Robots in Group Context: Rethinking Design, Development and Deployment

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Abstract
Over the last decade, the idea that robots could participate meaningfully in complex human contexts such as groups and organizations has developed from a promising vision into a reality. Robots now assist human collectives in simple tasks such as delivery through complex high-stakes tasks such as disaster response or surgery. Despite this dramatic increase, not much is known about how these systems affect and interact with the overall task oriented and social functioning of the groups and organizations they are embedded in and how we should design robots to support all aspects of such interactions. This panel brings together experts on design, robotics, organizational behavior, team dynamics and science and technology studies to discuss challenges and opportunities arising from the increased participation of robots in teams groups and organizations.

Author Keywords
Robots; Groups and Teams; Artificial Agents; Artificial Intelligence; Group Dynamics; organizational behavior; sociology; science and technology studies; design

Introduction
Over the last decade the idea that robots could become an integral part of teamwork developed from a promising vision [6] into a reality. For example,

Figure 1: Robot deployment during World Trade Center rescue response (Murphy, 2004).

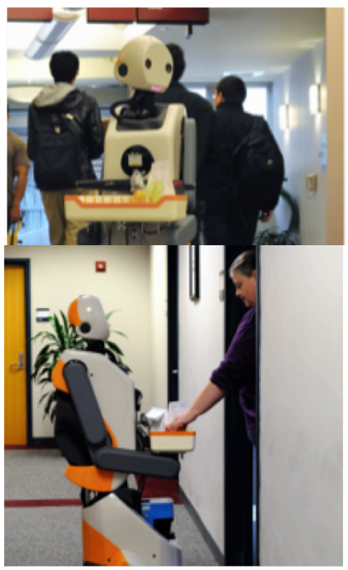

Figure 2: Snackbot delivering Snacks (Lee et al., 2012)

between 2007 and 2011 the number of procedures with the daVinci surgical robot increased by 400% in the U.S. alone, with a total of over 300,000 procedures per year in 2011 [2]. Robots support teamwork across a wide range of settings covering search and rescue missions [10], minimally invasive surgeries [4], space exploration missions [3], and manufacturing [15]. Further the shift in mobile tele-presence robotics from an expensive niche technology towards an affordable and widely available technology has enabled increased use of these robots in small teamwork settings in industry [18], cross-occupational collaboration in health care [1] and in larger group settings at conferences [14].

Scholars have increasingly explored the ways in which robots influence how work in teams is performed, but that work has primarily focused on task specific aspects of team functioning such as the development of situational awareness [12], common ground [17],and task coordination [16]. However, robots affect collective human interactions not only through the task- specific functions they have been developed to serve but also by a group's social functioning. On the group level, robots evoke emotion, can redirect attention and shift communication patterns, and on the organizational level can require changes to organizational routines and collaboration patterns [1], for example they can directly induce emotions in others, but also indirectly by affecting related social processes such as attention [13], and in often unintended ways [5].

These and related dynamics have important and underexplored implications for design, development and deployment of robotic systems, and for the study of such processes. With the increased placement of robots in groups and teams addressing these implications is important especially since the bulk of human-robot interaction research - to date – has focused on a single human interacting with a single robot and largely ignored the organizational context the interactions take place within.

As the Human-Computer Interactions community's interest in Human-Robot Interaction has been steadily on the rise over recent years it is timely to engage the CHI community in addressing how to understand human robot interaction in complex group contexts and to address how can we move towards a desirable future of working with robots and agents in groups and teams.

Goal of the Panel

The overall goal of this panel is to increase awareness within the HCI community for the social and technical challenges and opportunities that surround the placement of robots within work-groups and teams. We want the audience to leave this panel with new questions and ideas about robots that arise when thinking beyond interactions between a single human and a single robot. To address this goal, the panelists will offer insights and hitherto unanswered questions about the design and use of robots in groups from five disciplinary perspectives: Science and technology studies, robotics, design, organizational behavior, and team dynamics.

Format of the Panel

The core of the panel will be an interactive design critique of current robots that are used in the context of work in groups and teams. The design critique will offer perspectives about how the design of current robots

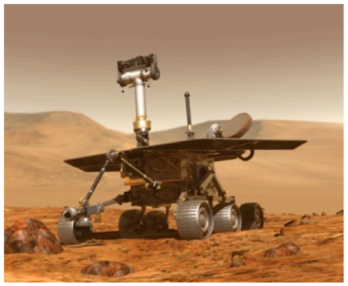

Figure 3: Mars Rover robot (upper) and Science Operations Working Group meeting with rover planners in the back row (lower) (Courtesy: NASA/JPL/Cornell).

impacts work in groups and teams and what we might consider in designing robots in the future. Broadly, the panel will be divided into three major parts:

Part I: Introduction (25 minutes)
A five-minute introduction to the panel and the panelists will be given by the moderator. For the first part of the panel (20 minutes) each panelist will present a brief (5 minute) position statement about what he/she sees as the key challenges and opportunities for the design and use of robots in group
Part II: Interactive Design Critique

The second part of the panel (40 minutes) will be used for an interactive design critique of a specific set of robots. A set of robots, that at least one panelist has studied, worked with or designed, will be introduced to the audience (See figures 1 to 3 for example) and one or two specific designs will be chosen for further discussion.

The panelists will first be asked to provide their disciplinary perspective on the design, development, and deployment of robot and then the discussion will be opened up for audience questions. An image of the chosen robot in use will be projected on the main screen to provide context for the insights given by the panelists and to prevent a generic discussion about robots. By showing an image of a robot in use we also hope to provide a fruitful ground for members of the audience to ask focused questions about a robot or use context. Questions we hope to address during the panel include:

DEPLOYMENT: What do we know about how the robot affects the social and task functioning of the groups and teams it is deployed in? With a group context in mind, what aspects of the robot seem well designed, which less so and why?

DESIGN AND DEVELOPMENT: How do current design approaches take what we know about groups and teams into account? What are the big challenges in developing robots for the context shown here? How might such a robot be redesigned, given what we know about work in groups, and given new technological advances in areas such as machine learning, ubiquitous computing (e.g. IOT), and crowdsourcing?

PART III: SUMMARY AND WRAP UP (15)
The final part of the panel (15 minutes) will be used for the moderator to highlight key areas of interest that emerged based on the questions raised by the audience. Panelists will then have the opportunity to provide additional insights into the emergent question and to provide concluding thoughts.

Panelists

Our panel brings together leading scholars on robots and their design and use in group and team settings. All panelists have confirmed interest and availability to participate in the panel discussion should this proposal get accepted.

Panelists were selected to represent 5 different disciplinary areas: Organizational behavior, design, robotics, team dynamics, and science and technology studies. Brief biographical sketches and proposed panel statement topics are listed in alphabetical order below.

Matt Beane (Organizational Behavior)
Bio: Matt Beane is a Ph.D. student at MIT's Sloan School of Management and Chief Human-Robot Interaction Officer at Humatics corporation. His academic research focuses on the implications of robotic technologies for skilled, collaborative work in organizations. His dissertation compares the practice of robotic surgery to traditional surgery across multiple elite hospitals around the United States, focusing on how professionals overcome associated coordination and learning challenges. At Humatics, he is responsible for design challenges associated with a new class of IoT sensor.

Perspective: I focus on how workers, teams and organizations contend with robotic systems once they have been designed, developed and purchased. In particular I focus on the shadowy side of these dynamics: norm-bending and policy-breaking practices that are tolerated because they enable productive interactions with robotic systems.

Jodi Forlizzi (Design)
Bio: Jodi Forlizzi is a Professor of Human-Computer Interaction in the School of Computer Science at Carnegie Mellon University and a Co-founder of Pratter.us, a healthcare startup. She designs and researches systems ranging from peripheral displays to agents and social and assistive robots. Her current research interests include designing educational games that are engaging and effective, designing services that adapt to people's needs, and designing for healthcare. Jodi is a member of the ACM CHI Academy and has been honored by the Walter Reed Army Medical Center for excellence in HRI design research. Jodi has consulted with Disney and General Motors to create innovative product-service systems.

Perspective: My group's research has shown that differences within groups and roles within an organization can drastically change how members collaborate with a robot. This suggests that the design of a collaborative robot may have to differ within the same organization, even when it is programmed to do the same task within similarly-structured environments. Ongoing research is needed to truly understand this dynamic.

Malte F. Jung (Team Dynamics, Moderator)
Bio: Malte Jung is an Assistant Professor in Information Science at Cornell University and the Nancy H. '62 and Philip M. '62 Young Sesquicentennial Faculty Fellow. His research focuses on the intersections of groups and teams, robots, and emotion. The goal of his research is to inform our basic understanding of robots in work teams as well as to inform how we design robotic systems to support teamwork across a wide range of settings. Malte Jung received his Ph.D. in Mechanical Engineering. Prior to joining Cornell, Malte Jung completed a postdoc at the Center for Work, Technology, and Organization at Stanford University.

Perspective: Affective processes are a crucial in determining team performance. Through our work we found that how emotions were expressed and regulated over time during short episodes of a team's interaction predicted subjective as well as objective outcomes of teamwork weeks [] and even months ahead [7]. We currently don't know what impact robots have on these affective team processes. Finding answers about a robot's influence on the expression and regulation of emotions in teams is pressing as the mere presence of a robot will likely influence emotions in teams in ways we simply do not know nor anticipate.

Robin Murphy (Robotics)
Bio: Robin Murphy is the Raytheon Professor of Computer Science and Engineering at Texas A&M University and the director of the Center for Robot-Assisted Search and Rescue. Her work focuses on identifying human-robot interaction with small ground, aerial, and marine systems for disaster response, recovery, and prevention, then designing training, new user interfaces, or adding autonomous capabilities in order to mitigate HRI deficits. Her analysis of over 30 robot deployments by agencies to actual incidents such as the 9/11 World Trade Center, Hurricane Katrina, and Fukushima is summarized in *Disaster Robotics* [10].

Perspective: Our field research illustrates how the successful use of robots depends on designing systems that support both teams and groups in formative domains. During a disaster, teams of robots operated by specialists provide information to non-robt experts across multiple agencies who may never worked with a robot or with other. Certainly, success depends on how well the robot teams can work with other robot teams to accomplish novel missions (e.g. a UGV assisting another UGV on a complex manipulation task at Fukushima). But ultimately success depends on two other considerations. One is how the experts, who are not necessarily co-located with the robot operators or each other, can interact with the robots and share robotic resources. The second is how the information is tailored to and delivered in time for each expert's decision cycle.

Janet Vertesi (Science and Technology Studies)
Bio: Janet Vertesi is an Assistant Professor in the Sociology Department at Princeton University. The majority of her research is on robotic spacecraft teams at NASA, and how the teams' social organization affects and reflects their robots' activities and scientific results. Janet's first book, Seeing Like a Rover: How Robots, Teams, and Images Craft Knowledge of Mars is based on over two years of working with the Mars Exploration Rover Mission, and was published by University of Chicago Press in early 2015. She is also working on an ethnography of the Cassini Mission to Saturn, thanks to a National Science Foundation Grant in Socio Computational Systems.

Perspective: How do team structures and cultures intersect with robotic action and imagined capabilities? I think about the organizational context of robotic work, such as the hierarchies, the formal and informal aspects of decision-making, and describe how these are essential for designing competent and effective autonomous agents.

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