

# Robots, Gender & Sensemaking: Sex Segregation's Impact On Workers Making Sense Of a Mobile Autonomous Robot\*

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**Abstract** – This ethnographic study suggests that social structures such as the sex segregation of jobs may impact how different groups of workers make sense of robots in their work environment. Designers may need to take such structures into account if mobile autonomous robots are to operate successfully alongside humans in the workplace.

*Index Terms* – Robots, sensemaking, social structures, work.

## I. INTRODUCTION

Robots remain fairly uncommon in the everyday world. With the technology still far from commonplace, many people seem to draw their ideas about robots largely from popular culture images and have limited knowledge of robotic capabilities. We can imagine, then, that people who learn that a mobile autonomous robot is about to be introduced into their workplace might make sense of the technology by drawing on existing images and structures in their social environment. To increase appropriate adoption and use of robots as robots are created for deployment in work settings, designers may need to take into account the various social structures in these environments that might impact how people understand – and consequently, how they interact with – the technology.

One set of structures in work environments is the sex segregation of jobs and occupations. Sex segregation is an institutionalized form of social distance between groups based on gender and generally implies the subordination of one group to another. Even entering the twenty-first century, the vast majority of jobs remain sex segregated. These structures of sex segregation have been shown to impact men and women's lives in multiple ways, contributing for example to women's lower wages, lower status, limited promotion opportunities and lower levels of authority [1]. These structures also affect the status of men who work in jobs primarily associated with women, although men seem to experience more opportunities than women to advance from these jobs [2].

Because structures of sex segregation embody the dominant, taken-for-granted gender ideology and sex stereotypes that are part of what Giddens [3] calls society's stock of knowledge, we might expect these workplace structures to have subtle but important affects on workers' experiences, including their understanding of technologies such as robots. Giddens, for example, argues in his theory of structuration that existing structures both constrain and enable the ways people understand situations. People make

sense of situations and events by invoking various cognitive frames – “perceptual sets that direct an individual's critical cognitive processes, including directing what information to attend to and how to interpret that information” [4].

In this paper, we explore how sex segregation of jobs may impact the way men and women make sense of a mobile autonomous robot – a technology with which they are generally unfamiliar. Segregation of jobs places men and women into structural positions that can be quite dissimilar from one another and from which they must make sense of what is happening around them. These dissimilar positions may therefore lead men and women in the workplace to each draw on distinct cognitive frames as they engage in sensemaking in a variety of situations, including in the introduction of new technologies.

To examine how sex segregation structures may shape how male and female workers make sense of robots, we draw on data from an ethnographic study of a mobile autonomous robot's introduction into a community hospital. First, we discuss why a new technology such as a robot may be an occasion for sensemaking; second, we describe the site, methods and technology involved in this study; and third, we discuss how structures of sex segregation seem to have constrained and enabled how various workers made sense of the robot. The data analysis indicated not only the existence of gender and status differences among jobs in the hospital, but also that men and women segregated into various jobs seemed to draw on quite different cognitive frames during the sensemaking process. Thus we argue that sex segregation may well impact not just workers' opportunities and pay, but also how they make sense of their environments and the technologies within them – creating differences in perception and action that may need to be anticipated and addressed if robots are to be successfully deployed to work alongside humans.

## II. TECHNOLOGY AND SENSEMAKING

Sensemaking is a social process through which people make sense of situations and events [5]. Weick [6] suggests that sensemaking “...is less about discovery and more about invention...to construct, filter, frame...and render the subjective into something more tangible” (p.14). People engage in sensemaking when their ongoing flow of activities is interrupted, when something surprising happens, or when they pick up discrepant cues from their environment. The novel or unexpected can draw people out of automatic

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processing and into a mode of “active thinking” [7], or people may be prodded out of automatic processing by being asked to think about a particular situation or event [7-9]. When people are interrupted or jogged into noticing some segment of the ongoing flow of activities around them, they begin to make sense out of cues they extract from that segment [5]. The introduction of a robot, a not-so-commonplace technology, can be just such a disruption that triggers a sensemaking process.

Although academic researchers often treat technology as though it were immutable, technology is subject to the same social construction processes as every element of reality [10]. That social construction is constrained and enabled by existing structures [3], leading various social groups to view the same technology quite differently [11]. Technology has been argued to have varying degrees of “interpretive flexibility” [12] or to be more correctly understood as an “equivocal” – something that has several possible and plausible explanations [13]. Because a single material artifact can be viewed differently by different people, a technology’s introduction into an organization may trigger sensemaking as the organization’s members attempt to understand the technology’s purpose and just what the technology means for their particular roles and identities [5].

It is reasonable to expect, then, that the introduction of a mobile autonomous robot – a fairly unfamiliar technology – might occasion sensemaking when introduced into a work environment. It also seems likely that the structures in which workers are embedded would constrain and enable sensemaking. Finally, because sensemaking is a social process [5], it is likely that groups of workers will arrive at common understandings as they share their interpretations of a situation with one another. Thus we argue that structures of sex segregation, which are pervasive in our society and, certainly, in the hospital studied, might lead workers in predominantly female-occupied jobs and those in predominantly male-occupied jobs to understand the same robot in highly different ways.

### III. SITE AND METHOD

We and another researcher conducted an ethnographic study at “Community Hospital,” an independent community-based hospital located in an agricultural area of Northern California. The robot’s manufacturer gave Community Hospital an autonomous mobile robot for a limited time as part of a large contract for other technologies. The hospital acquired the robot in May 2002, and the administrator who was in charge of the acquisition originally communicated that the hospital would deploy the robot before the fall of that year. In the course of our study, however, deployment of the robot was delayed several times due to technical and process-related issues; the robot was not fully implemented until September 2003.

Because so little research has been done on social and organizational issues related to autonomous robots, this study is among the first to examine how workers in an organization perceive and interact with an autonomous mobile robot. We therefore chose to employ an ethnographic approach to the research, using observations and ethnographic interviews to explore people’s interactions and reactions related to the technology’s introduction into the institutional setting. The research team conducted

observations and interviews, spending two to six hours per week in the field through the pre-implementation and testing phase, for a total of approximately 100 hours of observations and interviews.

In addition to observations in nursing stations, the hospital pharmacy and hospital laboratory, the research team observed the meetings of a robot users group assembled by the hospital administrator responsible for the robot’s acquisition. The male administrator told the users group that they would decide how the robot would be used, where it would go in the hospital and how it would be configured. Supplementing our observations, the research team conducted individual ethnographic interviews with the administrator, the department directors who were members of the users group, and with various nurses and pharmacy workers to gain a more in-depth understanding of existing work practices, structures and attitudes, particularly concerning the use of technology such as the robot.

The researchers typed up each day the observation and interview data collected that day and sent these field notes to the research team. The field notes were then coded and analyzed, using methods outlined by Strauss and Corbin [14] for creating grounded theory. These methods involve reading through the data and identifying key categories that emerge, such as instances of people expressing their attitudes towards technology or making sense of the robot in a particular way. Using the software program NVivo, the entire set of field notes were then coded and recoded using the emerging categories. The team met every two weeks throughout most of the data gathering and analysis period to share insights and to continue to refine the research. The findings presented in this paper grew out of the analysis of the coded data.

We negotiated access to the hospital through a representative of the robot manufacturer, who had relationships with the hospital’s “gatekeepers.” The manufacturer positioned the robot primarily as a mechanism for delivering medications and supplies around the multi-floor hospital, particularly between the pharmacy and nursing units.

The first few months of observation focused on how the hospital currently handled these courier functions: How the pharmacy managed medication deliveries to nursing units, how medication orders were relayed around the hospital, and so on. The initial observations and ethnographic interviews provided an understanding of the current work environment and interdependencies and attitudes among different types of workers. We then observed as workers learned that a robot would be introduced into the hospital, and we observed and recorded interactions and reactions of workers during the pre-implementation and testing phases of the technology.

### IV: BACKGROUND ON THE TECHNOLOGY

The robot introduced at Community Hospital was a Pyxis HelpMate, designed for use primarily as a courier in hospitals and research laboratories. The HelpMate robot resembles a 5-foot-tall filing cabinet (see Figure 1), is approximately three feet in width and depth, weighs six hundred pounds, moves at a rate of two feet per second, and can deliver medications, specimens, documents and other materials weighing up to 200 pounds between specified locations within a building. Using a pre-programmed map

of the setting, the robots navigate hallways and around obstacles using wireless radio and laser scanning technology. The model we studied was equipped with keypads and touch-screen visual display, enabling employees to load items into the robot's storage space and specify deliveries by selecting pre-set locations from a menu on the display.



Fig 1: Pyxis HelpMate

The robots have a programmed human voice, either male or female, to announce their movements or their arrival at particular locations and to provide alerts to problems or obstacles. They also use wireless technology to call elevators so that they can move autonomously between hospital floors. The first such robots were deployed in hospitals more than 10 years ago; today, the manufacturer reports that more than 90 U.S. hospitals and laboratories are using one or more of these robotic couriers.

The Pyxis HelpMate is one of just several types of autonomous mobile robots now being used in work settings, but robots such as these are expected to spread to other work environments in the next few years [15].

## V. SEX SEGREGATION AND SENSEMAKING AT COMMUNITY HOSPITAL

The link between sensemaking and sex segregation structures emerged from our analysis of the observations and interviews conducted at Community Hospital during the robot's pre-implementation and testing phases. As hospital workers learned through various channels about the upcoming introduction of the robot, they attempted to make sense of it in relation to existing processes and structures at the hospital and to their own work roles and identities [5]. Consistent with Weick's [6] assertion that sensemaking is a social process, Community Hospital workers engaged in sensemaking in a robot users group and in informal interactions by trying out various cognitive frames with each other and by taking joint actions in response to the robot's acquisition. Because workers' roles and identities are tightly tied to sex-segregated structures, hospital employees seemed particularly constrained and enabled by these structures in the sensemaking process, as suggested by the distinct cognitive frames employed by the holders of sex-

segregated jobs: male engineers and high-level hospital administrators used cognitive frames that can be grouped into the category, "robot as machine"; female directors of predominantly-female departments, female food-service workers, and female pharmacy technicians generally employed a "robot as human male" cognitive frame; and the predominantly-female nursing staff frequently employed cognitive frames that can be grouped into the category of "robot as novelty." Each frame employed by these distinct groups of Community Hospital staffers invoked different expectations of the robot's abilities and seemed to emerge from the particular structural position of the group within the hospital status hierarchy. We now explore the relationship between each of these groups and the dominant cognitive frame each employed to make sense of the robot.

### A. Male Engineers and Administrators: "Robot as Machine"

Our analysis of the Community Hospital data revealed that men who held engineering jobs as well as those who held high-ranking administrative jobs at the hospital predominantly employed cognitive frames that fit into the category of "robot as machine." These male workers often referred to the robot as a "vehicle" or a "computer," frames that both suggest a machine that a human could control, although offering slightly different expectations of the robot's capabilities. The men who invoked the cognitive frame of a vehicle, for example, spoke of the robot as "driving" around the hospital, taking different "routes" and "maneuvering" around obstacles in the hallway. The head of engineering, for example, frequently talked about "souping up" the robot so that it would roll more rapidly around the hospital, and of "driving" the robot to its battery-change station in the Engineering department. By contrast, those using the cognitive frame of robot-as-computer talked about the technology as something that could be programmed to work in various ways. The director of the male-dominated pharmacy, for example, often spoke about programming the robot for specific rounds and about printing delivery reports from its computer memory.

The following is a typical exchange between a male hospital administrator (Jeff) and a member of engineering (Ben), employing the robot-as-computer frame:

*Ben says after Jeff goes through his explanation of how the segments might work, 'We would have to reprogram it for the average time needed each time....' He and Jeff talk about what Ben means about the programming of the robot. Ben says, 'You can send stuff just one way, or you can send stuff out and get returns....'*

The following interaction involving Larry the engineering director and Stan the pharmacy director is another example of this group of men's use of robot-as-machine frames:

*Stan walks up by the robot and Larry shows him on the screen how to program it to send it down to "Battery Charge". A woman in a dark blue coat calls to Stan from the lobby, "What's his name?" Stan replies, "We don't know yet." Larry turns to [the researcher] and asks, "Why do people say 'he'? I try to say 'it'. I've been calling it 'the vehicle.'"*

Whether male administrators and engineers referred to the robot as a computer to be programmed or as a vehicle to be driven, their frequent use of robot-as-machine frames suggests that these male workers saw the robot as a technology they could control. In fact, the male engineers

and the male administrators did have great control over how the robot was programmed, ultimately deciding where and how the robot would be used. Female workers, on the other hand, rarely used this set of cognitive frames unless responding to men's comments about the robot's programming or "driving," as sometimes occurred in the robot users group meeting.

### *B. Female Directors, Food Workers and Pharmacy Technicians: "Robot as Human Male"*

Unlike the male administrators and engineers, female directors of largely female departments such as Admitting, Medical Records and Media Relations joined female food service workers and low-status female pharmacy technicians in generally making sense of the robot by employing a "robot-as-human male" cognitive frame. Such anthropomorphizing of the robot is itself not surprising given that people tend to anthropomorphize objects even when those objects have not been intentionally designed to prompt such a response [16], or when the objects provide only minimal life-like cues [17]. What is interesting, however, is that 90 percent of references during the pre-implementation phase to the robot as human were made by women in the positions noted above – with all the women anthropomorphizing the robot as a male, even before they saw the technology. This widespread use of the robot-as-human-male frame may point to the relative lack of power and control over the technology that these workers felt, since the frame likely invoked the widely-held sex stereotype of males as agentic [18] and therefore suggested the robot was autonomous and competent.

Women's clustering at Community Hospital – as elsewhere in American workplaces – in low-status positions such as admitting, patient records, nursing and food service may have contributed to the sense of powerlessness over the technology that led to the use of the robot-as-human-male frame. Although holding director titles, the women administrators who used this frame, for example, were all in charge of low-status departments as compared to the male administrators who used the robot-as-machine frames. Thus, these female workers may have viewed the robot as out of their control, even though some of them served on the robot users group that ostensibly was to decide the robot's use – but which ultimately did not have much say in how it was deployed. The following excerpt from a users group meeting – in which all the participants held a director title – illustrates the use of this frame by female administrators:

*[Referring to the robot,] Trish says, "If everyone needs a special container, I'm concerned he's not big enough for everybody..." Jim says, "You weren't at the prior meeting, were you?" Trish says no. Larry says, "He's pretty big -- 2 feet by 2 feet..." Jim says, "And there's an optional backpack..." Trish says, "He has a backpack?" Louise laughs and says, 'That's what they called it!'*

Several female directors directly expressed the belief that male administrators rather than the users group would ultimately determine the robot's use. A number of female directors, for example, referred to the technology as "Pharmacy's robot", with Stan the pharmacy director having ultimate control over the technology because he had advocated for it. One department director expressed the following when asked after the third users group meeting who was responsible for the robot: "I feel like it's going to be Pharmacy....It's part of the Pyxis system...and Jim [the

vice president who acquired the robot] is the administrator for that area so....It seems like it is for Pharmacy specifically and now we are looking to see if we can utilize it more generally."

In addition to impacting workers' feelings of power over the technology, structures of sex segregation may have constrained how female workers made sense of the robot through the robot's association with the Pharmacy. Female workers at the hospital may have viewed the robot as "male" because it was associated with the predominantly-male Pharmacy, in which women held just one of six top positions and were mainly clustered in low-level "pharmacy technician" jobs. That the robot might be perceived as male because of its association with a "male" department is supported by the fact that a separate autonomous robot used in nursing homes is generally perceived as female, seemingly because its tasks include reminding patients to take pills and helping them walk down hallways [19] – tasks generally associated with predominantly-female nurses and nurses assistants.

Whether because of the robot's association with Pharmacy, because they perceived themselves as lacking control over the "agentic" robot, or because of some other, unidentified reason, female administrators, food staff and pharmacy technicians' predominant use of the robot-as-human-male frame indicates that these workers made sense of the robot quite differently than did male engineers and administrators – a difference that seems most likely explained by their segregation into different jobs than those that the men held.

### *C. Nurses: "Robot as Novelty"*

Although sometimes anthropomorphizing the robot as did the female workers described above, nurses and nursing directors more frequently employed cognitive frames during sensemaking that can be grouped into the category of "robot as novelty." These frames – including referring to the robot as a toy, an entertainment device such as a jukebox, or a "stupid thing" – suggested that the robot was a useless or frivolous item, rather than something that was needed for serious work at the hospital. Typical of this type of expression, one nursing director suggested that her staff would want to "play" with it and that doctors would "get on and ride down the hall." Another female nurse referred to it as the male engineering director's "new toy" when he accompanied it to her unit during testing.

As part of employing the robot-as-novelty frames, nurses frequently made derogatory statements or expressed resentment about the technology's acquisition, mentioning items they felt would be far more useful to the hospital than the robot would be. Perhaps the resentment stemmed from nurses' feeling that the robot acquisition was a demonstration of nurses' needs being subordinate to the desires of the higher-status male administrator and pharmacy director who were responsible for bringing in the robot. Nurses on several occasions, for example, expressed that the nursing staff really wanted new mobile IV pumps that would be easier to hook up to patients, with one nurse contrasting the pump's usefulness with the "waste of money" that the robot represented to her. The following two exchanges, which occurred during the robot's testing, are illustrative of nurses' framing of the robot as a useless technology:

*A nurse sitting at the station [as the robot rolls up] says, "We are paying \$12,000 for this thing...and this is what it does. They can't afford a break room and they can't afford a pay raise for us...but they can afford this thing!" [The nurse] sits back down in the chair behind the counter. She looks up and sees me watching and greets me, asking if I'm watching the robot. I say yes, and I ask her what she thinks of it. She says, "Not much, that's for sure. It got stuck up here this morning....[She looks at me.] I wonder how much that thing costs. [I say I don't know and she says:] A whole lot more than it's worth, that's for sure!"*

Because structures of sex segregation make nursing a predominantly female profession and therefore relatively low status compared to the positions of the men responsible for acquiring the robot, nurses likely felt as powerless over the technology as the female administrators did. Yet nurses' use of the robot-as-novelty frame seems to express that they saw the robot not merely as something they could not control but also as something that siphoned needed resources from them in order to satisfy male administrators' whims. Interestingly, nurses and the nursing directors who attended the robot users group meetings rarely expressed these views in front of higher status people such as the male administrators or pharmacists. Instead, nurses seemed to "play along" with the male administrators' views of the robot as a cutting-edge and useful machine and only shared contrary views when they were with those likely to share a similar mindset. Suggestive of the link between the job and the frame employed in sensemaking, the very few male nurses at the hospital joined the female nurses in using the robot-as-novelty cognitive frame to make sense of the robot as the following excerpt illustrates:

*[As the robot approaches during testing], no one in the nursing station glances up at first. But as the robot begins to roll away, a male nurse walks up to a woman sitting where the unit assistant or charge nurse usually sits and whispers to her, "When do we get that stupid thing?" She says, "I don't know...." They talk quietly and watch as it attempts to maneuver around mobile IV units in the hallway.*

Nurses, then, made sense of the robot according to their own sex-segregated positions, seeming to view the robot as a novelty that would not ease their own workloads but that perhaps instead symbolized the prioritization of the desires of men in higher-status, predominantly-male jobs over the needs of the low-status, predominantly-female nursing staff.

## VI. CONCLUSION AND IMPLICATIONS

Analysis of the data collected at Community Hospital suggests that sex segregation structures may have had an impact on how men and women, segregated into distinct jobs at the hospital, made sense of a new technology – a mobile autonomous robot. Male and female workers seemed to engage in sensemaking around the robot according to their positions in the hospital: engineers and male administrators generally saw it as a machine that they could control; female administrators and low-level female staff workers anthropomorphized it as a human male that acted with agency, and nurses, predominantly female, saw it as a technology with no work utility and perhaps as further evidence of the low value placed on their jobs and work needs.

Even if the choice of cognitive frames by different workers were not tied to the workers' sense of control,

powerless or resentment, this study suggests that structures of sex segregation might have subtle and not-so-subtle effects on how groups of men and women understand a technology – perhaps because of their relative power and status within the work environment, or perhaps because workers simply engage in sensemaking primarily with others in similar jobs, arriving as a group at what Weick calls "committed interpretations" [20] as they share these frames in social settings.

Professional service robots represent an application of robotics that is expected to grow considerably [21], yet little research has been conducted to understand how these robots are received and used within the work settings in which they are employed. There remains a dearth of empirical research on human-robot interaction, particularly research that focuses on how people respond to robotic technology. Even fewer studies exist of professional service robots that are embedded in complex professional settings comprised of a variety of people engaged in different tasks and organized into formal and informal groups. Our study begins to fill this gap and suggests that designers may need to account for group types and intergroup relationships in the target setting when considering design alternatives for professional service robots. For example, if women and less powerful groups are more prone to feeling a lack of control when robots are introduced, perhaps physical embodiments or voices that are less intimidating may engender more acceptance. Implementation strategies that allow workers to better understand how the technology is controlled also may increase acceptance.

The robot we studied was mobile and autonomous. Our study suggests that these characteristics may increase the extent to which different groups within an organization perceive the same robot differently. Most technologies are used in a particular setting or are moved by a person from context to context, but autonomous mobile robots move unaccompanied into and out of various settings. Because the technology moves on its own from context to context, individuals in one setting may make sense of the technology quite separately and differently from those in another. As mobile autonomous robots proliferate, understanding and anticipating the perceptions of multiple groups may be increasingly important.

The findings we present in this paper are preliminary and require further research and testing to see if they generalize to other types of robots, to robots performing other tasks, and to other work environments. Yet, this study suggests the importance of such research by showing that structures of sex segregation may affect far more than the wages and opportunities available to women and men. Such structures, it seems, may also shape how people make sense of their work worlds and of technologies within them. By constraining and enabling certain ways of making sense of the environment, structures of sex segregation might actually lead to the embedding of gendered structures into what might appear to be gender-neutral situations and objects, such as a new technology. What the embedding of such structures might mean for the acceptance and use of robotic technologies deserves further study as such technologies move increasingly into the mainstream.

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