 2010

[33] J. S. Arlbjørn, Danske producenters udflytning og hjemtagning af produktion, København: Syddansk Universitet, Institut for Entreprenørskab og Relationsledelse, and Kraks Fond Byforskning, 2013

[34] L. A. Suchman, Plans and Situated Actions: The Problem of Human-Machine Communication, Cambridge University Press, 1987/2007

[35] T. F. Hoad, Ethics, morals, values, In: T. F. Hoad (Ed.), The Concise Oxford Dictionary of English Etymology, Oxford University Press, 2003

[36] WFEO, WFEO (UNESCO) model code of ethics, World Federation of Engineering Organizations (UNESCO), 2001

[37] D. Graeber, Toward an Anthropological Theory of Value, Palgrave, 2001

[38] C. Kluckhohn, Values and value-orientations in the theory of action: An exploration in definition and classification, In: E. Shils, T. Parsons (Eds.), Toward a General Theory of Action: Theoretical Foundations for the Social Sciences, Harvard University Press, 1951, 388–433

[39] P. Doyle, Value-Based Marketing: Marketing Strategies for Corporate Growth and Shareholder Value, John Wiley & Sons, 2009

[40] W. Safire, On language; Principle vs. value, The New York Times, 12 Aug. 1984, 6–8

[41] B. Friedman, P. H. Kahn, A. Borning, Value sensitive design and information systems, In: P. Zhang, D. F. Galleta (Eds.), Human-Computer Interaction and Management Information Systems: Foundations, Routledge, 2006, 348–372

[42] J. Buur, L. Sitorus, Ethnography as a design provocation, Ethnographic Praxis in Industry Conference Proceedings, 2007,

146–157
[43] E. Wynn, Taking practice seriously, In: J. Greenbaum, M. Kyng (Eds.), Design at Work: Cooperative Design of Computer Systems, CRC Press, 1991, 45–64
[44] E. Cheon, N. M. Su, Futuristic autobiographies: Weaving participant narratives to elicit values around robots, In: Proceedings of the 2018 ACM/IEEE International Conference on Human-Robot Interaction, New York, NY, USA, 2018, 388–397
[45] N. C. M. Nickelsen, Criteria of implementing feeding assistance robots in disability care: A sociomaterial perspective, Journal of Comparative Social Work, 2013, 8(2), 1–30, 2013
[46] R. J. Anderson, Representations and requirements: The value of ethnography in system design, Human-Computer Interaction, 1994, 9(2), 151
[47] N. Rapport, J. Overing, Social and Cultural Anthropology: The Key Concepts, Routledge, 2002
[48] J. Law, J. Urry, Enacting the social, Economy & Society, 2004, 33(3), 390–410
[49] L. Suchman, Making work visible, Communications of the ACM, 1995, 38(9), 56–64

Paladyn, J. Behav. Robot. 2019; 10:66–76 DE GRUYTER

Research Article Open Access

Jamie Wallace*

Ethics and inscription in social robot design

A visual ethnography

https://doi.org/10.1515/pjbr-2019-0003
Received June 29, 2018; accepted October 4, 2018

Abstract: In this paper, by turning to examples of visual inscriptions adopted within HRI research, and more specifically social robotic interaction, I wish to explore through visual ethnography some of the challenges faced in designing ethical robots. Firstly, visual ethnography allows for an alternative categorisation of the inscriptions of HRI based on visual characteristics. Secondly, visual inscriptions show multiple and paradoxical meanings when appearing juxtaposed revealing challenges of diminished and asymmetric consideration of human orientated concerns in favour of technical and experimental certainty. Thirdly, by taking a human orientated perspective of experimental arrangements, the understanding of ethics becomes a way of framing and of looking at inscriptions. The paper calls for a better understanding of the role of inscription practices in HRI generally in order to find new approaches useful to bolster a more robust inclusion of ethics within the field.

Keywords: visual studies, visual ethnography, ethics, design inscriptions, visual inscriptions, design representation, design artifacts, HRI, social robotics, visual analysis

1 Introduction

The traditional view is that research within Human Robot Interaction (HRI) is largely non-ethical, involving the development through design and experimentation, of technical artifacts intended to perform unquestionably helpful tasks to improve the future lives of humans. The users of robots may well find themselves with ethical, legal and societal concerns, but these are outside the scope of the computer scientists and engineers developing the technical and computational aspects of these complex machines. My approach here is contrary and is that design is a far richer process than merely determining technical requirements [1]. It involves a process of determining and inscribing, or more precisely 'implicating', values [2] in the material and digital artifacts generated as part of the design process itself. Through the experimental and design processes of robotics, these implicated values will potentially go on to configure the futures of users and societies. Consequently, the design methods through which roboticists work, and more importantly, the inscriptions through which they transform and disseminate their thinking are important vehicles though which ethical values and concerns can, or equally not, become implicated in robots. It follows therefore that in order to develop ethical robots, ethics need to play some part in the inscriptions and inscription practices of the HRI community.

Roboticists engage with a wide range of representational practices. Typically working in multidisciplinary teams a large amount of their design and research activity involves constructing and working with differing types of symbolic representation and comparing those with their experimental arrangements. At first glance the types of visual inscriptions found in HRI include photographic imagery of various sorts, computer generated imagery including CAD and solid modeling media with graphics and diagrams. Alongside these design and engineering inscriptions are computational inscriptions representing mathematical and geometric relationships, as well as flow diagrams and computational architecture and algorithmic code. This diversity of inscription types shows HRI to be a multidisciplinary field in which design and research occur at the intersection of divergent fields of knowledge such as artificial intelligence, language studies, design, robotics and the social sciences. These separate disciplines have different inscription practices and, just as the demands of complex problem solving bring them together, so their inscription practices become combined and juxtaposed with one another. Despite ethical issues and the consideration of implicated human values becoming an increasing part of the interrelated problem solving of HRI, it is largely unresolved as to how these will become embedded within the wider use of inscriptions and design artifacts.

***Corresponding Author: Jamie Wallace:** Aarhus University, Denmark; E-mail: jw@edu.au.dk

Unlike the bringing together of text to form a continuous thread of understanding, inscriptions and images provide more fluid forms of knowledge and remain ambiguous (or polysemic) in their communicative function until they become embedded into the conversation. Moreover, they are not bound by the same criteria and characteristic of established discourse genres [3], and may remain available to negotiation and definition through further interactions. Unlike verbal interaction, images and inscriptions do not necessarily follow a linear path when viewed and since they can be rearranged, shown individually, or viewed as a group, the do not directly lend themselves to questioning in the same manner that verbal or written communications do.

The inscriptions considered here are those describing design decision making and research approach as they appear in scientific publications about social robotics. Although presented as part of a coherent textual account to convey the findings of design work, these visual representations and inscriptions reveal as much the knowledges [4, 5] and assumptions involved (or not involved), as they do the organisation and stages through which their work has developed. For that reason, the visual inscriptions found within HRI become a means to study the ethics and values of the field, and may begin to offer a point of departure for understanding the types of representations more appropriate for ethically implicated robots.

While ethics indirectly inform all methodological approaches in research, there are particular aspects of for example, privacy and rights for those, who appear or are depicted. These become particularly important with visual images [6] and can pose challenges for both participants and researchers. My concern here is not however towards privacy issues of the informants of experimental arrangements albeit important, but to understand the wider interconnection between ethics and inscriptions within social robotics and consider its implications for design practice.

Based on a comprehensive literature review, Frennert and Östlund considered the different ethical positions taken towards social robotics pointing towards the ways in which users are “implicated but not present in the development of robots and that their matters of concern are not identified in the design process” [7, p. 299]. In other words, the ways in which users become represented and perceived during the robot design process. Furthermore they call for an understanding of how knowledge is “translated, transformed and modified in the field of social robotics” [7, p. 305]. This leads to a view that ethics and human values aren’t static aspects of social robotic design but are rather subject to change, transition and reformation. For ethics to have real implications for end users it becomes important they remain central and salient to design activity. These two concerns are taken up in this paper by considering:

i) To what extent are ethical aspects of robotic design revealed through visual inscriptions?

ii) What is required to ensure that ethics can be more robustly inscribed with HRI design processes?

2 Study

The data for the study comprises the visual inscriptions appearing in four successive years of published proceedings of the International Conference on Social Robotics (ICSR) [8–11]. This amounted to 277 papers with almost all containing one more examples of inscriptions such as photos, charts, diagrams, mathematical notation, illustrations and flowcharts. Taking a visual perspective to the papers research issues, they typically involve finding ways of representing problems straddling technical and human issues crossing aspects of mechanical and electronic design with aspects of psychology and behaviour. These papers commonly lead to insights regarding experimental setups and suggestions for improved systems and software design.

Seen as the presentation of multiple research objectives, methods and findings, these provide a view of roboticists’ visual practices and their associated reasoning. They reveal the ways in which knowledge, and insight into the developmental direction of HRI are stored visually, employed to extend cognitive abilities, used as a medium to communicate with themselves and others, and as triggers to reason about robot design problems [12–15].

The study identifies representations in four main visual classifications often appearing in the same paper, frequently in combination or close proximity that facilitates readings across multiple representations:

1. Photos of experimental arrangements usually showing the position of humans and or the physicality of the robots used or developed (Figures 1 and 2).
2. The representation of a visual ’gaze’ being established between humans and robotic artefacts (Figures 3 and 4).
3. Sequential images showing dynamically changing conditions (Figures 5 and 6).
4. Processural, graphic and diagrammatic schema typically showing aspects of computational logic, geometry or the arrangement of software architecture (Figures 7 and 8).

Figure 1: Experimental arrangement from [16].

Figure 2: Experimental arrangement from [17].

As researchers learn to make and understand these kinds of inscriptions in their particular and evolving problem spaces, they do so on a number of dimensions such as the cognitive, the social and the material [24]. On the cognitive level they need to be able to perceive in the inscriptions, meanings and associations related to their situated problems. Ethical concerns therefore, need to be in some manner discernible from a reading of the inscriptions they generate. Additionally they must develop the skills needed to combine and extend inscriptions in new ways as design work unfolds and alternative ways of perceiving situations are called for. Robot ethics is not a fixed or added-on aspect to research, but rather something intertwined and varying as opportunities and findings present themselves. Verschaffel and co-authors [25] point to the way inquires relying upon creative thinking need flexibility able to represent issues in multiple ways and provide scope for seeing connections amongst diverse ways of inscribing.

Figure 3: Establishment of 'gaze' from [18].

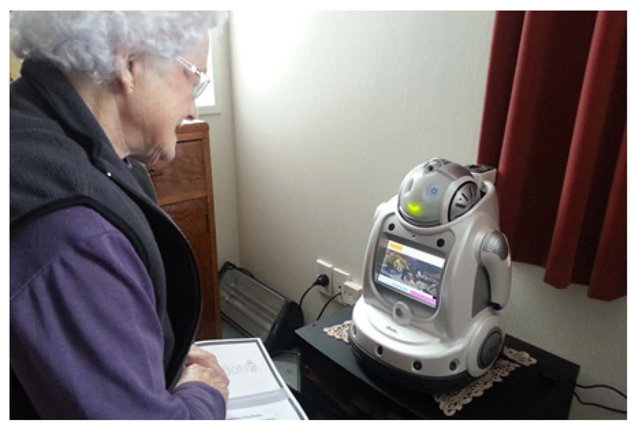


Figure 4: Establishment of 'gaze' from [19].

Figure 5: Image sequence from [21].

3 Methodology

In broad terms, visual ethnography is a methodology based on the consideration of the production, content and consumption of visual media rather than for example the direct observation or interviewing of participants. The

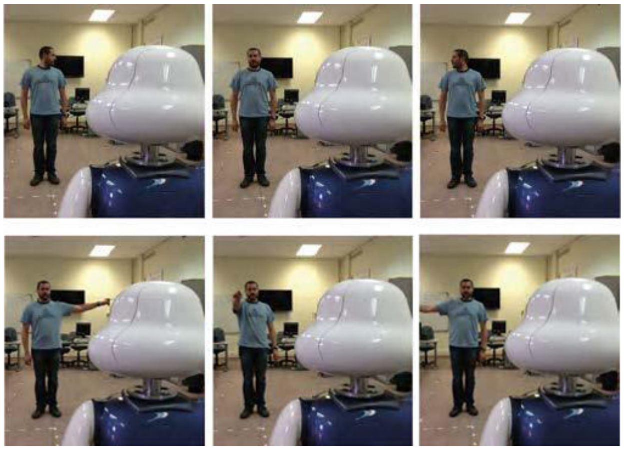


Figure 6: Image sequence from [20].

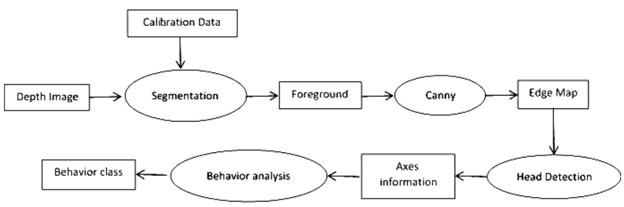


Figure 7: Diagrammatic schema from [22].

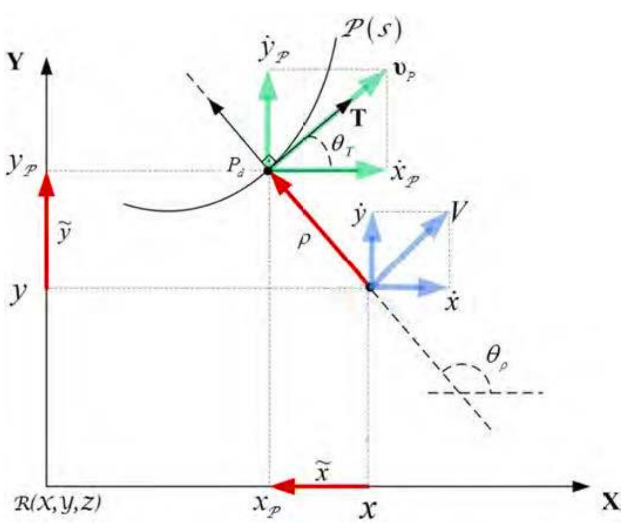


Figure 8: Diagrammatic schema from [23].

roots of visual ethnography lie in the use of film and photographic documentation for the identification and interpretation of cultural ideas and the provision of descriptive accounts. Adopted across a number of disciplines such as visual studies, semiotics, media and cultural studies, visual communication studies, visual ethnography and anthropology, as well as social semiotics and new literacies studies, it has led to a wide diversity in both application and focus. More recent approaches emphasis the role of the visual in processes of research and representation [26] and new configurations of relationships between images and words, as well as a range of new media. By adopting visual ethnography the aim here is to show how ethics are directly addressed through the meanings produced by the inscriptions made and employed in social robotics, and can therefore inform design practice.

The interest here in inscription is aligned with others who have turned attention to particular groups for which inscriptions play an integral part of their practice. These include such things as the blueprints and diagrams of engineers [27–29], the network diagrams of software engineers [30], computer screens of telecommunications controllers [31], artefacts of industrial designers [32], and inscriptions in architectural practice [33]. These studies go beyond simple descriptive accounts of visual materials to provide a deeper understanding of the social practices, relationships and knowledge [34] that inform the occupational cultures. For Kathryn Henderson, for example:

> "Examination of the construction and use of visual representations employed in many other kinds of work can reveal how access to information is controlled in ways that discriminate against some and empower others, how group cognitive work and its outcome is organized, and where centers of calculation and hence power are located in an organization or community," [28, p. 135].

The general approach to the content analysis of HRI images offered above presents one way of categorising visual inscriptions but by no means the only way. The difficulty to organise inscriptions into coherent categories [35] reflects the diversity resulting from a specificity of inscriptions and their relevance to researchers working in unique problem areas. From a social perspective, researchers need to establish agreement to the relationships the inscriptions have with the phenomena they are describing. This happens through interactions on a local scale, talking and negotiating [36] as well as through the publications of the field.

Although founded in the use of film for data collection, ethnographic analysis has extended across visual studies to include a view of scientific production [37] and the digital realm [38]. Visual ethnography has become a methodological approach in a range of disciplines spanning cultural studies, psychology, design and art research [39]. HRI publications such as the conference proceedings considered here present design work and robotic development within the paradigm of scientific experimentation. Through these conventions, inscriptions become a part of the scientific method such as the description of experimental arrangements and the presentation of data and findings. HRI researchers need therefore, to learn to mobilise their inscriptions as part of the scientific method within the heterogeneous communities of HRI. They become a part of different intersecting discourses joining multiple perspectives and diverse ways of creating and interpreting. Greeno and Hall [40] have shown the ways that inscriptions are used for constructing understanding on the one side and communicating and sharing it on the other. The particular challenge to the consideration of ethics as an aspect of HRI design, rather than as something that occurs separately, is finding ways it can become an active part of this meshing of multiple approaches and their interpretation and discovery.

The communicating and sharing within a community as large and global as HRI places challenges upon the shared interpretation of inscriptions and the ways conventions can become established. The structuring of proceedings through the conventions of scientific method may be questionable with an endeavour aimed at perfecting the making of material artefacts like robots, but it provides an established convention through which to share developmental insights. Engineering and design practices conducted outside of academic frameworks rarely adopt a science method approach in favour of organisational and procedural conventions mediating efficiencies of development and the satisfying of specification.

Figure 9: Example of layered modality from [41].

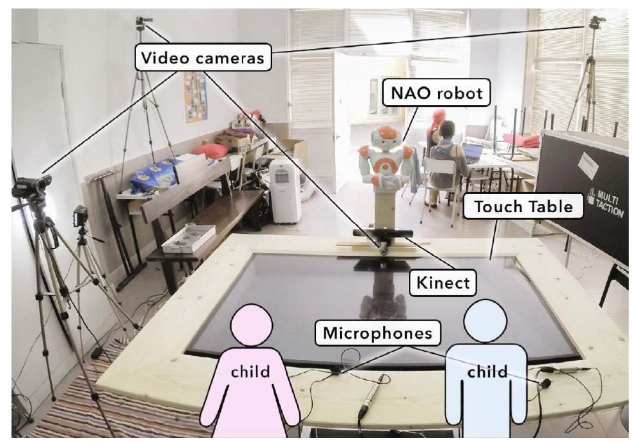


Figure 10: Example of layered modality from [42].

4 Findings

The four generalised classifications of visual inscriptions in social robotics offered above, although providing a visual perspective fail to show the complexities found within such a broad conceptual and experimental space. Rather than readily adhering to categorisation, inscriptions become hybridised formats or mixed modalities in which for example photographic, 3D modelling, schematic and computational elements become layered over one another.

This layering of graphical and visual formats occurs at the nexus of complex problem solving and the opportunities provided to researchers with digital tools and a widening awareness of visual media. Reliance upon representational diversity coincides with the developing focus in the 'multimodality' of literacy and communication, in response to changing social and material practices of communication, and with the overlapping of disciplinary boundaries. The use of digital video technology for example, provides duel and related opportunities with HRI. It offers input data for the development of robotic vision and image recognition through techniques and technologies such as sparsity recognition and modelling [43]. The visual inscriptions produced though these approached become opportunities for researchers to disseminate their findings, and explore new visual means of communicating and further developing their ideas.

Together with inscriptions made up of layered or hybridised formats, a common occurrence is the use of inscriptions placed in close proximity to one another. Whether this is intended or not by the authors, it results in intermingled relations established between them. Juxtaposition further contextualises representations by provoking the occurrence of differences and similarities between images [37]. Therefore, although the meaning of visual inscriptions are clearly constituted, at least in part, through the contextual elements they show, meaning and consequently values and assumptions are also informed by their particular juxtaposition, combination and sequencing. In other words, we consider their meanings as through produced across inscriptions [45]. Roland Barthes considered this by adopting the phrase "the third meaning" [46] and related it to the effects of film editing. The consequence of this 'third meaning' or juxtaposition upon the train of assumptions or rather epistemological leanings that result is considered in the following example from from D. Cazzato et al. [22]. The authors are developing a means to identify the occurrence of 'joint attention' established through the gesture and gaze of two people, a therapist and a child.

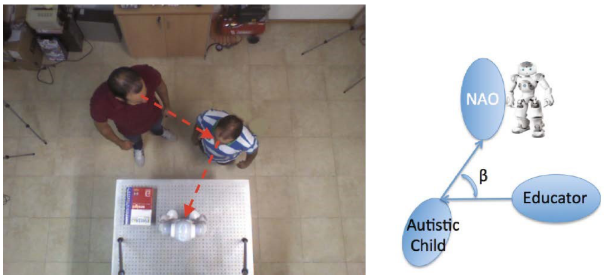


Figure 11: Juxtaposed inscriptions from [22].

On the left hand side of the inscription, a photograph taken with bird's eye perspective shows two people in front of a table with a robot on it. The person nearer the table is facing the robot and the other person on the left is facing him. From this perspective we are unaware of human aspects such facial expressions or direction of any human gaze adopted by the participants. We can infer their bodily stance and through their precise spatial organisation, as viewed from above, the scene appears a deliberate experimental arrangement and the result of careful positioning. The addition of dashed graphical arrows layered onto the photograph enhance the geometry of the scene and implies a specific direction of gaze by the two people. One established from the person to the robot and the other from the second person to the first. The direction of arrowheads suggesting, at least between the humans, that attention is focused in one direction only and consequently that human awareness of presence is not possible in the opposing direction, or in any wider spatial sense. Juxtaposed with this image is a graphical representation of the arrangement with an oval shape depicting each of the actors containing the designations of NAO (robot), Educator and Autistic child. Arrows are positioned between these shapes in the same configuration as the assumed gaze shown in the adjacent photograph. The angle established between these two arrows is denoted using the Greek letter beta. If considered in terms of a third meaning then the inscriptions are neither photographic nor geometric but present an epistemological operation with meaning transposed from one modality to another. The juxtaposition effectively visually authenticating the movement and reduction from human perception to a single geometric relation. The uncertainties of why and how two humans are positioned in space and relating to one another in the presence of a robot have become demobilised in the presence of algebraic certainty.

The emergence of this third visual space allows complex human situations to be simply understood and designed by means of crossing different modalities of visual communication. The movement from inscriptions able to reveal social and human orientations and ambiguities towards those suggesting mathematical and computational certainties becomes problematic when considering human values and ethics. It introduces an epistemological divide between what becomes 'seen' and 'unseen'. The 'seen' establishes the experimental argumentation and converges towards an unquestioning confirmation of computational and analytical order. Geometric certainty and algebraic operations become the 'context of experience' [47] within HRI, what Johanna Drucker calls a 'poetics of relations' [45]. On one level however, this can seem entirely reasonable given that the domain of computer science aims at producing working algorithms from concrete data. The 'unseen' however is qualitative human understanding and humanistic oriented inferences and interpretations that are ignored in favour of numerical and graphical ones. The overall visual aspect in scientific terms becomes assuredness and certainty. Visual ethnography provides an alternative view of complexity, ambiguity and vitality through revealing the presence of complex social and cultural values amid technological design and experimentation.

Whether from the professional or academic fields of robot development, the consideration of ethics as a part of inscriptional practice calls for shared explicit and implicit ways for sorting out human robotic issues and dilemmas through common vocabularies and codification systems. Building upon Goodwin's [48] insights about 'professional vision', Markauskaite & Goodyear [24] stress how learning to distinguish what relevant things need to be coded and inscribed involves developing a skilled set of methods and practices able to reveal certain features and aspects of a phenomenon as salient and distinguishable. What they term highlighting. For Latour [49] this means finding ways for 'knowledge discovery' to be possible through manipulation of the inscriptions themselves. This might be the equivalent of being able to contend with ethics simply through the consideration and writing of computer code. The complexities of designing for future states of human interaction require contending with multiple contingencies and situated understand that are not reducible to any single form of codified knowledge or representational modality. As pointed out by Latour and Woolgar [50], understanding phenomena in scientific work also depends upon material things, instruments and practices that are 'constituted by the material setting of the laboratory' (p. 64). As such, the inscriptions used to depict the arrangements of experimentation typically showing the robot in question in proximity with experimental subjects, become inscriptions of complex ethical meaning.

One of the difficulties encountered within the field of robot ethics is any agreement of what may in fact constitute ethical issues beyond for example well considered extreme cases centred on human safety and physical harm. A notable exception to this is the study of ethical issues in robot care for the elderly by Sharkey and Sharkey [51]. In their paper, the authors explore the issue of robot ethics from the perspective of how robots may alter human rights and shared human values. This draws upon aspects such as the physical and psychological welfare and the consideration of probable risks of reducing the social life and human contact of elderly people. They concluded with a range of 6 ethical concerns about the use of robots: (i) the potential reduction in the amount of human contact; (ii) an increase in the feelings of objectification and loss of control; (iii) a loss of privacy; (iv) a loss of personal liberty; (v) deception and infantilisation; (vi) the circumstances in which elderly people should be allowed to control robots. With these kinds of concerns in mind, it becomes interesting to apply visual ethnography to a photograph from a study by J. Welge and Hassenzahl [52] investigating aspects of companionship for elderly persons coping with loneliness.

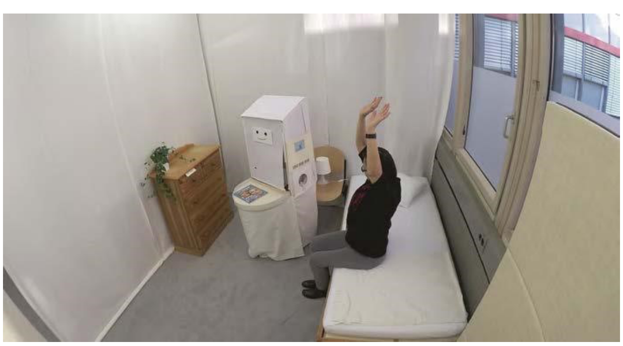


Figure 12: Experimental set up from [52].

The photograph presents us with an experimental set up, a scenario of a future case of robotic interaction between a human and a robot. The experimental space is an enclosed one with three visible sides. Two of the walls seem makeshift being constructed from stretched white sheets. The window on the right hand side appears to be the kind found in a public building, and the presence of a bed and two single articles of furniture strongly suggests a hospital room or some kind of care institution. Our view of this clinical space is from an elevated position looking down as if from a surveillance camera or maybe looking over the top of the unseen wall. The human, robot, bed and two pieces of furniture, a chest of drawers and chair, are all occupying the middle half of the image frame. The action of the scene occurs in an isolated part of the space and positions the viewer as an unseen onlooker. Perhaps not surprisingly if we see it as an objectively detached experiment! The wall and window on each side appear curved from the distortion of a wide-angle lens further accentuating a feeling of surveillance. This is a scene of the future in which robots are given to alienated subjects carefully observed by experimentalists.

The robot is directly in front of the person who is sitting on the bed. It is roughly constructed from paper and cloth with some kind of inner support that we are not able to see, and with a lower part resembling a bedside table with a magazine on it. The upright part is at a level higher than the seated person is, and has two images mounted on two adjacent sides. One of these is a simple smiley face drawn with two dots and a curved line. The second image consists of a blue rectangle, which could represent a small screen and a circle, which seems to suggest a hole with an arrow pointing into it. The hole is facing the human and the smiley is pointing towards the corner of the room. This is a prototype hastily constructed and therefore easily changed, but with clear design attributes and intentions. The person seated on the bed with knees together is facing the robot. The female figure is presented to us in the figure caption as a 'senior'. She is holding both arms in the air with the forward arm blocking most of her face. If we imagine the pose as being in-motion then it could appear as if she was exercising perhaps by following instructions given by the robot. If we see this as a more static pose, then the raised hands resemble someone who is being arrested and told to 'keep their hands up".

If we refer back to the ethical issues revealed by Sharkey and Sharkey [51] above, they are understandable though our ability to perceive how the presence of robots are able to influence human feelings. In consideration of this inscription, we can question whether it is able to invoke feelings through our analysis of the evident actions. Does for example the internal narrative of the image raise issues of human social relations. As a familiar image within HRI research, the answer may be no, although seen from a broader perspective with an external narrative of a future isolated from human contact, the answer may be yes. The researchers responsible for this inscription were only presenting it for their peers whereas its use in the context of this article involving visual ethnography and ethics means it is presented in another way and for a different audience. As stated by Marcus Banks "the multivocality of visual images means they can address different audiences in quite different ways, creating a problem of audiences" [53, p. 140]. In other words, the audience has a way of looking at inscriptions and if ethical concerns do not interest them then they will not be looking in that way. The particular compositional interpretation I provided here described something of the content and a spatial organisation of the image while also noting its expressive content through ideas of isolation and surveillance. I have not taken an intertextual [54] stance towards the image, considering it with reference to the author's text, but have instead chosen to follow my own interpretations. Doing this in light of Sharkey and Sharkey's ethical orientation means that my framing suggests, at least in part, visual equivalents for the findings of their study with robot having authority over the human in this otherwise dehumanised space.

5 Discussion

In an attempt to summarise the findings from the analysis above then these can be considered with reference to the proposed aims of the paper. Firstly related to i) to what extent are ethical aspects of robotic design revealed through visual inscriptions:

- Human values are diversely inscribed in social robotic design through an evolving visual culture rooted in forms of computational, design and technical representation produced through evolving media practices, technologies and techniques.
- Human values are embedded amid experimental and design concerns in multiple ways allowing scope for fluidity and the possibility of ambiguous and conflicting interpretation.
- Not confined to the content of individual inscriptions, human values are also embedded across different, and juxtaposed, visual modalities and forms of representation.

Secondly related to ii) what is required to ensure that ethics can be more robustly inscribed with HRI design processes:

- The inscription of ethics needs to acknowledge the complex and changing ways human values are interpreted. Concern and attention is called for to avoid technological deterministic readings of human situations and the tendency for computational certainty to discriminate over humanistic uncertainty.
- Understanding how multiple and layered images can shift the focus of values in ways that challenge what becomes seen and what remains hidden from view.
- A more robust inscription of human values in social robots necessitates a form of professional vision able to discover hidden complexities amongst the possible consequences of robots to all manner of human response, perception and sensibility.

Ethnography as the study and description of cultural groups can be applied as much to those within the field of HRI as to cultures intended to inform the progress of their research and development. The ethnographic study 'on' rather than 'in' HRI is able to shed light upon how they solve the complex problems of the field. HRI has a distinct visual culture, as do all scientific disciplines [55]. This visual culture is diverse integrating complex sets of information to illustrate phenomena that would be difficult or indeed impossible to describe in words [36]. As a sub field of computer science HRI is further imbued with computational signs, architectures and algorithms rarely considered in isolation but rather appearing in relation to other inscriptions providing a view of the social and epistemological phenomena of the field. HRI has therefore a particular way of seeing the world [28] linked to their material practices in achieving the goals of human machine interaction.

Visual inscriptions need to be accessible by researchers in ways that are appropriate to them in order to easily extract and manipulate information for their own needs. Visual inscriptions have the duel goal [55] of conveying information objectively about real world features such as how a robot is constructed, and secondly, doing this in a subjective form convenient for its transformation. For Larkin and Simon, the pioneers of AI, the advantage of visual over written communications was not a question of qualitative understanding but merely quantitative, allowing for an ease of informational retrieval at a glance. They conveyed this by referring to a reputed Chinese proverb that “a diagram is (sometimes) worth a Thousand words” [56, p. 34]. An ethnographic study of visual inscriptions within HRI draws upon the broad field of visual anthropology typically concerned with non-textual communication and the products of visual cultures [57].

The inclusion of the social sciences within HRI and the need to understand the ethics of human interaction with technology brings qualitative and contextual issues to the foreground. Whereas AI may have been largely a concern for quantifiable aspects, the recognition of societal and humanistic implications such as ethical and emotional responses to robotics points to the question of how such values can be included, objectified and manipulated. Warr et. al. [39] reveal the potential of ethical dilemmas and challenges associated with the descriptive and explicating character of images. Visual research methods may draw attention to private expressions of individuals that extend far beyond the intentions of the original media and necessitate ways to diminish any anxiety that this may cause. In this way, visual ethnography is in no way different from any other form of ethnography in being a qualitative means of investigation and analysis. Although the researcher is drawing upon different perceptual sensibilities, forms of knowledge and inscription, they are equally considering "the routine ways that people make sense of their world in everyday life" [58]. Ethnographic methodology refers to systematic ways that ethnographers apply social science techniques to their “looking, analysing, and reporting” [59]. The inscriptions presented by the field shed light upon the ways researchers make sense of, and find ways to achieve these goals. Concerned with the generation of a future state of human society their inscriptions provide a way to analyse their future imaginary and interpretations of what it is to improve life, and consequently what is involved with the quality of human life itself. This interplay of social and material innovation [60] requires ways to achieve just that, the interplay of technological and social understanding in actionable ways. Bringing social thickness and complexity back into the appreciation of technological systems has been a central aim of the field of science and technology studies (STS). It is from this field that the theme of inscriptions as a central element of knowledge practice emerged [24]. Focus turned to the ways scientific work and scientific knowledge become inseparable from the creation and sharing of inscriptions through documents such as research papers, protocols and presentations [50, 61, 62]. Inscriptions provide a way of making knowledge visible and integrating practices of collaboration and transformation [32]. Despite the focus upon the importance of inscription work within scientific and technological domains, the connections between knowledge work, inscription and visual literary remains poorly understood.

6 Conclusion

The focus of this study is the visual inscriptions within the field of social robotic interaction. This field is devoted to “improve quality of human life through assistance, enabling, for instance, independent living or providing support in work-intensive, difficult, and possibly complex situations....that enable social robots to have an impact on the degree of personalized companionship with humans” [11, p. v]. Despite these worthy aspirations a growing awareness for the need for ethics to play a more active role in the future development of robots raises questions as to how this can be achieved. The use of visual ethnography points to different approaches towards the analysis of inscriptions in this field, and challenges in determining and inscribing ethically oriented understanding.

In general terms, the study shows how the considerations of HRI designers are oriented towards their technical and computational needs and in so doing lead to an impoverished representation of human values and the ethical complexities of human interactions. It questions how knowledge and the visual realm are related within HRI in the ways pointed out by Johanna Drucker:

> “Visual knowledge is as dependent on lived, embodied, specific knowledge as any other field of human endeavour, and integrates other sense data as part of cognition. Not only do we process complex representations, but we are imbued with cultural training that allows us to understand them as knowledge” [45, p. 51].

Although acknowledging that all designers work occurs within certain domains of knowledge, the intention of the current paper is to draw attention to the ways in which this disparity or asymmetry of humanistic knowledge within the field of HRI occurs through the types and ways in which visual inscriptions are employed. Although HRI research strives to solve the technical barriers in pursuit of a better future assisted by socially engaged robots, there are dangers of successively diminishing the very representation of humanity and sociality it aims to support. If ethical, legal and societal issues are to be taken seriously by the HRI community then it would seem important to explore ways in which these can be implicated through practices of inscription and therefore actively conscripted [28] into design and experimentation. It would also seem that the field of visual studies and the approach of visual ethnography could prove to be beneficial in unearthing some of the complex assumptions involved within the shaping of technologies. In this way, fundamental ethical aspects of our human future can be tackled up front rather than being referred to as the ‘unintended consequences’ of unsuspecting engineers and computer scientists.

References

[1] J. van den Hoven, P. E. Vermaas, I. van de Poel, Design for values: An introduction, In: J. van den Hoven, P. E. Vermaas, I. van de Poel (Eds.), Handbook of Ethics, Values, and Technological Design, Springer, Dordrecht, 2015, 1-7

[2] J. Davis, L. P. Nathan, Value sensitive design: applications, adaptations, and critiques, In: J. van den Hoven, P. E. Vermaas, I. van de Poel (Eds.), Handbook of Ethics, Values, and Technological Design, Springer, Dordrecht, 2015, 11-40

[3] M. M. Bakhtin, Speech Genres and Other Late Essays, University of Texas Press, Austin, 2010

[4] K. Knorr Cetina, Sociality with objects: Social relations in post-social knowledge societies, Theory, Culture and Society, 1997, 14(4), 1-43

[5] K. Knorr Cetina, Objectual practice, In: T. R. Schatzki, K. Knorr Cetina, E. von Savigny (Eds.), The Practice Turn in Contemporary Theory, Routledge, London, 2001, 175-188

[6] R. Wiles, A. Clark, J. Prosser, Visual research ethics at the crossroads, In: E. Margolis, L. Pauwels (Eds.), The SAGE Handbook of Visual Research Methods, SAGE Publications, London, 2011, 685

[7] S. Frennert, B. Östlund, Review: Seven matters of concern of social robots and older people, International Journal of Social Robotics, 2014, 6(2), 299-310

[8] G. Herrmann, M. Pearson, A. Lenz, P. Bremner, A. Spiers, U. Leonards (Eds.), Social Robotics, Proceedings of the 5th International Conference on Social Robotics (ICSR 2013), Bristol, UK, October 27-29, 2013, Lecture Notes in Artificial Intelligence, vol. 8239, Springer, Cham, 2013

[9] M. Beetz, B. Johnston, M.-A. Williams (Eds.), Social Robotics, Proceedings of the 6th International Conference on Social Robotics (ICSR 2014), Sydney, NSW, Australia, October 27-29, 2014, Lecture Notes in Artificial Intelligence, vol. 8755, Springer, Cham, 2014

[10] A. Tapus, E. André, J. C. Martin, F. Ferland, M. Ammi (Eds.), Social Robotics, Proceedings of the 7th International Conference on Social Robotics (ICSR 2015), Paris, France, October 26-30, 2015, Lecture Notes in Artificial Intelligence, vol. 9388, Springer, Cham, 2015

[11] A. Agah, J. J. Cabibihan, A. M. Howard, M. A. Salichs, H. He (Eds.), Social Robotics, Proceedings of the 8th International Conference on Social Robotics (ICSR 2016), Kansas City, MO, USA, November 1-3, 2016, Lecture Notes in Artificial Intelligence, vol. 9979, Springer, Cham, 2016

[12] G. Goldschmidt, The dialectics of sketching, Creativity Research Journal, 1991, 4(2), 123-143

[13] G. Goldschmidt, On visual design thinking: the vis kids of architecture, Design Studies, 1994, 15(2), 158-174

[14] D. A. Schön, G. Wiggins, Kinds of seeing and their functions in designing, Design Studies, 1992, 13(2), 135-156

[15] M. Suwa, J. Gero, T. Purcell, Unexpected discoveries and S-invention of design requirements: important vehicles for a design process, Design Studies, 2000, 21(6), 539-567

[16] A. Ioannou, I. Kartapanis, P. Zaphiris, Social robots as cotherapists in autism therapy sessions: a single-case study, In: A. Tapus, E. André, J. C. Martin, F. Ferland, M. Ammi (Eds.), Social Robotics, ICSR 2015, Lecture Notes in Computer Science, vol. 9388, Springer, Cham, 2015, 255-263

[17] M. Lewis, E. Oleari, C. Pozzi, L. Cañamero, An embodied AI approach to individual differences: supporting self-efficacy in diabetic children with an autonomous robot, In: A. Tapus, E. André, J. C. Martin, F. Ferland, M. Ammi (Eds.), Social Robotics, ICSR 2015, Lecture Notes in Computer Science, vol. 9388, Springer, Cham, 2015, 401-410

[18] Y. M. Foong, X. Liu, S. S. Ge, J. Guo, Mechanical design of Christine, the social robot for the service industry, In: A. Agah, J. J. Cabibihan, A. M. Howard, M. A. Salichs, H. He (Eds.), Social Robotics, ICSR 2016, Lecture Notes in Computer Science, vol. 9979, Springer, Cham, 2016, 819-828

[19] J. R. Orejana, B. A. MacDonald, H. S. Ahn, K. Peri, E. Broadbent, Healthcare robots in homes of rural older adults, In: A. Tapus, E. André, J. C. Martin, F. Ferland, M. Ammi (Eds.), Social Robotics, ICSR 2015, Lecture Notes in Computer Science, vol. 9388, Springer, Cham, 2015, 512-521

[20] V. Gonzalez-Pacheco, M. Malfaz, J. C. Castillo, A. Castro-Gonzalez, F. Alonso-Martín, M. A. Salichs, How much should a robot trust the user feedback? Analyzing the impact of verbal answers in active learning, In: A. Agah, J. J. Cabibihan, A. M. Howard, M. A. Salichs, H. He (Eds.), Social Robotics, ICSR 2016, Lecture Notes in Computer Science, vol. 9979, Springer, Cham, 2016, 190-199

[21] A. Meghdari, M. Alemi, A. G. Pour, A. Taheri, Spontaneous human-robot emotional interaction through facial expressions, In: A. Agah, J. J. Cabibihan, A. M. Howard, M. A. Salichs, H. He (Eds.), Social Robotics, ICSR 2016, Lecture Notes in Computer Science, vol. 9979, Springer, Cham, 2016, 351-361

[22] D. Cazzato, P. L. Mazzeo, P. Spagnolo, C. Distante, Automatic joint attention detection during interaction with a humanoid robot, In: A. Tapus, E. André, J. C. Martin, F. Ferland, M. Ammi (Eds.), Social Robotics, ICSR 2015, Lecture Notes in Computer Science, vol. 9388, Springer, Cham, 2015, 124-134

[23] V. H. Andaluz, D. Pérez, D. Sáchez, C. Bucay, C. Sáchez, V. Morales, D. Rivas, Nonlinear controller of arachnid mechanism based on Theo Jansen, In: A. Agah, J. J. Cabibihan, A. M. Howard, M. A. Salichs, H. He (Eds.), Social Robotics, ICSR 2016, Lecture Notes in Computer Science, vol. 9979, Springer, Cham, 2016, 328-339

[24] L. Markauskaite, P. Goodyear, Epistemic Fluency and Professional Education: Innovation, Knowledgeable Action and Actionable Knowledge, Springer, Dordrecht, 2017

[25] L. Verschaffel, E. de Corte, T. de Jong, J. Elen (Eds.), Use of Representations in Reasoning and Problem Solving Analysis and Improvement, Routledge, London, 2010

[26] S. Pink, Digital visual anthropology: Potentials and challenges, In: A. I. Alfonso, L. Kurti, S. Pink (Eds.), Working Images: Visual Research and Representation in Ethnography, Routledge, New York, 2004, 1

[27] K. Henderson, The visual culture of engineers, In: S. L. Star (Ed.), The Cultures of Computing, Blackwell, Cambridge, 1995

[28] K. Henderson, On Line, on Paper: Visual Representations, Visual Culture, and Computer Graphics in Design Engineering, MIT Press, Cambridge, 1999

[29] L. L. Bucciarelli, Designing Engineers, MIT Press, Cambridge, 1994

[30] S. E. Newman, Here, there, and nowhere at all: Distribution, negotiation, and virtuality in postmodern ethnography and engineering, Knowledge and Society, 1998, 11, 235-267

[31] J. Hindmarsh, C. Heath, Sharing the tools of the trade: The interactional constitution of workplace objects, Journal of Contemporary Ethnography, 2000, 29(5), 523-562
[32] J. Wallace, Different matters of invention: design work as the transformation of dissimilar design artefacts, PhD dissertation, Aarhus University, Copenhagen, Denmark, 2010
[33] J. K. Whyte, B. Ewenstein, M. Hales, J. Tidd, Visual practices and the objects used in design. Build. Res. Inf., 2007, 35(1), 18
[34] S. Pink, D. Tutt, A. Dainty, A. Gibb, Ethnographic methodologies for construction research: knowing, practice and interventions, Building Research and Information, 2010, 38(6), 647-659
[35] J. Elkins, The Domain of Images, Cornell University Press, Ithaca, 2001
[36] W. M. Roth, M. K. McGinn, Inscriptions: Toward a theory of representing as social practice, Review of Educational Research, 1998, 68(1), 35-59
[37] H. U. Gumbrecht, Perception versus sciences: Moving pictures and their resistance to interpretation, In: T. Lenoir (Ed.), Inscribing Science: Scientific Texts and the Materiality of Communication, Stanford University Press, Stanford, 1998, 351-364
[38] H. A. Horst, D. Miller (Eds.), Digital Anthropology, A&C Black, London, 2013
[39] D. Warr, M. Guillemin, S. Cox, J. Waycott, Ethics and Visual Research Methods – Theory, Methodology, and Practice, Palgrave Macmillan US, Basingstoke, 2016
[40] J. G. Greeno, R. P. Hall, Practicing representation: Learning with and about representational forms, Phi Delta Kappan, 1997, 78(5), 361-367
[41] J. R. Orejana, B. A. MacDonald, H. S. Ahn, K. Peri, E. Broadbent, Healthcare robots in homes of rural older adults, In: A. Tapus, E. André, J. C. Martin, F. Ferland, M. Ammi (Eds.), Social Robotics, ICSR 2015, Lecture Notes in Computer Science, vol. 9388, Springer, Cham, 2015, 512-521
[42] P. Alves-Oliveira, T. Ribeiro, S. Petisca, E. Di Tullio, F. S. Melo, A. Paiva, An empathic robotic tutor for school classrooms: considering expectation and satisfaction of children as end-users, In: A. Tapus, E. André, J.-C. Martin, F. Ferland, M. Ammi (Eds.), Social Robotics, ICSR 2015, Lecture Notes in Computer Science, vol. 9388, Springer, Cham, 2016, 21-30
[43] H. Cheng, Z. Liu, L. Yang, X. Chen, Sparse representation and learning in visual recognition: Theory and applications, Signal Processing, 2013, 93(6), 1408-1425
[44] R. Coover, Interactive media representation, In: E. Margolis, L. Pauwels (Eds.), The SAGE Handbook of Visual Research Methods, SAGE Publications, London, 2011, 619-638
[45] J. Drucker, Graphesis: Visual Forms of Knowledge Production, Harvard University Press, Cambridge, 2014
[46] R. Barthes, The third meaning, In: S. Manghani, A. Piper, J. Simons (Eds.), Images: A Reader, SAGE Publications, London, 2006, 109
[47] J. Berger, J. Mohr, Another Way of Telling, Pantheon, New York, 1982
[48] C. Goodwin, Professional vision, American Anthropologist, 1994, 96(3), 606-633
[49] B. Latour, Drawing things together, In: M. Lynch, S. Woolgar (Eds.), Representation in Scientific Practice, MIT Press, Cambridge, 1990, 19-68
[50] B. Latour, S. Woolgar, Laboratory Life: The Social Construction of Scientific Facts., SAGE Publications, Beverly Hills, 1979
[51] A. Sharkey, N. Sharkey, Granny and the robots: ethical issues in robot care for the elderly, Ethics and Information Technology, 2012, 14(1), 27-40
[52] J. Welge, M. Hassenzahl, Better than human: about the psychological superpowers of robots, In: A. Agah, J. J. Cabibihan, A. M. Howard, M. A. Salichs, H. He (Eds.), Social Robotics, ICSR 2016, Lecture Notes in Computer Science, vol. 9979, Springer, Cham 2016, 993-1002
[53] M. Banks, D. Zeitlyn, Visual Methods in Social Research, SAGE Publications, Thousand Oaks, 2015
[54] G. Rose, Visual Methodologies: An Introduction to Researching with Visual Materials, SAGE Publications, London, 2016
[55] K. Hentschel, Visual Cultures in Science and Technology: A Comparative History, Oxford University Press, Oxford, 2014
[56] J. J. Larkin, H. A. Simon, Why a diagram is (sometimes) worth ten thousand words, Cognitive Science, 1987, 11, 65-69
[57] S. Pink, Digital visual anthropology: Potentials and challenges, In: M. Banks, J. Ruby (Eds.), Made to be Seen: Perspectives on the History of Visual Anthropology, University of Chicago Press, Chicago, 2011, 209-233
[58] P. Atkinson, M. Hammersley, Ethnography and participant observation, In: N. K. Denzin, Y. S. Lincoln (Eds.), Handbook of Qualitative Research, SAGE Publications, Thousand Oaks, 1994, 248-261
[59] C. Denton, Examining documentary photography using the creative method, In: K. L. Smith, S. Moriarty, K. Kenney, G. Barbatsis (Eds.), Handbook of Visual Communication: Theory, Methods, and Media, Routledge, London, 2005, 405-428
[60] S. Jasanoff, S. H. Kim (Eds.), Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power, University of Chicago Press, Chicago, 2015
[61] K. Knorr Cetina, Epistemic Cultures: How the Sciences Make Knowledge, Harvard University Press, Cambridge, 1999
[62] H. Rheinberger, Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube, Stanford University Press, Stanford, 1997

Paladyn, J. Behav. Robot. 2019; 10:128–139 DE GRUYTER

Research Article Open Access

Niels Christian Mossfeldt Nickelsen*

Imagining and tinkering with assistive robotics in care for the disabled

DOI: https://doi.org/10.1515/pjbr-2019-0009
Received May 28, 2018; accepted January 21, 2019

Abstract: The media and political-managerial levels focus on the opportunities to re-perform the Scandinavian welfare states through digitization. Especially in Denmark, this trend is prominent. Welfare technology is a Scandinavian notion used to point at assistive technologies intending to support the elderly, the disabled and care providers. Feeding assistive robotics (FAR) is a welfare technology relevant to citizens with no or low function in their arms. Despite national dissemination strategies, it proves difficult to recruit suitable users. There have been many promises for the potential of assistive robotics including more cost-efficient healthcare delivery, engaged patients and connected care providers. However, the realities of enacting assistive robotics, whether as patients or care providers, can be complicated in ways often unanticipated by government agencies and technology developers. This study discusses governmental agencies' and technology developers' visions with regard to what robotics may do and argues that these visions intertwine with affected stakeholders' organizing of their worlds. On this founding, the article discusses the resulting tinkering during implementation. The study exemplifies and demonstrates how ethnography can be used as an important method in Human Robot Interaction (HRI) research. The Actor Network Theory idea of 'follow the actor' inspired the study that took place as multi-sited ethnography at different locations in Denmark and Sweden. Based on desk research, observation of meals and interviews the study examines sociotechnical imaginaries and their practical and ethical implications. Human and FAR interaction demands engagement, sustained patience and understanding of the citizen's particular body, identity and situation. The article contributes to the HRI literature by providing detailed empirical analysis based on an ethnographic study where political strategies, technology developers' assumptions and affected stakeholders' everyday hassles are in focus at the same time.

***Corresponding Author: Niels Christian Mossfeldt Nickelsen:** School of Education, Aarhus University, Denmark;
E-mail: ncmn@dpu.dk

Keywords: sociotechnical imaginaries, tinkering, STS, assistive robotics, care work

1 Introduction

Based on an ethnographic study this article explores the relation between the health political vision of assistive robotics and ongoing transformation in care for the disabled. Citizens with low or no function in their arms are currently obvious candidates to use feeding assistive robotics (FAR). The Danish strategy for implementation of digital solutions and welfare technologies issued by the Danish government, the regions and the Danish municipalities in 2013 [1] states FAR may both enhance vulnerable citizens' self-reliance and ameliorate the care providers' working environment. The notion of welfare technology point at assistive technologies intending to support the elderly, the disabled and care providers (CPs). As part of this, FAR is endorsed based on a business case carried out in 2011-2013 [2]. It proves difficult to recruit suitable citizens, and to sustain use over an extended period [3, 4]. As early as in 1936, Charlie Chaplin envisioned mechanized feeding. In 'Modern Times' his little vagabond struggles to survive in the modern, industrialized world during the depression and is hired at a factory. As part of this imaginary, he is fed his lunch by crude machinery and, thus, Chaplin showed, according to him, the horrible conditions of efficient modern industrialization. The use of FAR in care for the disabled is obviously much less sinister, but it still presents a complication of the relations between the technology, users, and CPs. Arguably, in order to ensure ethical and responsible development of assistive robotics, there appears to be too much distance between policy makers, technology developers and affected stakeholders. This has likely to do with conflicting value systems that undermine the full use of the technology and hinder unfolding of potentials. In order to ensure ethical and responsible development of robotics, technology developers and affected stakeholders need to communicate more. In a comprehensive and thought-provoking review of ten pivotal ethnographic studies on the nature of the task of feeding dependent bodies [5] two consistently emerging tropes among CPs 'feeding as task' and 'feeding as relationship' are identified. Despite the fact that the task of feeding dependent bodies constitutes a common activity in many health care settings, it enjoys surprisingly little interest from researchers and practitioners. During the last decades, it appears that manual feeding is eliminated from nurses' responsibilities and relegated to non-professional staff because it is increasingly seen as 'an efficiency task' and not a valued opportunity of 'the art of nursing'. It has, in other words, become low status and, thus, it is now an obvious candidate for being supported by robotics.

Some groups have made compelling arguments and presented digital health technologies and robotics in a favorable light as the healthcare of the future [6]. There have been many promises for the potentials of these technologies including more cost-efficient healthcare delivery, engaged patients and connected health professionals [7]. Yet, the realities of enacting robotics, whether as patients or CPs, can be messy, uncertain and complicated in ways often unanticipated by policy makers, technology developers, and other advocates [8]. As a response to this, the research questions of this study are; 1. How do various stakeholders actively organize their worlds of action with assistive robotics? 2. How do visions and practices among government agencies, technology developers, CPs and users entangle in ongoing transformation in care for the disabled? In order to discuss this I draw particularly on Mol, Moser and Pols [9], and Jasanoff and Kim [10], and I present a case study of implementation of 'Bestic' - the second generation of FAR. An example of the first generation FAR is the British 'Neater Eater Robotics', which has been claimed to be noisy and take up space in the environment of its user. In this sense, it prescribes the user scenario and allots new tasks and responsibilities to the CPs [11]. Recently, second generation of FAR, the Swedish 'Bestic', has appeared on the market. Bestic is an electric spoon that is adapted to the user and quietly lifts the food up to the mouth. It is designed to help people who cannot use their arms when they eat. The user controls it with a button placed strategically in relation to the user's impairment. It can, for instance, be on the table where it can be controlled with the elbow. All meals can be eaten with Bestic. Bestic scrapes the bottom of the spoon on the plate, so the user does not waste. It folds easily together after the meal. Moreover, Bestic can easily be carried around in a handy carrying backpack. A fully charged battery can last a full day. In relation to the Neater-Eater robotics, Bestic is more mobile, leaner, and technologically advanced. In addition, it appears easier to manage for users and CPs. See Figure 1. This study highlights the visions, ethics and performed practices of government agencies, technology developers, and affected stakeholders in relation to implementation of Bestic.

Fig. 1. Pictures of Bestic 1 (left) and 2 (right).

2 Methods

2.1 Analytic inspiration and literature

Using material semiotics [11–13] as an analytic resource, this study draws on the Actor Network Theory idea of 'follow the actor' throughout the empirical work [14]. The analysis combines the notions of sociotechnical imaginaries and care as tinkering. The sociotechnical imaginaries in relation to FAR are scrutinized [15, 16] in combination with the attunement and tinkering involved in adapting and forming new routines in relation to the implementation of Bestic. To use these two notions in combination is an analytical point of this paper that tells us about the political visions of health robotics and, at the same time, about the implied transformations in practice among affected stakeholders, i.e. users and CPs.

The notion of sociotechnical imaginaries draws on science and technology studies (STS). This notion is defined as: '[The] collectively held, institutionally stabilized and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through and supportive of, advances in science and technology' [17, p. 153]. The naming of the concept of sociotechnical imaginaries indicates links to both political theory [18] as well as STS. The compound nature of this concept is intentional as it is an attempt to overcome the, arguably, excessive focus on the individual scientist and particularities of locality. Focusing on the sociotechnical imaginaries involved in FAR, invites the reader to dive into the relationship between imaginary in terms of applications of science and technology and the practical effects of this imaginary in mundane everyday life. Importantly, the notion of 'sociotechnical imaginaries' differ from 'discourse' or 'master narrative' by focusing, not predominantly on language, but specifically also on the relation between anticipations of the future and performed relations. Moreover, sociotechnical imaginaries differ from the notion of 'culture' by being less monolithic and by sociotechnical imaginaries being both contested and conflictual propositions. Various actors hold different sociotechnical imaginaries that shift when enacted in practice.

Sociotechnical imaginaries are interesting in relation to health care robotics because it suggests analyses that combines politics and interpersonal action and links structure and agency by putting together prescribed futures and practices that people aim to obtain or believe they ought to obtain. Therefore, I analyze sociotechnical imaginaries in regards to FAR as illustrations of ongoing re-imagination and re-performance of the Danish state and its institutions that have tangible implications for the everyday enactment of care for vulnerable citizens [16]. The sociotechnical imaginaries such as 'Denmark as a digital pioneer', 'Danes as world champions in digitalization currently penetrate the political-administrative landscape and discourses in the media [19]. Denmark has traditionally had an agricultural economy. In present times, focus is on the opportunities for Denmark to re-perform itself by way of digitization. Thus, every government funded financial and economic stimulus package leads more money into digitization, automation and shared economy. In order to promote this development, the Danish prime minister is currently the chairperson for the national Disruption Council in which leading officials and experts work to find potentials to use digitization in an increasing number of areas. As part of this imaginary four highly profiled welfare technologies are implemented on a national scale (FAR being one of them) to provide a modern care-infrastructure characterized by increased independence for users, better work environment for CPs and reduced costs [20, 21].

These strategic and political acts are elements in a sociotechnical imaginary on a national scale, but such imaginaries are not only ideals and intentions. They also engrain in practice on an everyday level when CPs and citizens enact the sociotechnical imaginaries in using FAR. By combining analyses of political level documents with observation and interviews with technology developers and affected stakeholders an analysis of imaginaries is in line with the ambitions of Latour of analyzing complex phenomena by both localizing the global and intangible and, likewise, globalizing the local by analyzing how particularities are linked to wider phenomena [22]. Moreover, an analytic focus on sociotechnical imaginaries not only puts focus on the here and now, but also includes the desirable futures and values towards which actors orient themselves. In that sense, sociotechnical imaginaries are performed value systems.

When seeking to understand care innovation in relation to the sociotechnical imaginaries of assistive robotics it is crucial to situate care workers' conduct not just in their relations with users/citizens, but also in all their relations. Focus must be broader than the discursive dimension; one must analyze the care workers values and how they practically organize their world of work through symbolic meanings and categorizations such as 'empathy', 'communication' or 'the body'. It is necessary to study their agency and modes of ordering [23, 24]. A number of leading researchers [9] propose that care work is a matter of attentive tinkering with arrangements of people and technical aids. Winance [25] has demonstrated the tinkering and experimenting involved in adapting wheelchairs for the disabled. Tinkering, she argues, is to shape and arrange humans and non-humans in ways that suit them. It is a matter of arranging people and technical aids and continually to change tiny details to ensure that the collaboration between humans and non-humans work optimally. Thus, according to Winance, care is not merely something a CP gives to a patient, an elderly or a disabled person. Rather, care is continuous experimenting with people and things. It is to shape, arrange and rearrange details. In this perspective, we are all both subjects and objects of care. This is interesting because it opens up the possibility that technology, not only constitute an aid (or hindrance) to the user, but also to the care worker.

Therefore, the notion of tinkering has comprehensive implications for how to analyze the relation between assistive robotics, technology developers, users and CPs. Instead of casting care and technology as opposed, as respectively 'warm' and 'cold', technology is just another part of care work that leads to movement. Technology simply adds to what is already there. Certain arrangements of humans and technical aids make competent users and others make incompetent users [26]. In this way, material semioticists [9] seek to rethink and reframe care and technology together. In other words, material semiotics seek to disturb, complicate and contribute to the care-technology relation. What do CPs, for instance, do with the technology they face? Tinkering is a crucial notion that helps focus on care workers active organizing of their participation in care innovation.

Another important material semiotic work problematizes the assumption that care work can be measured and defined outside the practice of caring [27]. This obviously refers to discussions in regards to accountability and evidence-based practice. I find that a national strategy and rollout plan for the use of FAR in 98 Danish municipalities exemplifies an accountability process in the sense that it embraces centrally defined assumptions of best practice. The key in relation to this analysis is that the use of FAR is defined outside the practice of caring and as such forms a sociotechnical imaginary of a golden standard. However, according to material semiotics there is no singular, shared form of care. Instead, they propose, we should try to understand 'multiple care' as this performs in different sites of care. In addition, they argue that improvement of care, in general terms, is not something that has to pass a golden standard or an outside judgement. Rather it is something that takes place as attuned attentiveness as part of care itself.

2.2 Why FAR?

This study focuses on FAR and particularly Bestic for a number of reasons. Firstly, due to the often high and widely expressed potential that is notably still unprecedented. Secondly, because the intimacy and the close human-machine encounter makes FAR an interesting case in relation to the issue of human-machine proximity as well as health robotics and future imaginaries more broadly. Thirdly, because of the paradox that FAR, in many observers' eyes, is immediately controversial, yet still broadly endorsed and implemented by the authorities.

2.3 Design of the case study

The empirical study comprises qualitative data in relation to implementation of FAR. The study is designed as a multi-sited case study at different locations in Denmark and Sweden [28, 29]. The notion of 'multi-sited' [30] designates that ethnographers increasingly move from conventional single-site location, contextualized by macro-constructions of a larger social order, such as capitalism, to multiple sites of observation and participation that crosscut dichotomies such as the local and the global, the lifeworld and the system. Resulting ethnographies are therefore both in and out of the world system. The appearance of multi-sited ethnography is located within new spheres of interdisciplinary work including, for instance, STS, cultural studies and media studies. By taking advantage of multi-sited ethnography, this study examines the relationship between politicians and technology developers' sociotechnical imaginaries as well as the practical use and implications of robotics. The methodological combination of following the actor and multi-sited ethnography made it possible to untangle a network of pivotal actors with regard to the application of FAR in a Danish rural municipality. The data collection consisted of desk research, observations and interviews. Alongside reading of public documents, the data collection consisted overall of the observation of three meals and 16 semi-structured interviews that took between 30 and 120 minutes. Two interview guides were developed for technology developers and affected stakeholders. The interviews were recorded on a Dictaphone and a research assistant transcribed all of them verbatim.

2.4 Government

First, I interviewed an official in Local Government Denmark (LGDK), the association of municipalities about the making and faith of LGDK's national welfare technology plan encompassing a plan for financial savings (2014-2017) [31]. LGDK systematically monitors implementation of welfare technologies in Danish municipalities. Internationally, it is extraordinary that Danish policymakers launch and control national rollout plans of assistive robotics. This likely has to do with the fact that Denmark is a small country and that Denmark has a universal health care system. Although Sweden also has a universal welfare system, they have no centrally controlled dissemination of welfare technology. In the Netherlands, they would never launch such a strategy due to a much more privatized and negotiated health care system.

2.5 Technology developers

The interview at LGDK was followed by an interview with Careware, the distributor of Bestic in Denmark and with the CEO and the developing engineer in Camanio Care, Stockholm (the producer of Bestic). The former interview was about the functionality of Bestic and the dissemination in all Danish municipalities. The latter interviews were about the design process and ethical considerations with regard to the practical use of Bestic. I first questioned the CEO and the developing engineer about the technical components and functions of Bestic. For example, one question was, why was Bestic developed? In addition, I asked about the design process and evaluations of technological readiness. Lastly, I asked about challenges, any unintended effects, and relations to policy makers and users. The technology developers' assumptions are less emphasized in the following analysis than the governments', the CPs', and the users'. This is because access to technology developers appeared to be difficult, and because more written material was found about the government agency perspective.

2.6 Care providers

I interviewed the head occupational therapist in a rural municipality about the local assistive robotics strategy. This gave access to a number of very interesting informants, i.e. directly affected stakeholders. Overall, eight CPs were interviewed - four CPs at home institutions and four CPs at day care centers. Six of these interviewees are formally educated as pedagogues. Two are care assistants. In this article, I, consequently, denominate all eight people 'CPs'. All mentioned names are pseudonyms in order to anonymize the informants' identities. I interviewed users and CPs in close relation to the observation of meals. I will expand more on the precise questions and method in the next section.

2.7 Observation of meals followed by interviews with users and care providers

The two users I observed and interviewed both have difficulty speaking, and since it is difficult to understand, I observed meals in combination with interviews with users and their CPs. The CPs could then immediately make sense of difficult sentences. The users both suffer from cerebral palsy. I observed Tonni eat with Bestic three times (three meals). I started my investigations in the day care center by interviewing Tonni and the occupational therapist together. Later, in relation to the observation I interviewed Tonni and three day care center CPs directly involved in Tonni's daily care. Furthermore, I observed Tonni eat his dinner in the home institution followed by an interview with Tonni and two home-institution CPs. Tonni was enthused by the autonomy the FAR gave him. Later, I got access to Tanja. Recently, she stopped using Bestic due to multiple problems. I found this span of experiences with Bestic interesting. First, I interviewed her and a CP at the day care center. Later, I visited Tanja at the home-institution where I also interviewed two CPs supporting her specifically about the decision to stop using Bestic.

In all of the mentioned interviews with the directly affected stakeholders, the functional and ethical issues, everyday use in practice, implementation and emerging routines were in focus. These interviews worked as further inquiry into the observations of the preparation, context and process of the meal. I asked about the FAR-meal as a worksite compared to the pre-robotics meal worksite. Thus, the focus was on: 1. Routines and changes of routines in relation to implementation of Bestic, 2. Any observed changes in the CP-user relationship, 3. Quality delivered to and experienced by the user. Apart from the meals with Bestic, I also observed traditional feeding meals. Two meals were at the day care center and one at Tonni's home institution. During the meals, I was sitting right in front of Tonni with a notebook and a cellphone. In advance, I had obtained permission to take photos and make small video recordings. Having in mind that eating is quite intimate; this set-up was perhaps excessive. It was supposed to support memory, analysis and detailed communication. From this position, I could observe and inquire into all aspects of the meal. I presented myself as a robotics researcher and all of my informants explicitly accepted my attendance and the set-up. The users and CPs unanimously reported they found it important to communicate their experiences. The interest during observation focused on the performance of the robotics, the CP's organization of the meal and the user's interaction with FAR. I was interested in what they did and what they talked about during the meal, how they treated the food, and how long a meal took. Before, during and after the meal I observed and noted as much as possible. I also talked with the users and the CPs to elaborate as much as I could on the observations.

I coded all the interviews by a simple read/re-read and highlighter approach along two themes: 1. CPs tasks and change of tasks in relation to the robotics meal, 2. Changes in the relation between CPs and users due to robotics. Then, I analyzed this material with the research questions in mind.

I found much inspiration in the notions of sociotechnical imaginaries and tinkering. By drawing analytically on Jasanoff and Kim and Mol, Moser and Pols, I followed the FAR around in various sites in order to explore how sociotechnical imaginaries on behalf of the government and technology developers have effects and interfere with implementation of Bestic. Desk research and interviewing of officials, the Camanio Care CEO and developing engineer relates in particular to mapping of sociotechnical imaginaries, whereas interviewing and observation of CPs and users relates in particular to tinkering and the implicated transformations in everyday practice of Bestic.

This method section does not intend to position these findings as universally generalizable, nor does it intend to confound assistive robotics in general with the specificities of FAR/Bestic. Currently, health care robotics, consist of a row of different set-ups and affordances [32]. My interest comes out of curiosity in relation to an ongoing national strategic implementation of welfare technology. Thus, my aim is to criticize and contribute to continued responsible, ethical and solid implementation of assistive robotics.

3 Results

A complex case study always has multiple facets, and focusing on any of these will necessarily foreground some aspects and marginalize others [33]. My approach to 'results' is to present a case of multiple intersecting sociotechnical imaginaries. The master narrative of 'Danes as world champions in technology' is evident throughout the case, and it's relevant point of origin is different government agencies. In 2014 LGDK established the 'Center for Welfare Technology', an office with the task to continuously produce outcome measures for the dissemination of robust welfare technology in the municipalities based on convincing business cases. Thus, they figured out the following welfare technologies support quality, savings and flexibility. It is decided to implement all of them on a big scale: 1. Patient lifting technologies, 2. Wash toilets, 3. FAR and 4. Better use of assistive technologies.

An example of a user of one of these welfare technologies is Tonni who is 32 years old and suffers from cerebral palsy. When I meet him, he had used Bestic for 14 months. He lives at a home-institution with five other challenged citizens. He gets manual help with eating in the mornings. He brings FAR in a knapsack from the home-institution to the day care center where he is part of a music group. At the day care center, he enjoys his lunch with Bestic. He also eats his dinner with FAR at home, but there are obstacles. In contrast, Tanja recently stopped using FAR. She also used it during lunch at the day care center - and it worked well. However, Tanja and the CPs in her home institution had trouble. Tanja used Bestic for three daily meals during five months before stopping. When she ate with FAR she spent 15 minutes more per meal, compared to eating manually with a CP. This was particularly an obstacle in the mornings. These two examples (Tonni and Tanja) point to the possibility that users and CPs appropriate Bestic differently due to situation, identity and bodies.

Technology developers face problems in implementing FAR in practice. '*It often stops with the CPs*', *they say. 'They need to change routines in relation to the meal'*. They assume this is mainly due to lack of knowledge on robotics and because there is no training in use of assistive robotics in formal basic education. Moreover, there is lack of professional courses for CPs. Technology developers particularly point at a need for training and continuing education in relation to problems arising during a meal. An initial assessment is that the key hindrance in implementing FAR is a lack of competencies and training. I will now revisit the above-mentioned in relation to analysis of sociotechnical imaginaries and show how various imaginaries intersect and are misaligned. I am interested in understanding more of what various imaginaries seek, foster and hope for and what is seen as 'good' and 'bad'. Moreover, I am interested in what happens when different performances of 'good' meet.

3.1 The users – 'Love of technology' as a sociotechnical imaginary

Tonni's use of FAR is not as smooth as it initially appears. A detailed scrutiny of a Bestic-meal illustrates both the empowerment and the daily hassles that comes with FAR. I will argue that the sociotechnical imaginary of being a leading nation in digitization intertwines with daily tinkering and footwork to make the robotics workable and meaningful.

The CP prepares Tonni's lunch by mounting a table on the wheelchair, then she unpacks the FAR from Tonni's knapsack and mounts it on this table. Attentively, she spreads chicken and rice from a box, Tonni has brought from home, on the plate. Tonni carefully activates the blue panel on the table with his left elbow. The Bestic-spoon and arm immediately goes down for food, but unfortunately, it shovels the food over the edge of the plate. It ends on the table. The CP smoothly lifts the food back with a spoon, and consequently gently adjusts the position of Bestic. As Tonni continues, the arm and spoon now swing too far out. Now, the spoon pushes Tonni's cheek and due to his lack of muscle control, Tonni has difficulties snapping the spoonful and getting it into his mouth. Again, the CP rearranges the position of Bestic slightly. The three CPs sit at an adjacent table. They have their lunch. Before Bestic, one of the CPs would sit completely with Tonni and manually feed him. Now, the three of them sit together and talk (now more or less a lunchbreak). However, one of them now and then needs to help Tonni. This provides them with flexibility and overview, they say. One of the CPs, June, is particularly fond of Bestic. She appears to be Tonni's favorite manual eating partner. She thinks Bestic not only cares for Tonni, but also for her. Feeding another human being manually can be demanding. The CPs tell about Tonni's manual eating partner hierarchy. Tonni prefers to eat with June, but he prefers the FAR to Nete, they say. Tonni does not want to eat with Helge at all, who is thus in the last place, and Bestic is rated as the second best eating partner. Tonni has given Bestic a name, 'Yvonne' – a woman's name. Thus, three 'women' top Tonni's eating partner hierarchy. A factor indicating affectionate, perhaps even erotic, connection to the food provider and the situation of eating. This, observation, I believe, illustrates both emerging opportunities and ongoing transformations in care work. Human services now compares with robotic assistance and CPs may to some extent exchange with robotics and emotional attachment even seems to take place between body and machine. This interferes to some degree with the CPs' imaginaries of care as a question of gathering, community, empathy and mutually positive regard. However, in this case, Helge stresses that he would rather fill his function of activating the attendees, which is to play music, than feed Tonni manually. Helge is thus limited positive towards Bestic.

Space and task appear to be important with regard to successful implementation of Bestic. The day care center is an activity offer and values playing music together. As long as Bestic frees up time it is welcome. Yet, at the home institutions the CPs express doubt as to the value of FAR. They constitute 'homes', the CPs' say, and thus articulate certain and interesting imaginaries in relation to robotics. Helle, a CP in Tonni's home-institution explains, '*Here it is important that we do the things that you do at home… When we eat, we sit down and therefore we are together. We are a home. There are some specific values that apply*'. As such, Helle emphasizes the particular context and style that applies to 'home' and as such, she questions whether Bestic has a role to play. In a home, you eat cozily together and not alone with a robot in your room, we learn. However, this is exactly what Tonni wants to achieve.

While the CPs at the day care center are fond of Bestic and see it as a tool for their use, the CPs at home stress that Tonni invariably ought to decide when to use Bestic. Helle worries that Bestic may be 'too convenient' and due to potential coming budget cuts, soon Bestic needs to function without the assistance of a human. As another CP puts it, '*It should not be so that Tonni uses Bestic because he has to*' (due to savings of personnel). Tonni agrees; '*I am the one to decide. Sometimes, if I don't want to use Bestic, I let it stay at home*'. In other words, he insists that Bestic is his tools. It is not the CPs' tool.

An important fact necessary to understand this is that Tonni loves technology. Technology enables him to have agency. His primary interface with his surroundings is a control box and a joystick mounted on his wheelchair. By way of this, he opens and closes the bedroom door. He controls the curtains and even the ventilator in the kitchen. He uses the joystick and control box to navigate his phone, put on music (also in the bathroom), and start movies. During evenings, Tonni prefers to eat alone with Bestic in his room while watching a movie. Unfortunately, there are important constraints. The CP needs to remove the control box to attach the eating table on the wheelchair, and thus Tonni is cut-off from interacting. The CP places Bestic with a Velcro strap so it does not fall or move; serves the food, starts a movie, and leaves the room. Tonni now eats alone, and that is an achievement, but he has no control besides simple activation of Bestic. He explains he is afraid of choking on the food and suffocating. If that happens, he cannot contact the CPs. He may shout, but no one will hear him, as during mealtime the CPs are busy in the dining room. If he wants to change the movie, he cannot. He can only wait. Because of this, the CPs have recently decided that Tonni can only eat alone in his room (with Bestic) when three CPs are at work. In the future, exactly due to Bestic, the CPs' fear they are scheduled to be only two at work at dinnertime. This tells of controversy in regards to the Bestic-implementation. A number of dilemmas in relation to savings, ambitions to take control of one's own life and flexibility of the working environment appear. In this case, those aims work simultaneously and collide.

This point relates interestingly to the notion of robot envelopment. In the literature, robot envelopment is a matter of organizing the environment so that it meets the needs of the robotics [34]. Tonni is actually able to eat alone in his room with Bestic, but, because the CPs need to dismantle the joystick to mount Bestic, he is cut-off from all other technologies. FAR surely is not properly enveloped. Thus, Tonni can eat alone, but he is left incompetent due to lack of integration among technologies. Because of incidences like this, the CPs see Bestic as impairing care.

3.2 The care providers – the sociotechnical imaginary of impaired care

Tanja also had trouble in using Bestic and stopped after five months. It was difficult for the CPs to make Tanja sit right at the table. For instance, she has a flex arm and a cloth attached to the wheelchair. Therefore, because she could not get close to the table, Bestic did not work properly. After some time they got another table, but then there was no space for the footrests mounted on her wheelchair. The CPs had to unmount the footrests at the beginning of every meal and reinstall them afterwards. Consequently, Tanja had trouble keeping her balance during meals, which is essential when using Bestic. The CPs tried to support her feet in various ways with a stool and pillows. The occupational therapist was involved and tried a number of options. She made drawings and templates to show exactly where Tanja ought to sit in relation to the table and Bestic. However, in order to eat comfortably Tanja had to place herself so close to the table that she could neither grab the cloth, nor press the blue panel to activate Bestic. After some time, she began to have neck-pain, likely due to a strained eating position. Furthermore, the spoon broke twice, the first time because Tanja had been stuck. Thus, there were continuous material and emotional arrangements, rearrangements and resistances. One day, Bestic fell on the floor, broke down and was sent to Sweden for repair. In fact, it never came back. In the meantime, Tanja ate with the CPs. The CPs then decided to abandon FAR. The contact person says, '*When Bestic broke down Tanja came back to the table and had social contact with the group again. It was as if Tanja, due to the [Bestic] table arrangement, was at a distance from the group. She was in a way sitting at the end of the table all by herself. She had come too far away and this made the contact difficult. I think she missed contact'*.

I suspect Tanja still wants to eat with the robot. Unfortunately, Tanja is a vulnerable person and does not articulate that wish well. Mostly, she communicates through sounds not easily understood. However, during the interview, Tanja continuously stresses that it makes a difference who helps her, and that the CPs do not have equally positive opinions towards robotics. Nevertheless, the contact person believes that Tanja prefers to sit together with other residents while eating, to have contact and enjoy empathy. Like Tonni, Tanja ate well with Bestic at the day care center. At the two home institutions though, intricacy and comprehensive tinkering emerged. Again, imaginaries of 'good' care differ. While, Bestic helps the day care center to focus on their primary activity, music, the home institution doubts whether Bestic is appropriate in a home.

Thus, Tanja's use of Bestic entangles in different sociotechnical imaginaries. It begs ethical questions of what is the most worthy; to eat self-reliantly with Bestic or to experience contact during the meal with fellow residents. While there are hardly any answers to that question outside the specificities of situations, the CPs blame themselves when the body-robot arrangements do not function. '*It could have been otherwise if we had done more*', a CP said as a response to why Tanja stopped. This points, on one side, to insurmountable tinkering to match bodies and aids that comes with Bestic. On the other side, the Tanja case points to a situation where CPs face a technology they believe impairs caring and which, at the end of the day, might take their own job. I can sum up this section by stating there are various perspectives among CPs in relation to the usefulness of Bestic, tinkering is necessary to make it work as is buying in to the imaginary of robotics being enabling of a more agential life. In the next section, I explore the imaginary that good care with assistive robotics assumes empowerment, education and training.

3.3 The technology developers – empowering the user as a sociotechnical imaginary

Camanio Care in Stockholm designs and sells Bestic. A factory in Eskilstuna, Sweden assembles it. Just like the usage stories, the Bestic design story includes interwoven technology and people. An engineer in automation and mechatronics, who had recently graduated university, met an affluent economist suffering from post-polio. He had a dream of producing an eating aid for himself. She was looking for a job, and eventually they started designing the first version of Bestic in 2004. Patients at hospitals with amputated arms acted as informants throughout the early design process. At a later stage, the design process took place in close collaboration with a group of three design students from the university doing voluntary work. They worked on the Bestic design case as part of their Masters project. For half a year, the development engineer even had an office at the university. Thus, in close collaboration, they designed Bestic. The first versions of Bestic came with a five-button control panel. It had arrows and colored buttons indicating arm-directions and speed. It appeared too complicated for many users. To compensate, they developed the simple blue one-button panel to activate the arm and spoon. Consequently, the robot can be set to different programs depending on rhythm of the meal, and the users' physical and cognitive ability. Furthermore, in relation to start-up, Bestic is individually set in terms of exact position, how far the arm swings out, and how high and deep it goes. As soon as it is individually set for a certain user, it does not need adjustment.

The CEO and the developing engineer at Camanio Care expound four ethical claims in connection with practical use of Bestic: 1. Empowerment, 2. Usability, 3. Changes in meal-routines, and 4. Education. The first and most important claim is the question of empowerment. Empowerment is, according to the technology developers, an issue of really wanting to support and help the user. The FAR user ought to control decisions. Therefore, empowerment is about respect, caution and security. The CEO says,

> *Being fed by a person may very well feel more unethical than eating by yourself with an aid. Those coming to help me can be anyone who I do not know and who do things more or less the way I prefer. To say that humans are always ethical and machines are always unethical is too black and white. Humans do not necessarily represent the ethical dream. One can seriously problematize the extent of human empathy.*

Secondly, according to the developing engineer the questions of usability and aesthetics are crucial. Usability was a guiding principle throughout the design process. A meal is not simply about eating, nor is it only a matter of moving food from the plate to the mouth, rather the meal is a cultural setting to which we have all kinds of expectations. Among other things, it relates to community, gathering and conversation. The development engineer says, '*at almost every celebration we have a meal. That is what we want the users to be part of. So, Bestic shouldn't stick out too much*'. In order to be used Bestic must fit on a table, be neat and blend into the environment. It should not look too much like a robot. The technology developers agree that the earlier models, such as the Neater-Eater robotics, are too prominent and noisy. Consequently, the developing engineer listened to a number of motors, and in order to make Bestic as silent as possible, it ended up having two small motors. The design group wanted Bestic to be white and shiny. Although it is made of plastic, it intends to look like porcelain to fit on a table. Throughout the design process, it was valued that Bestic was easy to clean and wipe off.

Thirdly, roboticists find CPs ought to be prepared to change work routines in relation to the meal. Bestic shifts the meal in relation to what it was before. The financing as well as the development of assistive robotics, is challenging and long term. It takes time and effort to enter the market. Thus, the technology developers explain, it is not fair to see Bestic simply as a commercial product. Rather, it constitutes a new philosophy of the meal. The CPs, for instance, have to charge Bestic in advance, to make sure all the needed elements are in place and they need to serve the right food. Not least, they need to relate differently to the user during the meal. According to the technology developers, the use often stops, because the CPs are not willing to make these changes. It is a key value for the technology developers that the user and not the CPs are in control. If the user controls Bestic, it is ethical, they say. Perhaps, sometimes the users ought to be more assertive and say, '*I really want to use this robotics, could you please help me?*' The point is that assistive robotics is not something you try for a period due to it being funny or interesting. It is a new way to eat, think, care and work. In relation to the fourth point, the technology developers propose there is lack of knowledge. Training is lacking with regard to assistive robotics in formal basic education, as well as in continuing education. The technology developers particularly point at a need for training in understanding the problems arising during a meal. Due to this lacking, there are destructive myths in institutions about savings instead of quality, instrumentality instead of empathy, etc. The CEO says,

> *The use of feeding assistive robotics does not lead to more quality or less quality in itself; neither does it lead to more or reduced staff in itself. This is a question of what you do with it, but there are often not sufficient staff at breakfast, lunch and dinner. This is where Bestic may or may not lead to improved quality.*

Consequently, Camanio Care developed 'Mealtime Puzzle', a course they teach at Karolinska University Hospital in Stockholm. They have also developed an app called 'Mealtime quality index' consisting of a number of questions posed to both CPs and users to consider what a good meal is. The course treats a number of issues during a meal that you have to be aware of - nutrition, speed, senses, physical arrangement, organization, etc.

3.4 The government – the sociotechnical imaginary of digitized care

After a 2011 election in Denmark, in their coalition agreement 'A united Denmark' [35, p. 44], the new government wrote, '*We will work for a more cohesive focus on telemedicine and will promote ambitious and binding goals, which commit regions and hospitals to welfare technological services on a large scale'*. The government coalition agreement mentions welfare technology five times - even as a prominent Danish export article. According to an agreement among the government, the regions and the municipalities [31] there are three goals that need to be justified in order to obtain funding for welfare technology from the Welfare Fund: 1. Labor savings, 2. Quality experienced by the citizen, and 3. Work environment flexibility. The municipalities' financial agreement for 2014 launched a joint municipal effort for national dissemination of mature welfare technology solutions. They promoted this in relation to a plan of a profit realization of 70 million euros. LGDK's social policy proposal titled 'Invest before it happens' states that municipal efforts must be based on the citizens own resources, their active participation and be able to support people's self-determination and independence. Increased use of assistive robotics, they claim, is one means to realize the visions. In the years 2014-2017 The Center for Welfare Technology produces yearly status measurements for the implementation of the four prioritized welfare technologies. The latest report states that the municipalities have purchased 180 FARs and that 100 of those are in use. At the same time it is stated by LGDK that the municipalities have already realized the projected for profit of the investment.

4 Discussion

The combination of the notions of sociotechnical imaginaries and tinkering is useful in analyzing how different agents organize their worlds of action as a response to a new advanced technology, what their goals are and how they realize these goals. Inspired by material semiotics [9, 11–14], I have presented some crucial sequences of events in relation to implementation of FAR in Denmark that adds complexity to the existing literature on implementing care robotics. Although there have been critical voices [8, 9]. There have mostly been promises regarding the potentials of assistive robotics [2], including better and more cost-efficient healthcare delivery [6], engaged patients and connected health care professionals [32], and engagement of professionals in more patients and users [7]. However, as I have argued and demonstrated enacting these visions is messy, uncertain and complicated, in ways often unanticipated by government agencies and technology developers. The point I am making is that assistive robotics constitute a strong, but controversial sociotechnical re-imagination of care for the chronically ill, the elderly and the disabled as well as the welfare state. This relates to both imaginaries of *savings*, *quality* and *flexibility* in care work. Although, Bestic is indeed such a technology, this study contributes to the existing literature by emphasizing that there are noteworthy discrepancies between the visions of government agencies, technology developers and practical implementation of robotics in care work. These discrepancies interweave and complicate the implementation. In Table 1. I sum up the article's argument/results by displaying four different sociotechnical imaginaries, goals and forms of tinkering in relation to the studied implementation of FAR. See Table 1.

The table illustrates that implementation of FAR comes with a number of differences that have practical effects during the implementation. The point is that sociotechnical imaginaries, goals and tinkering in relation to the four mentioned agents come with tension and embrace controversies.

Table 1. Implementation of FAR - agents, sociotechnical imaginaries, goals and tinkering.

Agent	Socio-technical imaginary	Goal	Tinkering
Government agencies	Digitized welfare/Digitized state	Savings, self-reliant users, flexibility for care providers	Promoting, monitoring
Technology developers	Empowerment of the user	Usability	Educating shifted meal routines
Users	Love of technology	Self-reliance, control, agency	Experimenting
Care providers	Impaired care, An aid improving flexibility	Gathering, community, empathy	Arranging people and technical aids, change tiny details to see if it works

4.1 Implication in practice

What are the consequences of this article's argument for the practitioners involved in policymaking (government agencies), design (technology developers) and implementation (CPs)? This study points to the fact that policy makers need to rethink whether FAR is mature enough and earn mandatory dissemination in all municipalities. Moreover, the study demonstrates that learning needs to be done. Technology developers are, for instance, not involved in implementation, and the CPs at different sites do not communicate. CPs claim at a certain moment that Bestic would be more usable if it was equipped with voice recognition. Technology developers ought to learn from this by attending. In terms of CPs, many point to the possibility that they stop implementation too early due to dichotomization between values of empathy and coldness/instrumentality.

5 Conclusion

This article discusses the complexities that come with technologically driven innovation of care work. I have exemplified from a mandatory national implementation strategy concerning FAR in care for the disabled in Denmark. Analytically and methodologically, I have used inspiration from material semiotics, desk research, observation and stories told by a number of affected stakeholders. The Bestic case elucidates both users' strivings for self-reliance, CPs hassle and tinkering implying threats that the entire health political vision crumbles due to difficulties to make persistent and convincing connections between bodies and robotics. The imaginaries and expectations in relation to assistive robotics are considerably different as the involved agents perform them. As part of this divide, I argue that imaginaries in relation to the FAR of government agencies, technology developers, users' and CPs' weave into the daily practice and shape present-day practice of care work. As an extension of Mol, Moser and Pols, I propose that much is at stake and that body-robot interaction demands thorough engagement, continual tinkering as well as deep understanding of the particular situation, identity and bodily condition of the user. This study contributes both to the literature on HRI and STS by providing an empirical example based on detailed ethnography done from the middle of things, and in a manner where both political visions, technology developers' assumptions concerning usability, users strive for independence and CPs tinkering, are in focus at the same time. Thus, the analysis invites readers to embrace the scope and potentials of ethnographic methods in the HRI field.

References

[1] Regeringen, Fællesoffentlig Strategi for Digital Velfærd, 2013-2020, Digital Velfærd - en lettere hverdag, 2013 (The government, Joint Public Strategy for Digital Welfare, 2013-2020, Digital Welfare - an easier everyday life)

[2] L. Gaedt, Spiserobot til borgere med fysisk handicap, Velfærdssteknologi vurdering i Socialstyrelsens ABT projekt, Teknologisk Institut Robotteknologi, 2013 (Feeding Assistive Robotics for citizens with physical disabilities, Welfare technology assessment in the Social Agency's ABT project, Technological Institute Robotics, 2013)

[3] N. Nickelsen, Criteria of implementing feeding assistance robots in disability care – a sociomaterial perspective, Journal of Comparative Social Work, 2013, 8(2), 1–20

[4] M. Juksa, A techno-anthropological investigation of the design assumptions of the assistive eating technology, Master thesis, Department of Planning, Aalborg University, 2015

[5] B. Martinsen, B. Paterson, I. Harder, F. Biering-Sørensen, The nature of feeding completely dependent persons: A meta-ethnography, International Journal of Qualitative Studies on Health and Well-being, 2007, 2, 208–216

[6] G. Roos, Technology-Driven Productivity Improvements and the Future of Work – Emerging Research and Opportunities, IGI Global, 2017

[7] R. Susskind, D. Susskind, The Future of the Professions – How Technology will Transform the Work of Human Experts, Oxford University Press, 2015

[8] D. Lupton, Critical Perspectives on Digital Health Technologies, Sociology Compass, 2014, 8(12), 1344–1359

[9] A. Mol, I. Moser, J. Pols, Care in Practice: On Tinkering in Clinics, Homes and Farms, Bielefeld: Transcript Verlag, 2010

[10] S. Jasanoff, Future imperfect: Science, technology, and the imaginations of modernity, In: S. Jasanoff, S. Kim (Eds.), Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power, University of Chicago Press, Chicago, 2015

[11] W. Orlikowski, The sociomateriality of organizational life: Considering technology in management research, Cambridge Journal of Economics, 2010, 34, 125–141

[12] W. Orlikowski, Using technology and constituting structures: a practice lens for studying technology in organizations, Organization Science, 2000, 11, 404–428

[13] S. Timmermans, S. Epstein, A World of Standards, but not a Standard World: Toward a Sociology of Standards and Standardization, Annual Review of Sociology, 2010, 36, 69–89

[14] B. Latour, Science in Action: How to Follow Scientists and Engineers Through Society, Harvard University Press, 1987

[15] S. Jasanoff, S. Kim, Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power, University of Chicago Press, Chicago, 2015

[16] M. McNeal, M. Arribas-Ayllon, J. Haran, A. Mackenzie, R. Tutton, Conceptualizing imaginaries of science, technology and society, In: U. Felt, R. Fouché, C. A. Miller, L. Smith-Doerr (Eds.), The Handbook of Science and Technology Studies 4th Edition, MIT Press, Cambridge, 2017, 435–464

[17] S. Kim, Social movements and contested sociotechnical imaginaries in South Korea, In: S. Jasanoff, S. Kim (Eds.), Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power, University of Chicago Press, Chicago, 2015

[18] B. Anderson, Imagined communities: Reflections on the origin and spread of nationalism, 1st ed. Verso Books, 1983

[19] M. Bernsen, Silicon Vallensbæk og Kalundfornien, Weekendavisen, 2017

[20] S. Slota, G. Bowker, How infrastructures matter, In: U. Felt, R. Fouché, C. A. Miller, L. Smith-Doerr (Eds.), Handbook of Science and Technology Studies, Fourth Edition, MIT Press, Cambridge, 2017

[21] S. Star, The ethnography of infrastructure, American Behavioral Scientist, 1999, 43, 377–391

[22] B. Latour, Reassembling the Social: An Introduction to Actor-Network Theory, New York, Oxford, 2005

[23] J. Law, Organizing Modernity, Blackwell, Oxford, UK, 1994

[24] I. Moser, On becoming disabled and articulating alternatives – the multiple modes of ordering disability and their interferences, Cultural Studies, 2005, 19, 6

[25] M. Winance, Care and disability: Practices of experimenting, tinkering with, and arranging people and technical aids, In: A. Mol, I. Moser, J. Pols (Eds.), Care in Practice: On Tinkering in Clinics, Homes and Farms, Bielefeld: Transcript Verlag, 2010

[26] I. Moser, J. Law, Good passages, bad passages, In: J. Law, J. Hassard (Eds.), Actor Network Theory and after, Oxford : Sociological Review and Blackwell, 1999

[27] A. Mol, Proving or improving: on health care research as a form of self-reflection, Qualitative Health Research, 2006, 16, 405–414

[28] B. Flyvbjerg, Five misunderstandings about case-study research, Qualitative Inquiry, 2006, 12(2) 219–245

[29] R. Yin, Case Study Research, Design and Methods, 5th ed., SAGE Publications, London, 2014

[30] G. Marcus, Ethnography in/of the world system: the emergence of multi-sited ethnography, Annual Review of Anthropology, 1995, 24, 95–117

[31] Kommunernes Landsforening, Statusmåling vedrørende Velfærdssteknologi (Local Government DK, Status measurement with regard to welfare technology), 2017

[32] A. Van Wynsberghe, Healthcare Robots: Ethics, Design and Implementation, Springer, Dordrecht, 2014
[33] S. Star, Power, technology and the phenomenology of conventions: On being allergic to onions, In: J. Law (Ed.), A Sociology of Monsters, Essays on Power, Technology and Domination, Routledge, London, 1999
[34] L. Floridi, Philosophy and Computing, Routledge, London, 1999
[35] Regeringen, Regeringsgrundlaget – et Danmark der står Sammen (Government basis, A Denmark United), 2011

Research Article Open Access

Lasse Blond*

Studying robots outside the lab: HRI as ethnography

https://doi.org/10.1515/pjbr-2019-0007
Received June 29, 2018; accepted January 14, 2019

Abstract: As more and more robots enter our social world, there is a strong need for further field studies of human-robot interaction. Based on a two-year ethnographic study of the implementation of a South Korean socially assistive robot in Danish elderly care, this paper argues that empirical and ethnographic studies will enhance the understanding of the adaptation of robots in real-life settings. Furthermore, the paper emphasizes how users and the context of use matters to this adaptation, as it is shown that roboticists are unable to control how their designs are implemented and how the sociality of social robots is inscribed by its users in practice.

This paper can be seen as a contribution to long-term studies of HRI. It presents the challenges of robot adaptation in practice and discusses the limitations of the present conceptual understanding of human-robot relations. The ethnographic data presented herein encourage a move away from static and linear descriptions of the implementation process toward more contextual and relational accounts of HRI.

Keywords: human-robot interaction, social robots, long-term interaction, robots in the wild

1 Introduction

Elderly care is seen as a field of 'special interest' [1] within social robotics. As the population ages and a lack of caregivers are expected [2], social robots are increasingly viewed as technological fixes to demographic and age-related challenges, e.g. loneliness and cognitive impairments [3, 4]. Social robots have already entered elderly care facilities in various countries [5–10] and the adoption of various social robots is expected to continue [11, 12]. As these robots emerge in society, it becomes an even more urgent task to relate to effects of robots designed for social interaction, to critically consider citizens' perception of robotics, and to be able to assess how robots meet the desires and expectations of their users.

Understanding how social robots are adapted into practice in various use contexts will yield crucial insights of robot applicability in general. It will raise important design and policy questions [13] and assist addressing ethical questions to lessen the unforeseen consequences of emerging robots [14]. The author agrees with de Graaf, Ben Allouch, and van Dijk [15] that the scope of investigation has to move outside of the design laboratory and beyond the short-term studies of HRI in order to study effects of the presence of social robots and account for more than novelty and exposure effects. This research agenda calls for long-term studies of HRI and ethnographical encounters with robots in the wild [16].

To contribute to the still scarce [17], yet much requested, long-term studies of HRI [15, 18–24], the author has conducted an ethnographic study of the socially assistive robot Silbot's transfer from South Korea to Denmark and Finland in 2011 and the following adaptation there. An updated version of Silbot is still used in Danish elderly care, but this paper argues that the robot's adaptation and usage in practice has only recently been normalized [25] as the robot's use has become somewhat stabilized. The author considers this paper an occasion to elaborate present theories about human-robotic interactions, the models used to describe adaptation of robots in practice and to assess the value of ethnography to the understanding of HRI.

2 Defining a socially assistive robot

Roboticists Dautenhahn and Billard define a social robot as a robot able to 'engage in social interactions' [26]. Humans can interact with these robot as they would with any other 'socially responsive creatures' [27]. Such robots are designed 'to produce effects of sociality and agency' [28] and function as believable interaction partners [29]. They adhere to rules of expectable social behavior [15, 30], and

***Corresponding Author: Lasse Blond:** IT University of Copenhagen, Copenhagen, Denmark; E-mail: blon@itu.dk

are constructed to operate as humans and in some cases even as human surrogates [31]. Fong *et al.* call robots like these *socially interactive* [20] stressing the social interaction as a primary function, albeit applied to various purposes.

Socially assistive robots can be understood as a subcategory. Their specific function is to help their users [2, 12] through social interaction and they are produced to "create close and effective interaction with a human user for the purpose of giving assistance and achieving measurable progress in convalescence, rehabilitation, learning etc." [32].

2.1 Robots as social agents

To comprehend the sociality of social robots it seems necessary to point out that these technologies are "enveloped by human practices" [33] and the author questions whether these robots can be understood outside of social practices [5]. As Giddens [34], the author considers the "domain of the study of social sciences" to be "social practices ordered across time and space". Like other social scientists, the author regards technologies, such as social robots, as elements in social practices carried out by humans [35, 36]. In other words, social robots are 'nothing' unless integrated into social practices [37] and to have "effects" these machines must be used by humans [36]. As other technologies social robots display nonhuman agency [33], but their actions are only visible to the social scientist or ethnographer, once the robots are allowed to function as material elements in real-life practices.

According to Alač, it makes good sense to study robots ethnographically [28] and as part of social practices [28, 38–40]. Not to establish what a robot is, but to explore "how its status is done in practice." [28]. Alač has studied how human users interact with and make robots "become alive" [38]. She argues that even though a social robot is specifically engineered to generate impressions of life and responsiveness its sociality cannot be understood as an intrinsic value alone. Rather, it is dependent on human interactions in social practices where users "enact the social character of the machine." [39]. In a series of participant observations, Alač and her colleagues have observed how adults and toddlers engage with a social robot in a laboratory setting i.e. how the adults' enactments of the social robot as an intentional being further the toddler's interest in interacting with the robot. When these adults speak to and via the robot they "imbue the technology with its social character." [28]. Alač argues that the social robot needs such "interactional support" or *interactional maintenance* to function as a social agent, without it the toddlers lost their interest in engaging with the robot [40]. It is important to emphasize that Alač's ethnographic studies of HRI were done in more or less controlled laboratory settings. She speculates about what happens when the social robots move out of the laboratory to interact with users distant from their designers [39]. Hopefully, this article can enlighten this speculation and will be considered a contribution to the still few studies of HRI outside the laboratory and in everyday practices [16].

2.2 A robotic brain fitness instructor

The South Korean Robot Silbot, designed by the Korean Institute of Technology (KIST) in 2010, can be characterized as a socially assistive robot [12]. Silbot-2 was shaped like an egg resting on top of three wheels and had the height of a six-year-old child (approximately 41,4 inches). The 66 lb. robot had a friendly looking, cartoon-like robotic face capable of real-time facial expressions. During the interaction the robot would unfold its two arms, and flap its penguin-like flippers, and its voice would sound from the two inbuilt speakers above its waistline. The robot was reprogrammed from a tele-operated English teacher in South Korean elementary schools [7, 41] to a facilitator of cognitive exercises to elderly citizens with the purpose of preventing or halting age-related illnesses such as dementia. The latter use case was presented to Danish and Finnish health care representatives at separate occasions. Silbot was tested in the Finnish capital, Helsinki, and the Danish city of Aarhus between the fall of 2011 and early 2012. Apart from the socially assistive robots Silbot and Mero (a talking head with a moveable neck), the concept of "Brain Fitness with Elder Care Robots" included 16 digital cognitive games e.g. a calculation game, a tile-matching puzzle game, Bingo, a sing-along session, and a game where the participants had to memorize a route taken by Silbot on a checkered floor in order to walk it themselves. In a regular Brain Fitness session the participants would usually play two or three of cognitive games selected by the game instructor beforehand. One session would ordinarily last 90 minutes with a short break after the first 45 minutes.

The elderly citizens played the games and interacted with the robots using Samsung touchscreen tablets, while Silbot functioned as a quiz master, explaining the game rules, cheering up and hurrying the elderly participants. During the game sessions the citizens would be seated behind small tables in a semi-circle or straight line facing Silbot. The robot would move around on a checkered floor in the middle of the room, while Mero would be positioned on a podium behind it. At the far end of the room a flat screen would display either the game instructions or the animated games being played. The robot system operator would be seated behind a PC next to Mero and the flat screen, while the human game instructor (in the Danish case an occupational therapist) would walk around the room to elaborate the game instructions or help the elderly citizens with using their tablets.

The Danish and Finnish Pilot tests were concluded with different results. In Helsinki, the project team considered the robots unnecessary, underdeveloped and *too* expensive and the collaboration with KIST ended after the pilot project was concluded. This paper will not go into further details about the Finnish pilot project, as the author have written about it elsewhere [5, 42]. In Denmark the Municipality of Aarhus bought three exemplars of Silbot (Mero was taken out of operation due to technical problems) and promoted the Brain Fitness classes for elderly citizens. In 2012 Silbot-2 was replaced in Aarhus with a new version constructed as a response to various shortcomings and requirement specifications stated by its Danish operators. This version, Silbot-3, was distinctly different from the first version. With the height of 45,20 inches it was shaped like an hour-glass-like torso mounted on a mobile platform. A small flat screen revealed a pensive, friendly Caucasian female face above the flexible neck. The penguin-like flippers were replaced by two movable arms with flexible joints and its 46 lb. weight gave a slightly slimmer and taller impression as compared to its predecessor. Silbot-3 is still used; as elderly citizens of various ages and with various types of dementia participate Brain Fitness classes in Aarhus on a weekly basis.

3 Methods

I have conducted ethnographic fieldwork in both Denmark and Finland to explore user experiences with adapting Silbot into practice. In Helsinki, I visited the original test bed in late January 2016 and interviewed six relevant stakeholders of the original pilot project. In Aarhus, I have conducted 13 interviews in 2016-2017 with seven stakeholders from the original pilot project 2011-2012 and some of them are still involved in operation of Silbot. I have been a participant observer [43, 44] at various Brain Fitness sessions throughout the years 2015-2016. Besides from this I have collected and analyzed various documents in relation to Brain Fitness. As other authors have argued [43, 44], I find that none of the methods mentioned above can stand alone or make up for an ethnographic approach to e.g. human-robot interaction, as no singular method can "reveal all relevant features of empirical reality", whereas different methods will reveal various aspects of empirical reality [45]. I will describe my methods in the following sections.

3.1 Participant observation

I have observed the training of future game instructors and system operators on three separate occasions. When I entered the field, the game instructors also had to operate the robotic system themselves, besides from taking care of elderly citizens. In the pilot tests in Denmark and Finland 2011-2012 the system was operated by Korean engineers from KIST. The training sessions of future game instructors were organized by the Municipality of Aarhus and introduced the aspiring game instructors to Brain Fitness by allowing them to play the cognitive games and discuss the health benefits, pedagogy and game strategies with the former game instructors, responsible for Brain Fitness from 2011-2015. I followed and observed how these game instructors interacted and worked with Silbot in three regular game sessions, where elderly participants played the cognitive games. On other occasions I observed how Silbot was presented and demonstrated to stakeholders from other departments of the Municipality of Aarhus as well as external interested parties. These demonstration sessions would typically proceed as the regular game sessions with senior citizens, i.e. the interested parties would participate in Brain Fitness by playing two or three of the cognitive games followed by a discussion of the benefits of Brain Fitness with the game instructor.

As a participant observer [43] I was present at the Brain Fitness sessions mentioned above. Usually, I would be seated among the participants behind one of the tables at the far end of the room. From this position I observed the ongoing interaction with the robot, wrote down 'situated vocabularies' [44], took field notes, occasionally drew quick sketches of the robot, took photos, or recorded its movements. On one occasion, in one of the training sessions for future operators, I participated in the Brain Fitness session and played along with these soon-to-be game instructors. I discovered myself having difficulties and being frustrated with remembering the values in a calculation game while being far better at solving a 16-piece puzzle within the pre-set time frame. As Davies [43], I have found participant observations have enabled open discussions with people in the field and helped me identify key informants. They have provided a sound basis for qualitative interviews to follow up on the insights generated from during fieldwork.

3.2 Qualitative interviews

The qualitative interviews in Finland and Denmark were conducted as semi-structured interviews following an interview guide [46] with pre-formulated questions and with the flexibility to generate new questions during the interviews. All interviews were recorded and transcribed – apart from three unstructured interviews in Denmark in the beginning of 2015 with the project managers. These interviews provided background information before the fieldwork was conducted. The interviewees in Finland consisted of the former game instructor, the director of the elderly care center where the pilot test was conducted, the former head of elderly care services in the Municipality of Helsinki, the former project manager, a project team member, and the managing director of the Finnish company responsible for conducting the pilot test. In Denmark I interviewed the first Danish game instructor, three members of the initial project team, the current project leader, an external partner in the original pilot test, and the present Danish game instructor. Some of the Danish interviewees have been interviewed more than once in the study period. These interviews have allowed the interviewees to elaborate upon statements made in various documents and evaluation reports I have obtained as part of my research. The Finnish interviewees discussed whether they considered their pilot test a success or failure and the adaptability of Silbot to a Finnish elderly care context among other topics. The Danish interviewees have responded to various topics, incl. the original setup of the pilot test, the ongoing collaboration with the Korean stakeholders, the various versions of Silbot, and their pedagogical approach to and changes to Brain Fitness, etc. The interviews have allowed the interviewees to clarify what can be read ‘between the lines’ in evaluation reports and project plans, but also to position themselves in relation to the robot and accentuate their own role and responsibility in relation to Brain Fitness as a practice.

3.3 Document analysis

In addition to qualitative interviews and participant observation, I have read various documents about the pilot projects (including project contracts, evaluation reports, journal entries made by the first Danish game instructor, a requirement specification report and various press releases) many of these documents were formulated in collaboration with KIST. These written materials have provided valuable insights into the negotiations, personnel, and dynamics behind the Brain Fitness setup. I agree with social scientists Atkinson and Coffey that documents should be considered “data in their own right.” [47]

3.4 Doing ethnography

According to Bruun, Hanghøj, and Hasse [16] providing “hard-and-fasts descriptions” of ethnographic methodology seems challenging as ethnographic data-gathering methods are flexible and adaptive to the real-life settings they are designed to investigate. The ethnographer knows that real-life settings under study, i.e. the object of ethnography is emergent [48] and that this requires methodological adaptability. At first sight, fieldwork might appear as just being about “chatting with people” and ethnography as something anyone can do without particular expertise [49]. However, doing ethnography requires substantial analytical skills as the ethnographer must be able to “*understand* and *analyze* what people say” [49] and mean [16]. This must be followed up by observations as the ethnographer realizes that in order to know what people do asking them is not enough. What people do in real-life settings might not be consistent with what people say they do [49]. People tend to overlook certain aspects of their real work, e.g. Forsythe [49] found that technical people display a tendency to ‘delete’ social and communicative work when asked to reflect upon their own work processes. Ethnography, and participant observation in particular, can make these invisible actions of people visible.

Participating in the real-life settings under study can be considered a “distinct (anthropological) avenue towards understanding” [48]. In other words, doing ethnography is about learning and enabling ethnographers to become a co-constructors of their own data [43] through their embodied participation in the empirical field. Ethnographers acknowledge their presence, their situatedness, their perspective, and that the facts they establish depend on their social relations [48]. Yet, with the willingness to learn from their informants they can “identify and problematize things that insiders take for granted” [49] and allow the ethnographer to document the “complex reality of social and material life” [16]. Analyzing what matters to people endows the ethnographer with a pronounced sensitivity towards humans and materiality [50].

4 Findings

When the Korean robots arrived in Aarhus in 2011 they were less developed than the Danish stakeholders expected. Interviews with the first Danish game instructor and other stakeholders in the pilot project give the impression of a fragile robotic system that needed a lot of onsite tuning to perform Brain Fitness. Only 8 of the 16 cognitive games functioned. Still, the games and the robots as presented by the Koreans were plagued by recurrent technical problems. Onsite debugging proved a time-consuming task as the system feedback were deemed insufficient by the Danes, who had to stay in constant contact with the developers in South Korea throughout the test period. The following sections will present some of the insights gained through my ethnographic study and hopefully will give the reader an idea about discoveries made possible by ethnographic data-gathering methods.

4.1 Hardware problems

The built-in sensors in Silbot (as well as the motion sensor used by the system to track player movements) proved highly sensitive to bright and direct sunlight. This caused Silbot to lose its directional input and made the robot drive off its checkered floor, meant to keep it in place, and crash into the nearby wall or furniture more than once. During my fieldwork at the Danish rehabilitation center I experienced Silbot-3 driving off the game floor and crashing into the table in front of me. The game instructor rushed to get hold of the robot to prevent it from crushing me. This happened despite the fact that the present version of Silbot is equipped with several built-in sensors to avoid collisions. During power-up Silbot has to calibrate in order to locate its position on the checkered floor. However, this phase sometimes goes critically wrong and leaves the robot unresponsive and unable to move inside the squares. Once, I had to help the game instructor move the entire checkered floor as she estimated that this would be easier than re-calibrating the robot.

In one of the games where the players can catch animated moneybags displayed on the flat screen, the motion sensor could not detect all of their movements. The game was constructed based on the average height of Korean citizens and Danes are considerably taller. Likewise, I observed how the tablets were prone to run out of battery during the game sessions. They crashed or "froze" and, as a result, the elderly citizens unable to finish the games. In addition to these technical problems, the game instructors have had to restart the games several times during a training session as the players could not interact with the system.

The present game instructor emphasizes that the technical problems occur only once in a while. Furthermore, the project manager underlines how the operational reliability of the robot has been considerably improved after years of testing and modifications. She finds that cognitive games work and considers the robot fully functional and ready for service without need of constant adjustments and extensive maintenance. However, the technical failings discovered during the participant observations show how operational reliability is something that requires continuous attention and maintenance of the robotic system by the Danish stakeholders. The recurrent tuning needed to keep Silbot running is observable and accentuated by participant observations.

4.2 Software problems

Since 2011, the software, i.e. the operating system and the cognitive games, has been adjusted. Upon arrival in Denmark, Silbot's vocabulary was translated into Danish word-for-word to advance the robot's integration into practice. Yet, during the game sessions Silbot turned out quite rude and insensitive to users struggling with solving the games. It used inappropriate language, hurrying and scolding the elderly citizens to make them complete the cognitive games within the pre-set timeframe. Entering a wrong answer would result in preprogrammed loud boos making the players uncomfortable. However, the citizens learned to accept the robot's odd behavior as explained by the first Danish game instructor:

"Initially, they [the elderly citizens] were startled by its use of words, but then they started laughing at it and somehow excused it; as it didn't know better."

In the present version the most critical phrases have been removed and the competitive element of the cognitive games have been de-emphasized. In spite of this reprogramming Silbot continues to use awkward phrases as I have observed:

"Silbot: Buck up! Time is running out."

This instruction made the game instructor excuse the robot and its impatience. She suggested to the players that Silbot might be tired of playing the same games over and over again. New players still find the robot provocative at times, and the present game instructor has explained how she handles such awkward situations with humor to make them more acceptable for the players. This is a good example of how the Danish stakeholders through their talk to and via Silbot imbue the robot with sociality and make it sociably acceptable to the elderly participants of Brain Fitness.

Silbot's synthetic voice has proven problematic in itself, as many of the elderly users experience difficulties making out what the robot says and understanding its game instructions. I have observed several Danish game instructors repeat the robot's statements to make sure that all players had understood the rules. Still, Silbot's pronunciation confuses the players, e.g. when it pronounces "User A" as "Use'er A" or asks if the users are "murdering" ("morder" in Danish) themselves - instead of enjoying ("morer" in Danish) themselves. In one of the games, the players are asked to memorize a story about "Keld den Store" instead of "Karl den Store" (the Danish translation of Charles the Great). Sometimes the users will comment on these mispronunciations but mostly they are focused on solving the games.

4.3 Usability problems

Apart from the hardware and software problems observed by the author and described in depth by the informants, the usability of the robotic system has been a recurrent theme throughout the ethnographic fieldwork. Even small adjustments have proven burdensome, because the Korean developers maintain that they ought to handle all reconfigurations. Everything is hardcoded and the Silbot operating system has no graphical user interface (GUI), which also complicates its control and navigation. In some of the cognitive games the pre-set timeframe remains too short for the players to complete the games, e.g. solving a puzzle with 16 pieces within 10 seconds. In other games it is difficult to end the games after one or two rounds as all three rounds have to be completed. The robot will sometimes continue to tell its story or sing its song even though the game has been shut off. Though having been translated into Danish, the game instructions need to be explained by the game instructors in order to make sense as pointed out by the first Danish game instructor when she introduced Brain Fitness to future game instructors:

"*I will show you how to play the game. If you just had to read the game instructions by yourself, you would run away screaming. They are so miserable, that it is almost impossible to work out how to play the games.*"

I have observed her emphasizing how operators must be able to explain what the games are about and assist the players with understanding them. She stressed to future operators:

"*It [Silbot] is not pedagogical at all. You are the ones who must be pedagogical.*"

She made up for the underdeveloped games by working around the test schedule dictated by the Koreans (i.e. letting the robots do the talking alone) as she estimated that these instructions would be insufficient for the Danish citizens to play the games. By means of a blackboard she explained the rules and benefits of the games thoroughly and made sure that every participant understood the instructions before the game session began. I observed one of the instructors working around the limited timeframe in the games by allowing the players to continue to solve a puzzle after the time had run out. At several instances she repeated Silbot's words making sure everybody understood what the robot said.

The present game instructor describes how she discusses benefits of the games and explains how the players can transfer these game-solving strategies to their everyday lives. She considers the usability problems a recurring challenge that spurs her to act creatively and elaborate her understanding of being an occupational therapist.

Instructions to the games and the usability of the system has been enhanced by the Municipality of Aarhus with their formulation of a comprehensive user manual with detailed descriptions of every game, the cognitive benefits, and the pedagogy to be used by the human instructors. This manual is deemed crucial to the outcome of Brain Fitness by the first game instructor. Without it "Silbot is nothing except for a funny fellow" as she stresses:

"*You will gain nothing from just turning on the robot.*"

The project manager agrees with her and points out that Silbot is not capable of acting on its own:

"*You will always need humans around this system if it has to make sense as well. The system is not capable of delivering the benefits to the world...*"

To the author, it seems clear that the Danish game instructors are engaged in the same type of interactional maintenance that Alač explored in laboratory settings in the US. The qualitative interviews do not reveal exactly how the Danish stakeholders enact the robots, however, observing Silbot in everyday practices and as part of the social practice Brain Fitness renders this enactment visible. Ethnographic fieldwork thus highlights the invisible work that the Danish stakeholders have to do to maintain Brain Fitness as a practice.

4.4 Multiple use cases

Though Silbot has been running day-to-day in elderly care in Aarhus since 2015, and the concept of Brain Fitness has been continually developed and refined since the robot arrived in Denmark in 2011, its function and use are continually evaluated and only somewhat stabilized. The ethnographic observations and interviews reveal that project members keep coming up with new test scenarios and regularly consider new use cases. The robot's effects have been tested on citizens with mental disorders. A new test will study whether the use of Silbot and the participation in Brain Fitness can reduce social isolation among disabled citizens. In the interviews, the stakeholders in Aarhus spoke about their ideas for the future use of Silbot and the need for developing new cognitive games targeting different population groups with various challenges. Ever since the Municipality of Aarhus bought the copyright to the cognitive games and robot a recurrent theme has been the possibility of selling Silbot in Denmark and the rest of Europe. Yet, this scenario has been somewhat obstructed as the municipality cannot lawfully sell any products (except knowledge and know-how). No private company has been willing to sign a seller's contract with the municipality, though several companies have shown interest in the concept of Brain Fitness. The ongoing constructive collaboration with the Korean developers RoboCare and KIST has slowed down since 2016, and the stakeholders in Aarhus do not know whether the Koreans would be willing to provide full technical support for Silbot in the future. In Aarhus, this support is deemed crucial for the continued use of Silbot.

5 Discussion

Aside from furthering in-depth explorations of human-robot interaction and conveying how users anthropomorphize robots in practice, which however, will not be elaborated herein, ethnographic long-term studies of HRI allow for more elaborate understandings of how robots are accepted, adapted, and enacted in practice. It affirms society (or the context of usage) as an active shaper rather than a "passive receptor" of robots [51], reveals users as co-constructors *in situ* [7, 39, 42], and acknowledges robots as agents mediating changes in their natural environments [12, 24]. Such insights can be difficult to derive from controlled environment studies or short-term explorations of human-robotic interaction. I will discuss and clarify how insights from ethnography, such as the ones mentioned above, can benefit future HRI-research.

5.1 Sociality inscribed by users

De Graaf, Ben Allouch, and van Dijk argues that "roboticists need to acknowledge that social robots are essentially not social per se. Social robots are machines programmed in such a way that their behavior is perceived by humans as social, which, in turn, evokes social responses from human users. In other words, the robot's sociability is shaped in the mind of the user." [15]. Other studies likewise stress how the sociality of social robots is constructed in social practices [2, 28, 40, 52]. The ethnographic fieldwork presented in this paper supports these findings. The various observations and interviews reveal the robot's sociality and social acceptability as dependent on the actions of its human operators. They have the ability to explain and excuse the robot's sometimes odd behavior to the users, compensate when the robot seems ill-adjusted in practice, and improvise when the robot does not respond as expected [8]. In the case of Silbot the lack of a clearly defined use case spurred the end-users, i.e. the Municipality of Aarhus, to reconsider the vaguely defined Brain Fitness-concept developed in Korea, further refine it and establish a social practice, where Silbot functions as a material element. In other words, the stakeholders had to make sense of the robot in their everyday practices. Their continuous exploration of possible uses keeps the robot running in Denmark. Based on these observations, I encourage roboticists to explore how the use of their robots remains flexible to interpretation by end-users. By examining contexts of use and by speaking to potential users during the design process and onwards, the robot engineers can improve how their robots are accepted in practice by building robots that supports and eases human work processes already in place. This will allow roboticists to consider how to encourage the users' willingness to interact with and maintain the robots interactionally and thereby keep their robots running.

5.2 Reassessing long-term interaction models

I sympathize with Sung, Grinter, and Christensen's intention that HRI-research must get past novelty effects to understand long-term effects of human-robot interaction, however, I find their stage-model of pre-adoption, adoption, adaptation, and use/retention, called Domestic Robot Ecology (DRE) [53], too limited to account for the ethnographical findings in the case study of Silbot. Though other authors have supported the usability of DRE [19], I do not see any signs of routinization in use after only two to six months, as Sung, Grinter and Christensen do [24]. Their suggestion of a two-month baseline long-term study would not be sufficient to identify the adaptation of Silbot as it took more than five years before any routine usage could be identified, and in the Danish case-study the robot still appears *multistable* in its use [54, 55]. De Graaf, Ben Allouch, and van Dijk [15] present a model of six robot acceptance phases (expectation, encounter, adoption, adaption, integration, and identification). Though similar to the DRE-model it is more elaborate. Yet, both of these models seem too linear to explain the acceptance of Silbot. The reason might be that they are developed from long-term studies of domestic robots (a robot vacuuming cleaner and the Karotz home companion robot), whereas Silbot is a socially assistive robot designed for health- and elderly care services in a public setting where a multitude of users, i.e. health care personnel and elderly citizens are involved in the complex structural setup. Sung, Grinter, and Christensen acknowledge that "different timeframes may be necessary for other robots or routines" [24]. I consider the limitations of the present models used to account for long-term acceptance an obligation for further research of the long-term acceptance of social robots (also robots used outside the home). Such studies, where interviews with users are supplemented with participant observations of everyday usage, would allow for more elaborate understandings of long-term human-robotic interactions and more dynamic and multimodal models of robot implementation than the linear ones in use inspired by Rogers' implementation and diffusion-model [19, 56]. Models that are more "iterative and evolutionary" [57, 58] and capable of accounting for the "change and modification" [59] that is ongoing and apparent in every phase of technology use. Participant observations allow the observer to examine how users actually engage and interact with robots in real-life. Ethnographic studies, as the one presented in this paper, can thus provide the basis for a more "thick" and comprehensive account of long-term HRI. It can equip roboticists with a methodology to explore the sometimes invisible acts that people do, but do not mention when asked, to maintain robots interactionally and to make them social and socially acceptable in real-life situations.

5.3 Design considerations

I agree with de Graaf, Ben Allouch, and van Dijk, that there is a "need for more ecologically valid research and the inclusion of the actual potential end-users required to be able to gain insight into how people perceive, accept, and interact with robots in real-world contexts as well as to test their feasibility and/or usability in such contexts" [15]. This will not only help the robot designers explore "natural interactions and human interactions" [15], it will further the realization that technological designs remain multistable and flexible to interpretation by different users in various use contexts [60–62]. Therefore roboticists should avoid making mere assumptions about end-users and possible use-cases during the design phase [63], but instead explore these in their natural settings. This can be done ethnographically as such studies advance contextual understandings of robots as dependent on social relations and not simply replacements for these [12, 16]. Ethnographic studies can also uncover users' trust in various robot designs and the sustainment of human interest in recurrent robot interaction [4, 16, 64] as well as clarifying ethical dimensions of human-robot interaction by describing new forms of normativity, as they are formed in the relations between machines and humans [65].

Roboticists must recognize that robots, like other technologies, are enveloped in social practices [33], and that their use and meaning are constructed in practice and not something that can be designed in advance [27, 39, 52]. If the ideal is to design responsible and understandable robots compatible with the needs of their users [20] then I suggest, besides from constructing the robots, that roboticists must also pay attention to the use case i.e. the social practice in which their design will function as a material element. Roboticists could study the social practices in place in order to assess potential users' ability to receive and adopt robots, but also to understand how their robots could enhance, mediate, and support social practices instead of replacing them. In other words, ideally the roboticist should be concerned with practice design [66, 67]. Paying attention to the future operators and users will likely further the intention of keeping humans in the loop [68] and increase the likelihood of successful long-term acceptance [69]. Although it remains a time-consuming task, ethnography and ethnographic data-gathering methods will enable designers to learn from their potential users and explore possible use practices for their robotic designs – as ethnography can be considered an occasion to study *with* their users [16]. I suggest these design questions can be explored ethnographically (or by including ethnographers early on in the design process [49]) as this will advance the successful adaptation of robots in practice and further a comprehension of design processes as a multimodal, open-ended and iterative [16].

6 Conclusion

In this paper the author has presented the empirical findings of his ethnographic fieldwork conducted over a period of two years. He has followed the Danish implementation and further development of the socially assistive robot Silbot and the performance of Brain Fitness. He has approached questions of human-robot interaction, adoption, and adaption as part of an ethnographic study of the transfer of Silbot to Denmark and Finland.

Such an ethnographic approach to questions of long-term effects of human-robotic interaction and robot acceptance is shown as viable as it is demonstrated how ethnography can yield insights about the adoption, adaptation and routinization of robots in practice, the temporality of HRI and end users' acceptance and use of robots. The author argues that ethnographical studies of HRI can provide the basis for more elaborate and dynamic models of long-term adaptation of robots.

Knowledge generated from ethnography and ethnographic data about robots in natural environments thus seem valuable, not only as an important contribution to the conceptual development of HRI-studies, but also as a way to ground future design of robots and their imagined uses in real life contexts [1, 70].

Acknowledgements: My thanks to my supervisors Finn Olesen and Cathrine Hasse. To Morana Alač and her lab group at UC San Diego, and the Humanity Centered Robots Initiative (HCRI) at Brown University for allowing me to discuss the ideas presented herein. Special thanks to my wife Anne S. Blond.

References

[1] L. Neven, C. Leeson, Beyond determinism: understanding actual use of social robots by older people, In: D. Prendergast, C. Chiara (Eds.), Aging and the Digital Life Course, Berghahn, 2015, 84–102
[2] A. Lazar, H. J. Thompson, A. M. Piper, G. Demiris, Rethinking the design of robotic pets for older adults, In: DIS'16 Proceedings of the 2016 ACM Conference, (2016, Brisbane, Australia), Queensland, 1034–1046
[3] G. Balthus, D. Fox, F. Gemperle, J. Goetz, T. Hirsch, D. Magaritis, et al., Towards personal service robots for the elderly, WIRE-2000, Workshop on Interactive Robots and Entertainment (2000, Pittsburgh, USA), Pennsylvania, https://www.ri.cmu.edu/publications/towards-personal-service-robots-for-the-elderly/
[4] M. A. Goodrich, A. C. Shultz, Human-robot interaction: a survey, Foundations and Trends in Human-Computer Interaction, 2008, 7 (3), 203–275
[5] L. Blond, F. Olesen, Unpacking the cultural baggage of travelling robots – how socially assistive robots are integrated in practice, In: C. Hasse, D. M. Søndergaard (Eds.), Designing Robots, Designing Humans, Routledge, 2019 (in press)
[6] M. M. A. de Graaf, S. Ben Allouch, Evaluation of a socially assistive robot in eldercare, HRI'14 (2014, Bielefeld, Germany), ACM Press
[7] C. Hasse, Multistable roboethics, In: J. K. B. O. Friis, R. P. Crease (Eds.), Technoscience and Postphenomenology – The Manhattan Papers, Lexington Books, 2015, 169–189
[8] C. Leeson, Anthropomorphic Robots on the Move, PhD thesis, University of Copenhagen, 2017
[9] W-Y. G. Louie, D. McColl, G. Nejat, 2014, Acceptance and attitudes toward a human-like socially assistive robot by older adults, Assistive Technology, 2014, 26(3), 140–150
[10] J. Robertson, Robo sapiens japanicus: robots, gender, family, and the Japanese nation, University of California Press, 2017
[11] H. I. Christensen (Ed.), A roadmap for US robotics: from internet to robotics, Technical Report, Georgia Institute of Technology, 2009
[12] C. Hasse, Artefacts that talk: mediating technologies as multistable signs and tools, Subjectivity, 2013, 6(1), 79–100
[13] K. Darling, Extending legal protection to social robots: the effects of anthropomorphism, empathy, and violent behavior towards robotic object, We Robot Conference (2012, Miami, USA), Florida, https://dx.doi.org/10.2139/ssrn.2044797
[14] P. Lin, Introduction to robot ethics, In: P. Lin, K. Abney, G. A. Bekey (Eds.), Robot Ethics – The Ethical and Social Implications of Robotics, The MIT Press, 2012, 3–17
[15] M. M. A. de Graaf, S. Ben Allouch, J. A. G. M. van Dijk, 2016, Long-term acceptance of social robots in domestic environments: insights from a user's perspective, In: AAAI Spring Symposium Series, AAAI Publications, 2016, https://www.aaai.org/ocs/index.php/SSS/SSS16/paper/view/12692
[16] M. H. Bruun, S. Hanghøj, C. Hasse, Studying social robots in practiced places, Techné: Research in Philosophy and Technology, 2015, 19(2), 143–165
[17] I. Leite, C. Martinho, A. Paiva, Social robots for long-term interaction: a survey, International Journal of Social Robotics, 2013, 5(2), 291–308
[18] Y. Fernaeus, M. Håkansson, M. Jacobsson, S. Ljungblad, How do you play with a robotic toy animal? A long-term study of Pleo, In: IDC' 10 Proceedings of the 9th International Conference on Interaction Design and Children, (2010, Barcelona, Spain), https://doi.org/10.1145/1810543.1810549
[19] J. Fink, V. Bauwens, F. Kaplan, P. Dillenbourg, Living with a vacuum cleaning robot – a 6-month ethnographic study, International Journal of Social Robotics, 2013, 5(3), 389–408
[20] T. Fong, I. Nourbakhsh, K. Dautenhahn, A survey of socially interactive robots, Robotics and Autonomous Systems, 2003, 42(3-4), 143–166
[21] H. Hüttenrauch, K.S. Eklundh, K. S. Fetch-and-carry with CERO: observations from a long-term user study with a service robot, In: Proceedings of the 11th IEEE International Workshop on Robot and Human Interactive Communication (2002, Berlin, Germany), 158–163
[22] C. D. Kidd, C. Breazeal, Robots at home: understanding long-term interaction, IEEE/RSJ International Conference on Intelligent Robots and Systems (2008, Nice, France), https://doi.org/10.1109/IROS.2008.4651113

[23] A. M. von der Pütten, N. C. Krämer, S. C. Eimler, Living with a robot companion – empirical study on the interaction with an Artificial Health Advisor, ICM'11 (2011, Alicante, Spain) https://doi.org/10.1145/2070481.2070544
[24] J. Sung, H. I. Christensen, R. E. Grinter, Robots in the wild: understanding long-term use, HRI'09 (2009, La Jolla, USA) California, ACM Press
[25] C. May, R. Harrison, T. Finch, A. MacFarlane, F. Mair, P. Wallace, Understanding the normalization of telemedicine services through qualitative evaluation, Journal of the American Medical Informatics Association, 2003, 10(6), 596–604
[26] K. Dautenhahn, A. Billard, Bringing up robots or – the psychology of socially intelligent robots: from theory to implementation, In: Proceedings of the 3rd Annual Conference on Autonomous Agents (1999, Seattle, USA), Washington, https://doi.org/10.1145/301136.301237
[27] C. Breazeal, Toward sociable robots, Robotics and Autonomous Systems, 2003, 42(3-4), 167–175, https://doi.org/10.1016/S0921-8890(02)00373-1
[28] M. Alač, Social robots: things or agents? AI & Society, 2016, 31(4), 519–535
[29] K. Dautenhahn, Design spaces and niche spaces of believable social robots, In: Proceedings of the 11th IEEE International Workshop on Robot and Human Interactive Communication (2002, Berlin, Germany), https://doi.org/10.1109/ROMAN.2002.1045621
[30] C. Bartneck, J. Forlizzi, A design-centered framework for social human-robot interaction, International Workshop on Robot and Human Interactive Communication, (2004 Kurashik, Japan), https://doi.org/10.1109/ROMAN.2004.1374827
[31] S. Zhao, Humanoid social robots as medium of communication, New Media Society, 2006, 8(3), 401–419
[32] D. Feil-Seifer, M. J. Matarić, Defining socially assistive robotics, In: Proceedings of the 2005 IEEE 9th International Conference on Rehabilitation Robotics (2005, Chicago, USA), https://doi.org/10.1109/ICORR.2005.1501143
[33] A. Pickering, The mangle of practice – time, agency, and science, University of Chicago Press, 1995
[34] A. Giddens, The Constitution of Society – Outline of the Theory of Structuration, Polity Press, 1984
[35] M. Pantzar, E. Shove, Understanding innovation in practice: a discussion of the production and re-production of Nordic Walking, Technology Analysis and Strategic Management, 2010, 22(4), 447–461
[36] A. Reckwitz, Toward a theory of social practices – a development in culturalist theorizing, European Journal of Social Theory, 2002, 32(2), 243–263
[37] E. Shove, M. Pantzar, M. Watson, The Dynamics of Social Practice: Everyday Life and How it Changes, SAGE, 2012
[38] M. Alač, Moving android: on social robots and body-in-interaction, Social Studies of Science, 2009, 39(4), 491–528
[39] M. Alač, J. Movellan, F. Tanaka, When a robot is social: spatial arrangements and multimodal semiotic engagement in the practice of social robotics, Social Studies of Science, 2011, 41(6), 893–926, https://doi.org/10.1177/0306312711420565
[40] M. Alač, Points to and shakes the robot's hand – Intimacy as situated interactional maintenance of humanoid technology, Zeitschrift für Medienwissenhaft, 2016, 15, http://www.zfmedienwissenschaft.de/online/points-and-shakes-robots-hand
[41] A. R. Guevara, Techno-modeling care: racial branding, dis/embodied labor, and "Cybraceros" in South Korea, Frontiers: A Journal of Women Studies, 2015, 36(3), 139–196
[42] L. Blond, K. Schiølin, Lost in translation: getting to grips with multistable technology in an apparently stable world, In: J. Aagaard, J. K. B. O. Friis, J. Sorenson, O. Tafdrup, C. Hasse (Eds.), Postphenomenological methodologies: New ways in mediating techno-human relationships, Rowan & Littlefield International, 2018, 151–167
[43] C. A. Davies, Reflexive ethnography – a guide to researching selves and others, Routledge, 2008
[44] M. Hammersley, P. Atkinson, Ethnography – principles in practice – third edition, Routledge, 2007
[45] N. K. Denzin, The Research Act, Aldine Publishing, 1970
[46] S. Kvale, Doing Interviews, SAGE, 2007
[47] P. Atkinson, A. Coffey, Analysing documentary realities, In: D. Silverman (Ed.), Qualitative Research – Theory, Method and Practice, SAGE, 1997, 45–63
[48] K. Hastrup, Getting it right – knowledge and evidence in anthropology, Anthropological Theory, 2004, 4(4), 455–472
[49] D. Forsythe, "It's just a matter of common sense": ethnography as invisible work, Computer Supported Cooperative Work, 1999, 8(1-2), 127–145
[50] C. Hasse, An Anthropology of Learning – On Nested Frictions in Cultural Ecologies, Springer, 2015
[51] S. Šabanović, Robots in society, society in robots, International Journal of Social Robots, 2010, 2(4), 439–450
[52] L. Suchman, Human-machine reconfigurations – plans and situated actions, Cambridge University Press, 2007
[53] J. Sung, H. I. Christensen, R. E. Grinter, Domestic robot ecology: an initial framework to unpack long-term acceptance of robots at home, International Journal of Social Robotics, 2010, 2(4), 417–429
[54] D. Ihde, Technology and the Lifeworld: From Garden to Earth, Indiana University Press, 1990
[55] R. Rosenberger, Multistability and agency of mundane artefacts – from speed bumbs to subway benches, Human Studies, 2014, 37(3), 369–392
[56] E. M. Rogers, Diffusion of Innovations, Free Press, 2003
[57] J. D. Eveland, Issues in using the concept of "adoption of innovation", Journal of Technology Transfer, 1979, 4(1), 1–13
[58] C. R. May, M. Johnson, T. Finch, Implementation, context and complexity, Implementation Science, 2016, 11(141), 1–12, https://doi.org/10.1186/s13012-016-0506-3
[59] J. D. Eveland, Diffusion, technology transfer, and implementation – thinking and talking about change, Knowledge: Creation, Diffusion, Utilization, 1986, 8(2), 303–322
[60] W. E. Bijker, Do not despair: there is life after constructivism, Science, Technology, & Human Values, 1993, 18(1), 113–138
[61] R. Kline, T. Pinch, User as agents of technological change: the social construction of the automobile in the rural united states, Technology and Culture, 1996, 37(4), 763–795
[62] P. Rosen, The social construction of mountain bikes: technology and postmodernity in the cycle industry, Social Studies of Science, 1993, 23(3), 479–513
[63] M. Akrich, The description of technical objects, In: W. E. Bijker, J. Law (Eds.), Shaping Technology/Building Society: Studies in Sociotechnical Change, The MIT Press, 1992, 119–138
[64] E. Philips, K. E. Schaefter, D. R. Billings, F. Jentsch, P. A. Hancock, Human-animal teams as an analog for future human-

robot teams: influencing design and fostering trust, Journal of Human-Robot Interaction, 2016, 5(1), 100–125
[65] P.-P. Verbeek, What Things Do: Philosophical Reflections on Technology, Agency, and Design, The Pennsylvania State University Press, 2005
[66] O. Korkman, K. Storbacka, B. Harald, Practices as markets: value co-creation in e-voicing, Australasian Marketing Journal, 2010, 18(4), 236–247, https://doi.org/10.1016/j.ausmj.2010.07.006
[67] E. Shove, F. Trentmann, R. Wilk, Time, consumption and everyday life - practice, materiality and culture, Berg, 2009
[68] D. A. Mindell, Our Robots, Ourselves – Robotics and the Myths of Autonomy, Viking, New York, 2015
[69] M. M. A. de Graaf, S. Ben Allouch, J. A. G. M. van Dijk, Long-term evaluation of a social robot in real homes, Interaction Studies, 2016, 17(3), 461–490, http://dx.doi.org/10.1075/is.17.3.08deg
[70] A. van Wynsberghe, Healthcare robots – ethics, design and implementation, Ashgate, 2015