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"Here comes my son!"

On the underlying invisible work and infrastructure of a telepresence robot in a Danish nursing home

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Abstract

The article uncovers the formation of an infrastructure made to facilitate the implementation of a telepresence robot in a Danish nursing home. Ethnographic fieldwork data illuminates how myriad of human and non-human actors, such as supporters, Wi-Fi networks, care workers and cameras, work together as a hybrid, socio-technical collective. This collective constantly coordinates and improvises in a joint effort to construct, maintain and stabilise the flexible infrastructure, which facilitates the implementation of the new communication technology in the daily routines of staff and residents at the nursing home. The main argument of the article is that implementation of new technology is dependent on large amounts of work on the part of both of human and technical actors. Much of this work is normally invisible to and lack acknowledgment by decision makers. Thus, the article argues that a focus on infrastructure proves crucial in the uncovering of otherwise invisible work processes.

Keywords welfare technology, telepresence robots, implementation, infrastructure, invisible work

Introduction

In recent years, politicians have brought an increased focus on digitalisation and welfare technologies in the Danish public sector. Concurrently, investments have been made to introduce welfare technologies as part of the existing welfare services (The Danish Government 2011, The Danish Government et al. 2013, KL 2014). In particular, the domains of health and elderly care have been highlighted as areas that would benefit from implementation of more welfare technology (The Danish Government 2011, 49). Often, politicians argue that new technologies will help older citizens become more independent which will thereby improve their quality of life. Furthermore, it is argued that influx of welfare technology will mitigate labour shortage in the care sector (The Ministry for Social Affairs & KL 2010: 5). One of the explanations for the latter is that welfare technology is expected to streamline the ways in which tasks are performed, which would reduce man hours. Therefore, investments in new technologies are portrayed as a potential method for coping with the "elderly dependency ratio" in a future scenario where Denmark has fewer workers in the elderly care sector.

The Danish concept of welfare technology is related to the English term *assistive technology* (ATiA 2016), which encompasses rehabilitation technologies and assistive devices aimed at people with function impairments such as handicaps. In Denmark, welfare technology is strongly linked to the public welfare system and social and health services. Thus, welfare technology is aimed at people with addictions, older people, and other citizens with functional impairments who receive welfare services. A distinction is made between two types of welfare technology. The first type performs practical functions in e.g. nursing homes. An example of this type of welfare technology is robot vacuum cleaners, i.e. a technology that relieve citizens or employees of physical, routine tasks. The second type of welfare technology is information or communication technology such as intercom systems, surveillance cameras and GPS tracking devices, which relay information or allow people to communicate. In this article, we focus on an example of the second type; a communication technology in the form of a so-called telepresence robot that the manufacturer named "Beam".

The article investigates how a municipal welfare technology trial project plays out at Solbjerg Local Centre on the outskirts of Aarhus, Denmark. The municipality wanted to implement Beam based on the idea that it would facilitate conversations between nursing home residents and their families; thereby making residents less lonely.

The central analytical perspective in our analysis of Beam is inspired by Geoffrey C. Bowker & Susan Leigh Star's (1991) concept of *infrastructure*, which, with its updated version of the concept of network, emphasises the coordination work that is required in order to implement new technology. The article's data material shows that the implementation of this communication technology requires the formation of an infrastructure made up of networks of socio-material elements such as Wi-Fi connections, webcams, care workers, mobile telephones, relatives and support staff. Together, these elements constitute a working, hybrid collective (Law & Callon 1997) that carries out a range of crucial micro-processes that may be visible or (initially) invisible. This hybrid collective continually coordinates and adapts itself to suit new practices while new supporting actors and functions are added to the network to facilitate the implementation.

Infrastructure and invisible work

The published literature on Human Computer Interaction (HCI) includes several articles on telepresence robots aimed at older users. However, these articles are mainly concerned with robots in private homes of older people and focus on evaluating and testing this technology in practice (see for example Boissy et al. 2007, Moyle et al. 2014; Sumioka et al. 2014 and Kristoffersen et al. 2011). Thus, the HCI literature consists primarily of feasibility studies; i.e. quantitative studies of whether the technology is successful in the tasks for which it is intended, based on predetermined parameters. This article positions itself within the interdisciplinary field of Science, Technology & Society Studies (STS), in which technology studies is pivotal. The classic STS technology studies describe how technological artefacts are constructed as hybrids between the social and the technical (see for example Latour 1987, 1996; Law 1989; Bijker 1997). One recurring theme is the (mis)match that often arises between a technology developer's ideas about the practice, into which the technology will be integrated, and the actual situation (see for example Akrich 1992). Therefore, this article points out the importance of not only studying the development of technologies but also their implementation in practice. A recent study discusses the care robot 'Alice', that is tested as a conversational partner amongst older people, who live alone, with the purpose of preventing loneliness. The study supports how micro-processes involved in the implementation is key to the understanding of technology-in-practice and how care and technology are not necessarily opposites, but gets entangled in all sorts of ways in practice (Schwennesen 2016).

The key analytical concept in this article, infrastructure, is inspired by the technology approach in STS, as well as perspectives from symbolic interactionism. In symbolic interactionism, the emphasis is on how actors act and interact with other actors and objects, and particular attention is paid to the work that the actors invest in specific situations. Focusing on the extensive work that is required for situations and practices to unfold and function brings about an analytical sensitivity to the (often unseen) extra work that actors undertake in order to make a specific situation succeed. Furthermore, the classifications and standards that support practices become more readily apparent. Infrastructures are thus relational, hybrid networks, which act as facilitating systems that enable things (i.e. technologies) and practices to function. At the same time, infrastructure can be a challenge or a barrier and always requires constant maintenance. Infrastructure should not be understood as merely a substrate upon which something else functions, such as a road network or water pipes, but rather as an active, relational network, which requires on-going investments and coordination of work (Star & Ruhleder 1994, Star 1999).

In our analysis of the implementation of Beam, we see it as part of a larger socio-technical, infrastructural network made up of the relationships between human and non-human actors such as suppliers, software, nursing home residents, care workers, supporters, spare parts, cleaning staff and instructions. The analysis describes how technological and social actors continually coordinate and undertake adaptations to enable the technology to function within the daily life of the nursing home. In order for Beam to be implemented and have value for the residents, families and staff at the nursing home, the socio-technical actors must work together to create an infrastructure that facilitates its function and embedding in the local work routines and everyday practices.

Method

Our analysis draws upon empirical material generated through fieldwork at several nursing homes in Aarhus Municipality for one of the authors' Master's thesis. In this article, we focus primarily on one participant observation, a usage situation involving a female nursing home resident and her son, in which the telepresence robot Beam was used as a communication tool. The participant observation was coordinated by the nursing home's welfare technology instructor, who was also present. It took place in a common area, an employee's office, and in the citizen's apartment at the nursing home. The observation was documented using the American anthropologist Clifford Geertz' classic concept of ethnography as a 'thick description' (Geertz 1973). According to Geertz, a thick description of a situation is a highly detailed description which includes factual circumstances and captures and interprets symbolic nuances as well as reflexive commentary - both from the ethnographer and the other participants in the situation.

Thus, in the observation of a specific usage situation with Beam, the observer made comprehensive field notes, laden with as much meaning as possible. These field notes provide a detailed basis for mapping the numerous micro-processes that occur on the robot's journey from its base in the docking station to the female resident's apartment, where the conversation takes place. Along with the observation itself, this article also draws upon interviews with the welfare technology instructor and the resident's son. The informants are anonymous but for readability we call the resident Edith, her son Hans, and the instructor Gitte.

The following analysis is structured chronologically; i.e. we follow the entire process of the conversation from Hans' call, to transporting the robot to the Edith's apartment, and the conversation itself. First, we briefly introduce the telepresence robot and the communication welfare technology trial project of which its presence at the nursing home was a part.

Beam's socio-technical arrangement

In January 2015, Solbjerg Local Centre received the telepresence robot Beam as part of the municipal trial project *Telebesøgsvenner* (*Telecompanions)* (Aarhus Municipality 2015). The project was launched by the municipality with the aim of investigating whether this communication technology could increase the amount of contact between residents and their loved ones. Furthermore, the care staff expressed hope that increased contact would reduce loneliness amongst residents. Beam was placed on the first floor of the nursing home and was solely used by residents on that floor. When the robot was not in use, it was placed in a docking station located in one of the centre's corridors (see image 1). The relatives who were set up as users could call the robot to speak with the residents and the staff at the nursing home.

Courtesy of Penton Design, Engineering and Sourcing Group

Photo by Marie Anna Svendsen

Telepresence robots like Beam are commonly known as 'Skype on wheels' as they are a technology for video communication reminiscent of the popular IP telephone service. However, in contrast to Skype, telepresence robots allow an external user (pilot) to navigate the robot in a remote environment (the nursing home) and interact with the people there. The videophone technology, which is called mobile robotic telepresence (MPR) connects two or more callers, who can see each other on their screens. Beam is also different to Skype, where the two callers use the same computer program to communicate, as it is only the 'pilot' (i.e. the user located outside of the nursing home) who interacts with the computer program Beam App via a user interface (see image 2). Beam App can be installed on the pilot's computer, which must be connected to the internet. Using the program, the pilot can guide the robot around the nursing home with the help of two video feeds. The pilot steers the robot with his/her computer mouse or arrow keys. Beam is a box mounted on two wheels, which is linked to two legs upon which a screen with a camera lens is positioned. The pilot can turn the cameras that send the two video feeds if he/she wants to see something out of range. From the local user's perspective, there is no user interface to operate. Since the robot is connected to the nursing home's wireless network, the pilot is connected immediately and can interact directly with people in the nursing home without anyone having to answer the call.

Arranging the call: the importance of support work

> Gitte has arranged with Edith and Hans that Hans will call Beam at 2pm. First, Gitte finds Hans' phone number under Edith's profile on the desktop computer. She calls Hans to confirm our agreement and tells him that I am with her today. Gitte hangs up and tell me that Hans will call Beam in a moment. We walk from Gitte's office to the corridor where Beam is located in its docking station. We are looking at the robot for a while and talk about how we hope that it will work today. There were some problems due to a software update the week before, Gitte tells me. However, Blue Ocean, the company that provides support services for Beam, quickly sent someone to the nursing home to replace a spare part. It is supposed to be working again now. Shortly after Hans' face appears on the screen. He is a middle-aged, friendly looking man with grey hair. It looks like he is sitting in an office at home, which I am told is not far from the nursing home. Hans says hello, and Gitte responds (Excerpt from field notes, November 2015).

Hans' sudden appearance on the screen, brings life to the otherwise 'dead' robot. This is possible because of a vast amount of work hidden behind the scenes, which only becomes visible when a problem arises, and support is summoned. Invisible work, such as the on-going support in this case, maintains the infrastructure that is required for a technology like Beam to function within the everyday practice of the nursing home.

The infrastructure and accompanying support work consist of numerous actors and sub-processes, which unfold both before and after implementation of the robot. One example of this is installation of the wireless network to which Beam connects in order to send and receive information such as the video feed, sound, and navigation between the robot and the pilot's computer. Practical knowledge is required about where to place routers, how to connect wires as well as technical knowledge about bandwidth and range. The nursing staff does not possess this knowledge. The supplier and support provider for Beam in Denmark is Blue Ocean, a company based in Odense while the developers of the communication technology are an American company called Suitable Technologies. However, it is crucial that the company responsible for supporting Beam is based in Denmark, because maintenance of the robot involves repairing or replacing parts and thus requires the physical presence of a technician.

Gitte described the working relationship with Blue Ocean as positive and unproblematic. She explained that Blue Ocean's technicians had quickly repaired the robot when it was out of service the week before the observation. She also said that she often received emails if the supporters noticed that the robot was offline because it had not been correctly placed in the docking station to recharge and had run out of battery. This rapid and on-going support is crucial when it comes to maintaining the relatives' and residents' enjoyment of and trust in the service provided by the robot. Support work located behind the scenes may seem trivial, but it is decisive to the success of the technology implementation. If the support element of the infrastructure does not work, the users' experience of the technology will be completely altered.

The description above also provides an insight into the number of different technical and human actors that are involved in Beam's infrastructure. Beam can only function if a relative has his/her own computer with Beam App installed, a stable internet connection, a webcam (preferably HD), a microphone, and a computer mouse or mouse pad. Besides the aforementioned support worker, the human actors are Gitte, who, in her role as welfare technology instructor, orchestrates contact between the various users, i.e. Hans, a relative and external user and Edith, a resident and local user. Thus, an additional component of the infrastructure, that enables Beam to function in practice, is a heterogeneous network of actors, internal relationships, and an on-going allocation and distribution of tasks.

From the docking station to the resident's apartment: ad hoc adaptations and technological goodwill

> Gitte suggests that we – Hans with Beam, Gitte and I – move down to Edith's apartment, situated at the other end of the nursing home. Edith lives in apartment 26, Hans says. Hans leads the way with Beam, rolling slowly down the corridor. Gitte and I follow. Gitte has told me that Hans is able to steer Beam using the arrow keys on his computer keyboard. On the way, Hans notices a problem with the robot. It suddenly stops and will no longer move forwards. It is something to do with the network connection. Gitte asks Hans whether the image on his screen is clear. Hans responds by saying that the image is sometimes unclear and that there are large squares on it like on a digital television. He explains that the connection is often poor in the part of the nursing home where Edith lives. (Excerpt from field notes, November 2015).

As described, the infrastructure only tends to become apparent when it suddenly fails to function optimally. The problem in this case is failure of the network connection, which prevents Beam from moving on its way to Edith's apartment. This means that we have to stop and wait for the robot to work again, and interaction between Hans and the rest of us suddenly seems unnatural and awkward. We are no longer able to interact with Hans as though he is actually with us in the room. Instead, we are now forced to focus on Beam as a communication technology that is not functioning optimally. A stable wi-fi connection is crucial to the image quality and the pilot's user experience of Beam. Depending on who is piloting the robot and the user's knowledge of the nursing home's layout, this can be more or less significant. Hans explains that at times, the connection has been so bad that it would have been hard for him to orient himself in the corridors if he had not been so familiar with the surroundings of the building. However, since he knows the nursing home well, because he often visits his mother in person, he can live with the quality being less than optimal. It would be a different matter if a relative, who was not intimately familiar with the layout of the nursing home, were to try to navigate in the blurred landscape of pixels. Hans has put in a great deal of work into installing Beam App and learning how to steer Beam in order to use it to communicate with his mother. In addition to this, he has also carried out the 'work' of visiting the nursing home in person, which serves him well now that he has to navigate Beam through a pixelated landscape. These efforts of invisible work are significant to the practice that involves Beam. If Hans were unable to steer from the docking station to Edith's apartment by himself, he would have to seek help from the nursing home staff or give up entirely. In the interview with Hans, it emerges that he has a personal interest in Beam and therefore has a great amount of goodwill towards the technology. This means that he is willing to find solutions when problems with the robot arise. According to Gitte, this interest is uncommon for relatives of the nursing home residents. However, it has meant that Hans was able to learn how to operate the Beam App user interface with ease. Gitte explained how a relative of one of the other residents had found it very difficult to learn how to use the user interface of Beam App, and that Blue Ocean consequently had spent a long time training her. Indeed, such training may be necessary for relatives who are not used to using computer programs. As well as proving that Beam can be complicated to learn to operate, this also shows that an investment of time and goodwill is required of the actors involved if the technology is to be used in practice.

> On the way to Edith's apartment, we meet a female resident, whom Gitte greets. She asks, "Who do we have here?" "It's Hans, Edith's son," Gitte explains. "Aha, ok," the resident responds, seemingly familiar with the situation. Gitte and I have to open a double door into Edith's corridor so that Beam can enter. […] The door into num-

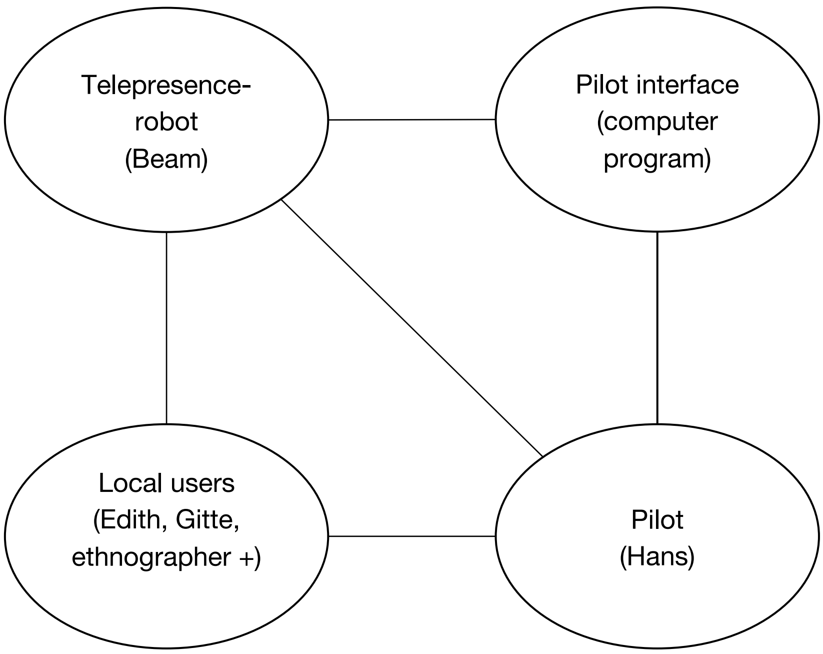
> ber 26 is open. One of the care assistants stands in the doorway. She tells us that Edith is in the bathroom. "Then I will wait a bit," says Hans. Edith comes out into the living room and says hello. Hans rolls into the apartment, and Gitte and I follow. Gitte explains to me how I should open the front door for Beam, when it has to roll out again. It is important that I press a button on the wall to keep the door open so that it has time to roll out. Afterwards, I have to press another button to close the door (Excerpt from field notes, November 2015).

Beam is not able to climb stairs or take the elevator and cannot open doors. This is a problem, both when Hans tries to enter Edith's corridor which has a closed double door, and when he tries to enter Edith's apartment. Since Edith finds it hard to make arrangements in advance due to her dementia and does not have a phone, it is impossible for her and Hans to plan when he will visit her with Beam. Therefore, the staff also become part of the infrastructure that supports Beam by opening the doors to the corridor and the apartment, pressing the button in Edith's apartment to keep her front door open while Beam is inside and, finally, helping Edith to shut the front door again when she is unable to remember how the automatic door works. Hans explains that he has to call the nursing home using his phone if he does not meet any of the staff on his way to Edith's apartment. Although it may not seem like a lot of effort to open a couple of doors, it does require the staff to be available on their cell phones and take their time to help out when they meet Beam in the nursing home corridors, even when they are on their way to help another resident. This is another example of invisible work, which must be carried out by someone, but is transient and dependent upon who happens to be in the corridor at a specific moment and upon agreements between Hans and the staff, and their understanding of the technology and its limitations. However, despite the transience of this aspect of the infrastructure's microprocesses, it is nonetheless crucial if the technology is to function as intended. Another prerequisite for the success of the conversation between Hans and Edith is that the care workers are supportive of the technology and willing to interrupt other tasks to assist with it.

In the description of the relatively short journey from the docking station to Edith's apartment, it is apparent that a successful implementation of the technology is both dependent upon a multitude of actors and functions and upon a number of ad-hoc adaptations during the usage situation. In addition to this, the relatives, residents and staff must have a certain degree of interest and goodwill if the technology is to be included in a meaningful practice.

The conversation: coordination between non-human and human actors

The figure below is a visual representation of the main human and non-human actors involved in the conversation that Beam facilitates as well as how they interact with each other.



The pilot, Hans, is presented as a physical manifestation via Beam. From his home, Hans is able to operate the user interface to navigate the robot around the nursing home. The local users can see and hear Hans via a video and audio feed, relayed from Hans' computer to Beam. Last but not least, Beam sends visual and audio information from the nursing home to Hans' computer.

Thus, successful communication between Hans and Edith requires the coordination of a number of technical sub-processes and collaborations between technology and people. Some of these sub-processes can be described as follows: Hans' computer and Beam must both be connected to the internet; Beam App must be installed on Hans' computer and have a functioning webcam; Hans must be able to operate Beam App's user interface in order to navigate Beam through the corridors of the nursing home without bumping into walls, furniture and people in the local environment; the human actors who are present in the nursing home must be able to see Hans on Beam's screen and hear his voice through the speakers, and they must then acknowledge Beam+Hans as a worthy conversational partner. All of these collaborative elements and relations make up an infrastructure that enables the conversation to take place.

> I greet Edith and we agree that I will sit on the sofa next to Edith's coffee table. Edith sits on the other side of the table on an armchair and Hans is positioned at the end of the table. I talk a bit about why I am here to see how Beam works today. Then Hans and Edith begin to talk to each other. The situation seems a little unfamiliar, and Edith asks whether there is anything in particular I want to see. I explain that Hans and Edith should just talk to each other as they usually do and that I want to see an everyday situation with Beam. It seems a bit awkward and unnatural that I am present, and the conversation between Hans and Edith is very short. Hans says that they sometimes talk for a longer time period. […]Then Hans navigates Beam out. I let him out of the apartment using the button on the automatic door opener that Gitte showed me. Subsequently, I ask Edith about Beam. She seems very confused when I say that Hans "calls her" via Beam. "But he doesn't call though," says Edith, "he just comes" (Excerpt from field notes, November 2015).

According to Hans, in the beginning it seemed foreign to Edith to talk to him via a robot, but in our brief interview, she seems to entirely ignore the technology and focus on the fact that it enables her to talk to her son. In an interview, Hans talks about Edith's initial resistance to the robot:

> It worked so well once she got used to it. The first time she said "I don't want that rubbish in my room. Get that robot out of here."… I mean, she is very much, you know, a robot sounds threatening…but when she heard that it was me talking from the screen, then it was allowed to come in (Excerpt from an interview, November 2015).

When Edith hears her son's familiar voice, her fear and the feeling of having to interact with something foreign subside. Beam becomes a representation of a familiar person and, in this way, the technology is demystified and her resistance dissipates. In order to the fear of an unfamiliar technology can be overcome in this way, it is important that residents are given the opportunity to interact with the robot while piloted by a familiar person.

Gitte explained that, in an attempt to demystify Beam for both the staff and residents', the nursing home manager had used the robot every day during a stay in the Philippines. The manager used Beam to participate in meetings, conduct job interviews, and also drove it round the nursing home talking to residents. In this way, the technology was introduced by someone with whom the residents already had a relationship. The idea was that a concrete manifestation of the goodwill of the staff would rub off on the residents.

The empirical excerpts above show two significant aspects of the invisible coordination work of the infrastructure. The first is the extensive work carried out by relatives, care workers and supporters to ensure that the arrangement of technical and human actors can function as a collaborative, hybrid collective, and that the conversation is a success. Thus, the successful implementation of the new communication technology requires a comprehensive and flexible infrastructure. The second aspect of the invisible work is the investment of goodwill towards the technology functioning in practice. This is undertaken by the manager, for example, who takes advantage of the extraordinary situation of a trip to the Philippines to increase familiarity with and goodwill towards Beam among both staff and residents in the nursing home. Therefore, it is important to note that the human actors' goodwill and work efforts are crucial to the success of the technology as a communication device. The technology only has worth when it is acknowledged as relevant by the human actors.

Conclusion

We have shown how the implementation of Beam takes place in a heterogeneous network of a (surprisingly) large number of human and non-human actors. Examples of these actors are care staff, municipal employees, internet connections, support staff, automatic doors and telephones. The actors in this heterogeneous network must coordinate and work together in order to create and maintain the infrastructure that enables the relatives and residents to use the robot as a relevant communication tool. The heterogeneous networks' collective work efforts consist of tasks both normally acknowledged as work, such as installing routers and establishing a wireless network in the nursing home, and more invisible work tasks such as being available to answer a telephone call or open doors for Beam so that it can reach the intended destination. Furthermore, it is important to acknowledge that the implementation is dependent on an infrastructure consisting of not only solid materials, but also goodwill and emotions. Beam is only able to demonstrate its value as a relevant welfare technology if it is possible to mobilise and stabilise an infrastructure in the already existing practices into which it is released. Thus, the article's detailed ethnographic descriptions provide insights into how the implementation of new technology involves large amounts of work, some of which is familiar and visible and some of which is more surprising and usually invisible. With our analysis of Beam, we emphasize how a focus on infrastructure illuminates the micro-processes, coordination and ad-hoc adaptations that are necessary when a new technology is implemented and adopted into everyday practices.

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