Hospital Robot at Work: Something Alien or an Intelligent Colleague?

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ABSTRACT
This paper describes a case study of the initial reactions to a transport robot running in a semi-public hospital environment. The robot was transporting goods and samples for an orthopedic department, moving within and between different departments for 13 days, and was used by the staff for five days. Based on this case, we discuss how the robot was perceived by staff and visitors and purpose an initial framework, a utopian model, describing four different perspectives; an alien, a machine, a worker and as a work partner. This has been derived from interviews, questionnaires and observation, and exemplifies different qualities that the robot was ascribed. We discuss how the perspectives may mutually co-exist and change, and are affected by time and familiarity with the robot at work.

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Human Factors; Design

INTRODUCTION

Hospitals have been studied extensively within the CSCW field (e.g. [45]), and a lot has happened since the late 60's when computer technology was first introduced in hospitals [7]. Many studies have revealed the complexity of workflows at hospitals where many different artifacts take part (e.g. [4], [45], [25]), and how tasks that are physically distributed are a challenge for the staff [5]. Studies of robots in hospital settings are an important emerging area for CSCW, to increase the understanding of robots in social practices and naturalistic settings. Today, robots are being designed to support staff in moving a person from one bed to another [11], take blood samples [50], support and perform surgery [35], and to be social companions and mediators for child patients [22]. Finally, there are courier robots for transporting goods, which may reduce the staffs' physically distributed tasks (e.g. [30], [44], [14]). However, much research is still needed to understand the emerging role, the acceptance, and use of different robots. This paper especially complements two previous studies that take emotional and social perspectives of how robots are perceived at hospitals ([39], [30]).

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From a CSCW perspective, studies that emphasize the artifacts often focus on its function in a practice. For example, what role does a patient record play and for whom (e.g. [9], [25]), and how do different representations of computer technology affect coordination (e.g. [37], [8])? We contribute with a complementing perspective, by focusing primarily on how a robot in a hospital setting is experienced. We exemplify how it may give rise to certain kinds of associations, and the experienced qualities in this specific setting.

BACKGROUND

An increasing amount of research focuses on experience-related aspects in work settings, such as affective states [23]. For example, a study on how emotions affect work in a hospital context was conducted by [29]. However, we strive to understand the specific qualities that technology is associated with or ascribed, which is different from investigating affective states such as emotions or moods [23]. Models such as the Technology Acceptance Model (UTAUT, TAM [48]) attempt to describe factors expected to influence intent to use and actual usage of a system, such as expectations of effort needed on the user's part, performance of the system, facilitating conditions and social influence. Our perspective is more related to more dynamic *experiential qualities* that describe how something is experienced, and refers to specific qualities that emerge in interaction with a system [41]. However, we do not strive to create a universal design language of qualities, but rather aim to understand different perspectives that ascribed qualities may relate to. Our perspective is also different from work focusing on interaction design qualities that for example are categorized within practical, social, aesthetic, structural and ethical dimensions [3]. Rather, the qualities we are investigating are related to how people make sense of a system and what they attribute it when striving to address it as a meaningful experience [28]. Qualities are related to *affordances.* Affordances refer to the kind of use that artifacts invite, originally introduced as "action possibilities" in Gibson's ecological psychology [33]. Affordances were considered a relationship part of nature that may or may not be visible, known, and desirable. Norman [33] has previously argued that in a design context it is the perceived affordances that are interesting, taking the user's perspective and perceptions of the artifact. Achieving suitable affordances (or Norman's more recent perspective of adding suitable signifiers) in a design, can create a correct association or metaphor to a specific use. However, nor signifiers or affordances necessarily explain long-term relations or perspectives of an artifact, as they refer to the "surface" of a design. Thus, this does not fully represent our perspective of qualities, even if an unfamiliar robot may invite for a specific use and may be ascribed qualities due to specific added signifiers.

Ascribing qualities to robot technology

What qualities do people ascribe to things and why? Ascribing qualities to a robot (such as intelligence) is investigated in Taylor's [45] research on machine intelligence and exemplifies how people see machine behavior as intelligent. Forlizzi and DiSalvo [20] describe how people ascribed intelligence to vacuum robots, despite the fact that they had spent much effort preparing for the cleaning, because of the robot's limitations (e.g. moving furniture to accommodate the robot). Attributing intelligent behavior to a machine exemplifies how people create relationships with things [45]. Studies by Reeves and Nass for example have shown that people tend to respond to technology in ways that resemble social responses in interactions between humans [38]. Ascribing intelligence to 'things', is often referred to as a type of anthropomorphisation (e.g. [6], [47], [49]). Antrophomorphisation involves reading human characteristics into artifacts and treating them as such [16]. It exemplifies how people may attribute qualities to things, and also provides underlying reasons as to why. This supports our perspective that people have social relationships with artifacts, similar to how humans have relationships to humans and animals. From a psychological perspective, anthropomorphism is **not** a behavioral description of an observable action. Instead it *"requires going beyond what is directly observable to make inferences about unobservable humanlike characteristics"* [15]:144. The strength of anthropomorphic inferences will vary from one domain or context to another. Anthropomorphism is elicited from accessible agent knowledge, meaning that it is based on ones *self-knowledge* required earlier. Theories on social motivation also show that when people are dispositional lonely, they have a stronger tendency to anthropomorphize agents (ibid). Finally, anthropomorphisation is about effectance motivation, which is our desire to interact effectively with our environment, and being able to understand, predict and control it. Thus, it can be argued that antrophomorphism is a human strategy to *reduce uncertainties and unfamiliarity* in our environment [16]. Potentially, this could mean that people would ascribe qualities that they normally associate with other objects (or people) to a robot to make it more familiar. Anthropomorphisation has also been questioned as a concept, for example by Nass and Moon [29] who argue that people mindlessly apply social rules and expectations to computers, even if they "know" that the artifact lacks human capabilities. Mindless or not, anthropomorphisation brings forward the tendency to ascribe human qualities to technology, which is relevant for this paper.

A related perspective of people's tendency to ascribe specific social qualities is provided by Goffman [21] who discusses social *performances*. He states that when individuals are in a situation with others, they try to discover social data about the others in that situation. In the absence of full information, individuals use cues, tests, hints etc as predictive devices to understand 'who' the other is. Thus, performance, appearance, and social behavior play a key role in how we perceive others, even if the cues we act on might not be actually 'true'. We believe that it is possible that people also apply this when interacting with robots and other technology. For example, when trying to understand and express 'what' the robot is, they ground this on their own experience, that may be more or less frequent, or extended over time, have influence from media, and their experience of other machines, etc. [19].

Anthropological research exemplifies how things can be seen as *social creatures*, whose values and perceived *qualities* are constantly changing depending on context. This represents a somewhat different perspective, for example considering things as goods that are being traded (e.g. with an actor-network perspective [26] as taken in [1]).

From a human robot interaction perspective, the investigated robot lacks many human social characteristics, such as expressing and perceiving emotions, and communicating with a high level dialogue that *social interactive robots* have been classified with [20]. However, we are interested in how the studied robot may be *perceived* as having qualities that are considered social for example by; being *socially evocative* (object for anthropomorisation); embodying more or less human like *social cues*; and being *socially receptive*, such as being perceived to adapt to social behavior (ibid). Thus, the robot may affect its social setting and be interpreted to display social behavior simply by being and acting among people (e.g. [20], [30], [12]). We want to investigate what qualities people will ascribe to it, not only from a social perspective, but with a more holistic perspective on having the robot introduced into a work practice. Thus, we take the perspective that users define technology as active creators [42], and that the *coupling* of technology properties and their use (resulting in a specific experience) is done by users and not the designers [13]. Thus, our perspective is that designers can only aim to give raise to a specific kind of experience, but the actual experience and any attribution of qualities (whether human characteristics or not) is done by the users (ibid).

Studies of Transportation Robots at Hospitals

Several studies have investigated the need for transportation robots and the potential strategies for implementing them at hospitals. Evans et al. [14] and Rosetti et al. [39] present studies showing how automated delivery can improve the efficiency of hospital transportation, improve the overall organization, and reduce costs. Another related study looked at existing routines at the hospital and in particular what types of transportation tasks that could be improved by a robotic system [51].

A research study on Aethon's TUG robot especially brings forward organizational issues for robots in hospitals [30]. Aethon's TUG can deliver a variety of goods and has sound and voice effects. This study compared how hospital units at the hospital, such as postpartum units and medical units, experienced the same robot differently in workflow, political, social/emotional and environmental perspectives due to various toleration for interruption. The social/emotional results show that the staff at the medical units was irritated with the robot, especially when the robot interrupted their work. The staff at the post-partum units with a more relaxed work environment, lower traffic in the corridors and a different nature of social relationships, dealing with less life-and-death situations, felt less interrupted by the robot during their work. This study also found that the staff prioritized personal care relationships more than other tasks. The design implications suggest that robots for work environments should be designed to minimize interruptions and that social aspects should be integrated in the technology, such as allowing the robot to mediate communication between staff. Another study in a hospital environment used sensemaking theories and took a gender perspective when studying how a robot was perceived. While male hospital workers referred to the robot as a machine and consider it as a device that they can control, female hospital staff tended to see the robot as a freestanding human male. Nurses, mainly females, explained the robot as a novelty, mostly refusing it as a useless or frivolous item [40]. This is related to the alien perspective discussed in later sections of this paper. Our work is also related to robot studies outside the hospitals, such as a study of vacuum robots in households [20]. This study had the goal of understanding people's attitudes and experiences in order to create general design implications, and found that people ascribed qualities such as intelligence to robots.

THE STUDY

The study was setup at an orthopedic department, where the robot was running for 13 days. The staff was observed, and at the end of the study, they were interviewed or got questionnaires. Below we will describe the setup of the study in more detail.

The orthopedic department

The orthopedic department cares for patients with fractures, or even amputations, after surgery. There are about 20 staff working during the daytime, such as assistant nurses, nurses, doctors, and administrative staff. The corridors are busy. Apart from the staff moving in and out from rooms with blood tests, medicine and more, there are patients practicing to walk with or without walkers in the corridors, often getting assistance from one or several staff. Cleaners are coming with cleaning machines or garbage cans on wheels, and visitors are coming to see patients. Sometimes the staff uses a scooter to move inside and between departments. Specialized transportation staff is called in to move patients in beds or wheelchairs to surgery or back from other departments. Along the corridors are beds, medicine cabinets on wheels and other objects that are put aside. The department does not have any system to send samples to the lab (e.g. no pneumatic tube-mail, small freight elevators), so staff members need to leave their department and hand over samples in person. Staff also goes to the lab to collect blood plasma. The distance between the orthopedic department and the lab is about 200 meters, but as they are located on different floors, the walk between them necessitates use of elevators. It takes about 10 minutes to walk back and forth.

The robot system setup

Even though the robot was present and moving in the department for 13 days, the staff had in total five days to use it for transports. The remaining days had to be spent on making the robot create a map of the environment, technical support, and to set up the stations, etc.

The robot is designed to carry small goods, to drive with trailers, assist staff with bed transports and to guide people. This study focused on transportation of blood samples to the laboratory. The robot team who developed the robot has been in contact with some of the staff during the design process. Meetings have been held both at the hospital and the robot lab, to discuss potential robot support with staff.

The robot is 120 cm tall, 65 cm wide and 115 cm long. It has a safe (cabinet) that is opened and locked with an automatic latch using an RFID key card. Inside the safe is a forklift that the robot uses for automatic loading and unloading of goods. The robot design also has a big stop button on top. In this study this was removed to make space for a laptop. A technician would follow the robot around

Figure 1. a) At department (box marked with ring). b.) Box close-up. c.) Station at the nurses' office. d.) Staff loading robot

with a wireless connection, prepared to support potential technical challenges.

The robot shape was initially inspired by the appearance of penguins and how they may be experienced; cute and not threatening, and the color is bright lime green. The robot moves in the middle of the corridors, and can speed up in some areas (for example in the hospital's basement where few people are walking). It uses natural landmark based localization. In the study, usage of the elevators by the robot was manually handled by the robot's technician, even though autonomous usage of the elevators was considered feasible to implement.

The orthopedic department was provided with two stations where samples could be sent or received, and one for charging. Firstly, the robot could be sent to be loaded and unloaded outside the nurses' office (see figure 1c). Secondly, a box at the department could be loaded or unloaded (see figure 1a,b). The box locked with a latch using an RFID key. The robot could automatically unlock it when docking or loading goods and then lock it again when leaving the station. A second box was placed outside the lab, a few floors down from the orthopedic department. The charging station was located in the patient cafeteria in the orthopedic department.

Ordering a transport

The staff had a computer at which they could place their orders, situated next to the nurses' office (See figure 1c). The staff would do a blood test, go to the computer and place an order, then typically wait for the robot to come to the marked spot, and load the goods directly into the robot.

Robot introduction

The robot team and the researchers held a general introduction to the robot with the staff during their daily coffee break. This included a presentation of the robot and its intended use, and of the team that would be present during the study. Two people from the staff were asked to test the robot by sending and receiving an order (box of chocolate). We also handed out and received consent forms for the study, and encouraged the staff to ask questions. Their questions included: Is it a he or she? How does it know its way? One person was worried about how to check ID if the robot would be used to collect blood from the lab. Information on how to conduct transportations with the robot was left in the coffee area.

Data collection

The study used a qualitative and ethnographic inspired methodology and research focus. We used several complementing methods to gather field-data. In total, 25 people shared their experience, either through an interview or a questionnaire. This was complemented with observations taken as notes. We focused especially on how the robot was perceived by the staff, its intended tasks and behavior in general. We also aimed to collect spontaneous comments about the robot, coming from staff, visitors and patients when meeting it in the corridor. One researcher from an independent research institute conducted the data collection, together with an assistant, who was hired by the robot team to support the study.

General interviews

During the last days of the study, we held general interviews with 12 people from the staff. Their names have been anonymized in the following text.

Seven of the interviews were held with the staff at the department, including a managing nurse (Kerstin), two nurses (Karl, Laura), and four assistant nurses (Peter, Emma, Sophia, Petra). The assistant nurses Sophia and Petra had only met the robot in the corridors, whereas all other interviews had also used it. The questions involved their current work practices, for example which type of errands they are doing, and how they felt about that. The questions also focused on the robot support, expectations and impressions of, for example, meeting it in the corridor and using it in their practice**.**

Three staff members from the lab were interviewed. One of the interviews included Anders, a biomedical analyst, and Elin, assistant nurse (responsible for the blood sample handling-in at the lab). They had collected blood samples from the box station together. The other interviewee, Anne, who was a biomedical analyst, had collected goods directly from the robot. The questions focused on their perspective to let a robot deliver blood samples, and how they felt about adapting their routines towards a potential robot system.

Two people from the cleaning staff, Johanna and Sonja, were interviewed together. Both had met the robot when cleaning the department. The questions focused on their overall experience of meeting the robot and potential concerns for their cleaning practice.

Four interviews were held with seven people visiting the hospital, found close to the entrance, when the robot was passing by. Four were women and three were men. One man and woman were approximately in their thirties, and the others were approximately between 60 to 75 years old.

Questionnaires

11 questionnaires were answered by four nurses and seven assistant nurses, who not had been interviewed. The questionnaires had similar questions as the interviews and were handed out after the robot had left the department. From the people who answered the questionnaires, five had used it once and six had met the robot in the corridor.

Observations

Overall, two people have conducted about 85 hours of observations, taking notes of peoples' reactions, for instance when meeting the robot in the corridor.

Analysis

We used an open coding qualitative analysis, using a bottom-up approach, starting from the data to find categorizations. The analysis covered transcribed interview data, observation notes, as well as questionnaires. Related quotations and observation notes were put in similar categories, and we went over the material several times during this process. The final categories are reflected in this paper, such as the staff's existing routines, expectations, using the robot to run errands, robotic support in development, and safety. Finally we have categorized perceived qualities into the different perspectives that are discussed in our model.

RESULTS

The results present the staff's perspective on running errands, their expectations of getting robot support, and their experience of the robot.

Perspectives of running errands between departments

All staff in the study confirmed that they carry out some kind of errands during their work. A majority of the staff carry out three or more different types of errands. The routine errands include transporting blood samples to the laboratory, beds, patients, trailers, medicine and food. In the case of blood samples, some are urgent and need to be analyzed by the lab immediately. Still, all are transported directly to the lab after being taken. The lab results are sent back to the nurses through the hospital's computer system.

The majority of the staff described that they run their errands 3-5 times per day, and others indicated that they usually run errands once per day or once almost every day. However, the number of the errands varies from day to day. Laura said the following about running errands in the department: "It is of course time-consuming, the time is taken from us." Assistant nurse Petra expressed that the errands cause some staff to "disappear from the department", so "if you can get help with it and avoid running, then it is good." Not all of the staff members were negative about running errands. Nurse Karl described them as a way to get some "breathing space" and that it's nice to "get a little rest from the department during those minutes."

Expectations of robot support

Early expectations about the robot's appearance may be inspired by science fiction or other prior media encounters with robots. Anne (at the lab) said: "if you think about robots, they are usually twitchy and edgy, with arms." Assistant nurse Peter said: "I thought.. it was not like that, I thought it was a small human […] wheels and arms maybe, like the ones that you see the Japanese having".

During the first days, we held an introduction meeting, and some of the staff described the idea of getting help from a robot as something "new and exciting". Some considered the robot as "the future" and when fully developed as "a big help" to the department. However, in line with this, some also expressed their worries about reduction of staff.

Using the robot to run errands

Overall, the robot was used for about 20 transportations during the 5 days that it was available for the staff. Half of the transports were real blood samples and the rest were staged transportations, all done by 11 people in the staff. The nurses primarily took blood samples in the morning, and this was the most busy time at the department. This was also the time when the robot was used to send real blood samples. Some of the staff used the robot to send real blood samples several times, and one nurse even sent an urgent test on a busy morning. For technical reasons, we had to follow the robot on its transports. Some staff only sent staged goods once or twice, such as an empty blood sample. Whenever they used the system for the first time, we explained the procedure as they placed an order and used the RFID.

Most transports were ordered from the office station, putting the goods directly in the robot. In fact, we ran into technical difficulties unloading a box station with the robot, so the nurses were eventually asked to send their order from the robot instead of the box station. Several of the staff expressed that it felt inefficient to wait for the robot to come to the office station. Kerstin, the managing nurse, said: "It was slow before it got to the right place". Several described that in stressful moments they wouldn't use the robot in the future if they would have to stand and wait. The managing nurse also suggested that the robot should have a signal when it was ready, but also said that in fact it would have been easier to simply leave the tests at the box station, instead of in the robot.

Robotic support in development

Nine people from the questionnaires wanted a robot to conduct transportations for them, two did not. One wrote "Short distances. Big and clumsy robot" and the other gave no explanation.

According to a majority of the staff at the department, the robot could potentially help them to save time, unburden them, and give them more time for the patients. The majority of them were positive towards using the robot to run errands such as for blood samples, and transport of trailers or beds. All interviewed staff was positive about robot support to offload tasks, but also expressed that this was a system under development. Assistant nurse Peter said that "It's really good I think, but it needs more development". Manager nurse Kerstin expressed: "I'm more positive now, I really am. I believe in this, that it could offload somewhat for the staff, and that it is so easy to use with only one click on the computer and then order". However, she also said: I guess there's more to develop" and expressed the need for a prioritizing function, so that urgent transports could be prioritized; not having to wait for the robot; and to solve the technical issues such as opening the elevators (this would also be implemented in a fully working system). Several interviewees expressed that there is a limit for the kind of errands which the robot could support. For example, nurse Karl would never let the robot transport patients and was skeptical to let the robot guide visitors. "It would feel strange… (..) Maybe it turns out well the day it happens, but I'm skeptical about it."

Safety

Overall, the staff was concerned about the patients and their potential reaction to the robot. They stressed that the patients' wellbeing and safety should be prioritized. A common concern about getting the robot in the department turned out to be the doubt if the robot would really stop and "properly identify situations when someone is in the way?" or if it would drive into people. The department has patients with fractures, recent surgery and limited mobility, who need to move in the corridors. Peter commented: "There are several hip-surgery patients that do not know the machine". Thus, the staff was concerned if the robot would run into someone or would be in the way of their work, and some also expressed that the corridor was narrow.

Towards the end of the study, Nurse Karl said that: "If there is something in the way - he'll move, and he stops if someone is approaching fast. I think it seems safe. But I don't know if I would have trusted it as much if you weren't here and could stop him if needed." Managing nurse Kerstin said that: "I think it feels good. It stops when it feels an obstacle. […] that was a sort of a concern […]. You may be scared if patients would be there, and if it would react quickly enough. But, I think it feels good."

The staff was also concerned about issues such as if the goods were safe: "will it lay still and not break?" That would lead to "having to take an extra blood sample from a patient." When loading the robot, several would put very small goods between the forklift's rails, instead of on top of them as intended. It was suggested that the forklift would need a clear instruction describing the correct way of placing goods as well as a container.

Some routines rely on, for example, that patient IDs are double checked by staff that are handling out blood as well as with staff that are collecting blood at the lab. Thus, introducing a robot would require a change in those routines, which also was pointed out by Karl. Another issue is the RFID keys, which were pointed out as a safety risk, in case they would be misplaced.

ASCRIBING QUALITIES TO THE ROBOT

When analyzing our results we found that the robot was ascribed qualities which we found reflected different perspectives, viewing it as – an alien, a hospital worker, a colleague, a machine, or a mixture of these. These are not exclusive and can be overlapping, but supported our understanding of the experiences of the robot in this semi-public hospital environment. Thus, users or encounters could see the robot as an alien in certain aspects and as a worker at the hospital in other aspects. Also, this perspective is likely change over time, for example from alien to work-partner as the robot becomes more familiar. There is a difference in how something appears at first sight and how is may be perceived over time.

Despite of the penguin design inspiration, the robot was named "Kermit" by Karl, a name that quickly caught on. This was likely inspired by the green color. Almost all of the staff perceived the robot as being big, even at the end of the study. However, some also described the robot as "a little green pea", "a little guy" and as the French children's book character "Barbapapa". Several of the staff described that they like the robot's appearance because it feels "round, cute and human" and "not that edgy" as other equipment at the department. Karl pointed out that the staff had discussed their personal preferences between pink and green of the robot and that his own choice was green because: "It's a cool color". Kerstin expressed it as being a "lovely color."

An alien

How is the robot experienced for those who find it unfamiliar, for example for encounters? In our case, the overall design is intended to appear friendly but not invite explorative interaction. Still, this may be perceived as something alien for people who are unfamiliar with it. Apart from vacuum cleaners [43], and robot toys [18], there are few examples of robots in semipublic work environments such as offices, hospitals and schools. Thus, a science fiction inspired perspective of robots is prominent among many people [19]. Even informed staff might not know what to expect from an existing robotic product. Similar to findings by Siino and Hinds [40], the robot was described by several participants as a novelty and as being the future, inferring a sort of distance towards the robot.

Several staff were initially wondering: “Does it talk?”. When we arrived at the hospital with the robot, and tried to find a space for the robot, someone in the staff was joking with the manager, saying “couldn’t it be in your office?” Overall, people looked skeptical when they saw the robot, and some in the robot-team even felt that they were not welcome the first few days. The robot was commented on as being big and clumsy, before it had even been tested by the staff. The robot movement and behavior in the corridors was also unfamiliar for some. In the current design, people needed to get close to the robot before it changed paths. Moreover, the robot would move in the middle of the corridor in order to avoid doors that might be opened. Both of the cleaners, Johanna and Sonja, expressed that they would watch out when the robot was coming. Sonja said “You get unsure and you stand there and wonder where it is going”.

The alien perspective was also found among visitors that did not know the robot and what to expect from it. Several visitors commented that it felt strange to meet the robot, even though they perceived it to move slowly. One visitor asked if it was intended for the moon, suggesting that it looked similar to something that is used in space. Overall, people appeared to be curious about the robot and asked: “What is it?”, “What does it do?”

With an alien perspective, we believe that either people may lack a point of reference, or they may have very vague reference that does not support them in understanding how to interact with the robot or what to expect from it. It is likely that an alien perspective will keep occurring for those who are unfamiliar with the robot unless robots become more standardized everyday artifacts. In our case, people were wondering if the robot could talk, even though the design does not have any signifiers suggesting this (e.g. a mouth or face). Thus, it is especially important to consider how to support encounters to make correct first affordances, and eventually move beyond an alien perspective.

A machine

Another perspective that we found was to consider the robot as a (somewhat familiar) device or machine, instead of something alien. This perspective suggests that people describe the robot with a clear point of reference. For example, nurse Karl described it “like the cleaners’ cleaning machine.” Assistant nurse Sophia said that “it is small machine, an unburdening-machine”, that has “no personality, it’s a device”, “like a small moving thing”. Similar to a perspective of using a machine, Anne (a biomedical analyst at the lab) expressed the opinion that “robots are not personal”. This machine perspective is different from the alien perspective, as it occurs when people use a machine as a reference point. Several visitors asked “Is it a cleaning machine?”, and others suggested that it was “a cleaning robot” when being asked by the researchers about what “that thing” was. We characterized their perspective as a machine perspective, as this suggest that they have some sense of what to expect from the robot. This supports previous studies that describe how anthropomorphizing or even metaphors is a psychological mechanism to reduce the complexity that the unfamiliar results in [16]. In this case people who do not know what the robot is or does are still ascribing it qualities that they find familiar such as relating it to a cleaning machine.

The machine perspective raises questions about what metaphors potentially should be a part of a robotic design. Is it suitable to design the robot so that it appears similar to something people already are familiar with? In our study, Karl referred the robot to appear like the cleaners’ cleaning machine and some visitors also referred it to this. As Norman and others have pointed out, metaphors are not always suitable to explain something unfamiliar [33]. If the metaphor is taken too literary, it can make the situation worse, by suggesting functionality or leading to a conceptual model that does not support a correct understanding of the system. If people would think that the cleaning machine has escaped from the cleaner when it is moving alone, this might not be a suitable metaphor. However, if people see this as a more futuristic cleaning machine that is cleaning autonomously, this may be an appropriate metaphor. In this specific case, personnel, visitors, staff, and patients that are not familiar with the robot, are not intended to interact with it either. Thus, the robot is intended to appear friendly and to be seen, but not provide affordances that invite people to interact and play with it. For example, there is no mouth (and the robot is not talking) and there is nothing in the design that is supposed to look like eyes.

A worker at the hospital

This perspective suggests that the robot takes a role as a worker at the hospital. From a perspective of looking upon the robot as a worker, it was clear that the robot should present itself as being part of the staff or the equipment at the hospital for visitors and patients. For example, the assistant nurse Peter suggested that, “It should be obvious that the robot works at the hospital. For example we have white coats.” He even suggested that some kind of medical sign on the robot should show to which department it belonged. As a robot worker, it should also be seen clearly. Several in the staff pointed out that the current color was good “because you see it clearly”, and “it should be green or orange or something like that. You see it [the color] well, clearly.” Argyle [2] describes how both people and animals use appearance as means of communication, and at hospitals, it is usually quite clear who are the doctors, nurses, cleaners and patients (pajamas). Medical uniforms impress with medical expertise, through creating social distance (ibid). Similarly, a robot can indicate that it works at the hospital and reflect some competence.

A worker at the hospital also has to be credible, perform his/her tasks well, while not breaking social conventions or introduce new risks, such as running into people.

A work partner

For some, the robot was described almost as a work partner or something that you have a personal relation with. We believe that this is something that requires that the robot becomes familiar in one's practices, and also has proven that it is successful as a worker for an individual.

Meeting the robot in the corridor was for nurse Laura a thing that "feels good, almost like meeting a colleague." This is a very different perspective from for example assistant nurse Sophia, who only had met the robot in the corridor and saw no personality, but merely a moving machine.

Overall, the staff was first reluctant to find a space for the robot, and several expressed that they experienced the robot as being too big and clumsy. However, a few days later, we were observing a change in attitude. The robot had then been moving around in the department and shown that it did not bump into people, that it stayed out of the way, that the overall system was easy to use, and that the goods were delivered successfully. The nurse Karl said that he did not believe the robot could do all that: "First I hated it. It was big and ugly. Now it's not so much in the way anymore. It has a good place to be at". At the end of the study, Karl described it with qualities such as "cute" and "intelligent, discrete, because it is never in the way and it is reliable". He also said that "[the robot] is like a colleague who goes with samples, so I can skip going myself and can devote my time to something else instead. He is not just a machine. A couple of us admired him yesterday because he was so cute when he went away." Several of the other staff also described the robot using words as "cute", "cool", and "clever". From an "emerging intelligence" perspective, this reflects how people, when noticing that a machine manages changing conditions and work in their practice, may refer to it as being intelligent [45].

Some staff are only trusted for certain tasks, and this is also true with robots. Nurse Karl noted that the robot only should do "errand boy job". "I would never send a patient-transport with a robot," he said. Concerning the division of labor the managing nurse Kerstin said: "I don't think it should reduce our staff. … It is a complement so we can avoid running around in the hospital. We do many things now that could be avoided." Lacking patient contact is one of the greatest frustrations when working as a nurse [34]. However, nurses do not only want to give practical care (e.g. give an injection), but need time for personal contact to get a good overview of the patient situation. This implies that design solutions that reduce routines and administrative work that takes time from patients, can make the overall work experience for the nurses more enjoyable. This may also affect the perception of the robot, if it is successful or not, to provide a more joyful work situation.

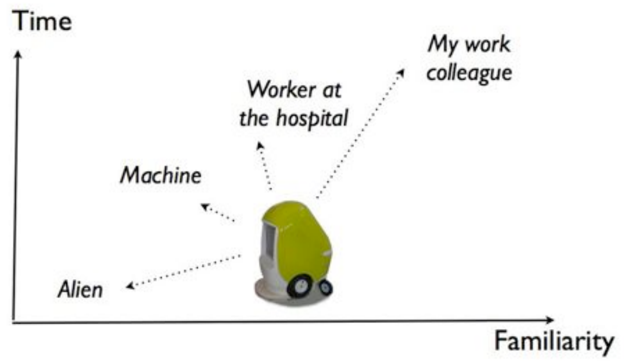

Figure 2: Utopian model over different user perspectives of robot qualities and how this may be affected by familiarity and time. Familiarity refers to if a robot successfully fits and contributes to the existing work practice.

DISCUSSION & FUTURE WORK

The theoretical outcome of this case study is presented as perspectives describing the robot as an alien, a machine, a hospital worker, and a work partner. This is a limited study, but the perspectives contribute to an increased understanding of robots in semi-public environments, reflecting on these as more general design challenges. The meaning of a technology "can only be described and its significance appreciated in the context of its uses and its users" ([10]:42). For Karl, the robot was both like a machine, and intelligent, and like a colleague. This exemplifies of how perspectives can mutually coexist, even for the same person. In some aspects or situations, it may be seen as a machine and in others, a kind of colleague.

The alien perspective suggests a design challenge when people do not have much experience with the robot, and do not feel comfortable or know what to expect, when they meet it. With more robots present in society, it is likely that the alien perspective will dissolve into the machine perspective and beyond, as people can get a better point of reference for robots due to a greater number of experiences with them. In the mean time, robots need to be designed with suitable signifiers and preferably provide references to machines that people are familiar with.

We exemplify the different perspectives in a model (See Figure 2). This could be read as a *utopia*, as many robotic designs (including the one presented here) may not be considered as a work colleague by most users. Only when a robot becomes familiar and proves to be successful, for example leading to more joyful work for the nurses overall, it may be perceived as somewhat intelligent or a kind of colleague. This also implies that even though a robot is designed with technically considered advanced 'social skills' (such as talking, understanding speech, face recognition etc), it may still not reach the level of being considered as a work colleague. Similarly, Groom and Nass discuss how design or research efforts that aims to position robots as human-like 'team-mates', rather than complements in specific situations and tasks, is unhelpful, and arguably an impossible goal to achieve [24].

Familiarity and *time* is required for people to consider that the robot is intelligent and may support them as some kind of colleague. The axis “familiarity” is a pre-condition for trust. We cannot trust something that is totally unknown, only gamble [25]. Our study was limited in duration, and even though staff became somewhat familiar with the robot, it is difficult to say if they have trust in the system. Familiarity is required in order to eventually start to trust that the robot will not run into people, make work more enjoyable etc. Karl expressed that he did not know if he would have trusted the robot moving about without the technicians. Kerstin instead said she felt good about it, as the robot had been stopping when it should. Time affects the possibility of interpretation [32], and more interactions over time will thus affect peoples’ interpretation of the robot. Even if interpretations are constrained by the artifact, various groups' purposes, context, power, and knowledge base also affect interpretation [34].

This case study provides preliminary and limited findings of how robotic support can be perceived in a hospital setting. In a longer study, it would be interesting to investigate how the robot affect the staffs’ collaborative activities such as coordination, and how it could be regarded by more people as “intelligent” in relation to their practice. Moreover it would be interesting to look into the aspect of trust as well as potential novelty-effects that only a larger long-term study can provide knowledge about.

CONCLUSION

We have conducted a case study of the initial reactions to a robot transporting blood samples at a hospital. Our contribution beyond the actual study, is a preliminary categorization of qualities that were ascribed to it, suggesting different perspectives that robot technology can be perceived as; an alien, a machine, a worker and a colleague. These may mutually coexist and are related to time and familiarity with the robot.

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