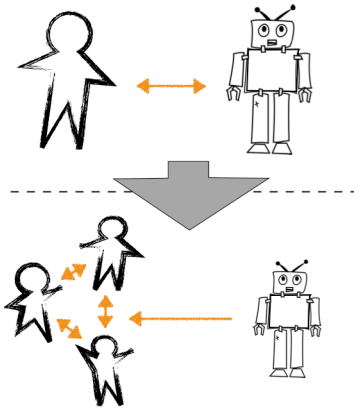

Figure 1: This workshop addresses the social and technical challenges that surround the placement of robots within work-groups and teams and addresses questions that emerge when shifting the focus from one-on-one human robot interactions to interactions of robots with and within groups.

Robots in Groups and Teams

Malte F. Jung
Cornell University
Ithaca, NY 14850, USA
mjung@cornell.edu

Friederike Eyssel
CITEC, Bielefeld University
33619 Bielefeld, Germany
feyssel@cit-ec.uni-bielefeld.de

Selma Šabanović
Indiana University
Bloomington, IN 47408, USA
selmas@indiana.edu

Marlena Fraune
Indiana University
Bloomington, IN 47408, USA
mfraune@indiana.edu

Abstract

Over the last decade, the idea that robots could become an integral part of groups and teams has developed from a promising vision into a reality. Robots are increasingly designed to interact with groups and teams of people, yet most human-robot interaction research still focuses on a single humans interacting with a single robot. The goal for the workshop is therefore to advance research in computer supported cooperative work (CSCW) and human robot interaction (HRI) by raising awareness for the social and technical challenges that surround the placement of robots within work-groups and teams. The workshop will be organized around three central questions: (1) How do robots shape the dynamics of groups and teams in existing settings? (2) How does a robot's behavior shape how humans interact with each other in dyads and in larger groups and teams? (3) How can robots improve the performance of work groups and teams by acting on social processes? These core issues will be covered across a set of presentations that initiate in-depth discussions around each question to improve the quality of and support the growth of research in the CSCW community that focuses on the intersection of robots, groups, and teams.

Author Keywords

Robots; Groups and Teams; Artificial Agents; Artificial Intelligence; Group Performance; Group Dynamics

ACM Classification Keywords

H.1.2. Models and Principles: User/Machine Systems; H.4.m. Information Systems Applications: Miscellaneous; H.5.3. Information Interfaces and Presentation: Group and Organization Interfaces.

Goal of the workshop

The goal is to advance research in computer supported cooperative work (CSCW) and human robot interaction (HRI) by raising awareness for the social and technical challenges that surround the placement of robots within work-groups and teams (Figure 1).

By bringing together researchers from the human robot interaction community (HRI) with members of the CSCW research community, we aim to facilitate discussion that will generate awareness of existing research at the intersection of robots and groups/teams and that will highlight open questions that current research has not sufficiently addressed.

Introduction to Open Questions (Themes)

Over the last decade the idea that robots and agents could become an integral part of groups and teams has developed from a promising vision (Hinds, Roberts, & Jones, 2004) into reality.

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 (e.g., Takayama & Go, 2012) and in larger group settings at conferences (e.g., Neustaedter et al., 2016).

More complex tele-operated robots also increasingly support high-stakes teamwork across a wide range of settings such as search and rescue missions (e.g. Murphy, 2004), space exploration missions (e.g. Diftler et al., 2011), and minimally invasive surgeries (e.g. Duysburgh, Elprama, & Jacobs, 2014).

Even fully autonomous systems are frequently employed as part of groups and teams for example by performing delivery tasks in hospitals (e.g. Ljungblad, 2012) or by working closely alongside people on manufacturing floors (e.g. Sauppe & Mutlu, 2015. Recent advances in AI and particularly in conversational agents will likely lead to an increased placement robotic systems in groups across domestic (e.g. Amazon Echo, Google Home, Jibo) and work settings.

This increase of contexts in which robots participate in groups and teams stands in stark contrast with the bulk of human-robot interaction research that - to date – has focused only on a single human interacting with a single robot. Studies that explore the intersection of robots and groups and teams are rare in CSCW research but would extend its contributions to research on the design, implementation and effects of embodied agent and communication technologies on group and team interactions.

The expansion in the number of users who are interacting on a daily basis with robotic systems in groups or teams should be reflected in an increasing number of research efforts addressing robots in groups and teams issues. Given the vast experience within the CSCW community to study how technology affects the life and work of groups and teams more broadly, we see an opportunity to bring together researchers from the HRI and CSCW communities to address open challenges and questions.

The workshop content will be driven by the interests and experience of participants, while at the same time focusing on the three core questions that have emerged:

How do robots shape the dynamics of groups and teams in existing settings?
Robots are already participating in work performed by groups and teams. For example, 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 (Cooper et al., 2013). Despite this tremendous increase in the use of robots in team settings, we have little understanding how robots shape the dynamics of the groups and teams they are employed in. For example, it is not clear how robots affect core group processes such as conflict or power dynamics, and how the impact of a robot on these processes shapes short- and long-term group outcomes.

How does a robot's behavior shape how humans interact with each other in dyads and in larger groups and teams?
The bulk of existing research on human robot interaction focuses on one-on-one interactions between a human and a robot. Studies that explore settings in which one human interacts with multiple robots (e.g. Jung et al., 2013) or settings in which one robot interacts with multiple humans (e.g. Jung et al., 2015; Short & Mataric, 2016) are rare. Past research has contributed fundamental understanding about the psychology of human robot interaction and how robots can be designed that interact and collaborate well with people (Shah et al., 2011). However, little is known about how robots affect the ways in which people interact with each other and even less is known about how robots affect or should affect the way people interact with each other in more complex group settings.

How can robots improve the performance of work groups and teams by acting on social processes?
Current technical approaches for robots to support teamwork rely mostly on approaches to support taskwork processes (Marks et al., 2001), that is, those processes that directly move the task forward (e.g. Shah et al., 2011). Given that the social and emotional functioning of groups and teams has been shown to be crucial for group performance (Barsade & Gibson, 2007), we see an opportunity for robots to improve group performance by acting on teamwork processes that ensure the social functioning of teams.

As robots increasingly participate in groups and teams, understanding their impact on the social and task oriented functioning of groups and teams through their mere presence or explicitly designed behavior becomes ever more important.

The need to address these questions and expand our understanding of human robot interaction from individuals to groups becomes even more urgent as new developments in AI have promoted a surge of new robots that enter into group settings.

Workshop Format and Activities

This is a one-day workshop for up to 25 participants that will be organized in three sessions around the three focal questions of this workshop. For each session, we will invite 2 or 3 workshop participants to present their ideas and research findings that broadly address the questions outlined above. Each session will be concluded by a round-table discussion to summarize key insights and open questions.

Workshop Speakers

Two invited speakers will present their perspective during the workshop:

Janet Vertesi

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.

Julie Shah

Pamela J. Hinds is Professor and Director of the Center on Work, Technology, and Organization in the Department of Management Science and Engineering, Stanford University. She studies the effect of technology on teams and collaboration. Pamela has conducted extensive research on the dynamics of geographically distributed work teams, particularly those spanning national boundaries. She explores issues of culture, language, identity, conflict, and the role of site visits in promoting knowledge sharing and collaboration. She has published extensively on the relationship between national culture and work practices, particularly exploring how work practices or technologies created in one location are understood and appropriated at distant sites. Pamela also has a body of research on human-robot interaction in the work environment and the dynamics of human-robot teams. Most recently, Pamela has begun to explore the changing nature of work in the advent of technology shifts such as increasing cyber-physical systems, intelligence and autonomy (e.g. autonomous robots, 3-D printing, open innovation, etc.). Her research has appeared in journals such as Organization Science, Research in Organizational Behavior, Academy of Management Journal, Academy of Management Annals, Academy of Management Discoveries, Human-Computer Interaction, Journal of Applied Psychology, Journal of Experimental Psychology: Applied, and Organizational Behavior and Human Decision Processes. Pamela is a Senior Editor of Organization Science. She is also co-editor with Sara Kiesler of the book Distributed Work (MIT Press). Pamela hold a Ph.D. in Organizational Science and Management from Carnegie Mellon University.

Participant Recruitment and Selection

We invite paper submissions that largely speak to the Core Questions I-III and/or fall into the topical areas listed below. Papers should be 4-6 pages (including citations), and can be on research that the authors have already conducted. We also encourage position papers and submissions on research that the authors plan to conduct; feedback can be given during coffee breaks or discussions. Papers should be formatted according to the Extended Abstracts Format. The workshop website will be updated to include the paper requirements, submission, and selection process:

http://hri.cornell.edu/robots-in-groups/

Possible paper topics include but are not limited to:

- Theories and frameworks about robots and agents in groups and teams
- Field studies of robots in group and team settings
- Ethical implications of employing robots in groups and teams
- Behavioral science research that examines the impact of specific robot attributes and behaviors on groups and teams
- Behaviors for robots and agents to impact social dynamics in groups
- Technical systems that enable robots to participate in group and team settings
- Design approaches for developing robots that participate in groups and teams
- Techniques for robots to improve team performance

Papers will each receive a minimum of two reviews. Accepted papers will be made publically available on the workshop website.

Out of the accepted papers, we will select two papers for each session to be presented orally. Papers that are selected will be presented in 5 minute lecture format and will be discussed further during the round table discussion and during a coffee break. Other accepted papers will be presented as posters and discussed during the coffee breaks. Accepted papers will require that at least one presenting author registers for the workshop.

Organizing Team

Malte F. Jung

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 and his Ph.D. minor in Psychology from Stanford University. Prior to joining Cornell, Malte Jung completed a postdoc at the Center for Work, Technology, and Organization at Stanford University. He holds a Diploma in Mechanical Engineering from the Technical University of Munich and an M.S. degree in Mechanical Engineering from Stanford University.

Selma Šabanović

Selma Šabanović is an Associate Professor in the School of Informatics and Computing at Indiana University, Bloomington. Her work combines the social studies of computing, focusing particularly on the design, use, and consequences of socially interactive and assistive robots in different social and cultural contexts, with research on human-robot interaction (HRI) and social robot design. A common aim of her research is to go beyond studies of one-on-one interactions between people and robots by understanding the effect of group-level, institutional, and cultural factors on HRI. She is currently the PI on an NSF-funded project focusing on group HRI. Selma has been a Visiting Professor at Bielefeld University (2014), a lecturer in Stanford University (2008-2009), and a visiting scholar at AIST, Tsukuba, Japan and at

Carnegie Mellon University (2005). Selma received her PhD in Science and Technology Studies from Rensselaer Polytechnic Institute in 2007.

Friederike Eyssel
Friederike Eyssel is a Professor of Applied Social Psychology and Gender Research at Center of Excellence Cognitive Interaction Technology at Bielefeld University, Germany. Friederike is interested in various research topics ranging from social robotics, social agents, and ambient intelligence to attitude change, prejudice reduction and sexual objectification of women. Crossing disciplines, she has published vastly in the field of social psychology, human-robot interaction and social robotics and serves as a reviewer for more than 20 journals. Current third-party funded research projects (DFG, BMBF, FP7) address user experience and smart home technologies, and ethical aspects associated with assistive technology. She has been a visiting professor at NYU Abu Dhabi, University of Cologne, Technical University of Dortmund and University of Münster between 2010-2015. She received her PhD in Social Psychology from Bielefeld University in 2007.

Marlena Fraune
Marlena is a Ph.D. candidate of Cognitive Science and Psychology at Indiana University, Bloomington. Her dissertation work involves the application of intergroup dynamics from social psychology to groups in human-robot interaction. In particular, she examines how the cohesiveness (i.e. "entitativity") of human groups or of robot groups affects how humans and robots interact together, as well as cultural differences in intergroup interaction with robots. Marlena Fraune spent the past three summers as a visiting researcher at Toyohashi University of Technology (TUT) in Japan (2014, 2016) and Bielefeld University in Germany (2015). In Winter 2016, she was a visiting researcher at the Advanced Telecommunications Research (ATR) Lab in Japan. Her work has been funded by the National Science Foundation (NSF) through the Graduate Research Fellowship Program (GRFP), East Asia and Pacific Summer Institute (EAPSI), and Graduate Research Opportunities Worldwide (GROW) initiatives.

Acknowledgments

This material is based upon work supported by the National Science Foundation under Grant No. IIS-1139161, and IIS-1421929. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

References

1. Barsade, S. G., & Gibson, D. E. (2007). Why does affect matter in organizations?. *The Academy of Management Perspectives*, *21*(1), 36-59.
2. Cooper, M. A., Ibrahim, A., Lyu, H., & Makary, M. A. (2013). Underreporting of robotic surgery complications. *Journal for Healthcare Quality*.
3. Diftler, M. A., Mehling, J. S., Abdallah, M. E., Radford, N. A., Bridgwater, L. B., Sanders, A. M., & Ambrose, R. O. (2011). Robonaut 2-the first humanoid robot in space. *Proceedings of ICRA 2011*, 2178-2183. IEEE Press.
4. Duysburgh, P., Elprama, S. A., & Jacobs, A. (2014). Exploring the social-technological gap in telesurgery: Collaboration within distributed or teams. *Proceedings of CSCW 2014*. 1537-1548. NY: ACM Press.

5. Hinds, P. J., Roberts, T. L., & Jones, H. (2004). Whose job is it anyway? A study of human-robot interaction in a collaborative task. *Human-Computer Interaction 19(1)*. 151-181.
6. Jung, M. F., Lee, J. J., DePalma, N., Adalgeirsson, S. O., Hinds, P. J., & Breazeal, C. (2013) Engaging robots: Easing complex human-robot teamwork using backchanneling. *In Proceedings of CSCW*, 1555-1566. NY: ACM Press.
7. Jung, M. F., Martelaro, N., & Hinds, P. J. (2015). Using robots to moderate team conflict: The case of repairing violations. *In Proceedings of HRI 2015*. 229-236. NY: ACM Press.
8. Ljungblad, S., Kotrbova, J., Jacobsson, M., Cramer, H., & Niechwiadowicz, K. (2012). Hospital robot at work: Something alien or an intelligent colleague?. *In Proceedings of CSCW 2012*. 177-186. NY: ACM Press.
9. Marks, M. A., Mathieu, J. E., & Zaccaro, S. J. (2001). A temporally based framework and taxonomy of team processes. *Academy of Management Review*, 26(3), 356-376.
10. Murphy, R.R. (2004). Human-robot interaction in rescue robotics. *IEEE Transactions on Systems, Man, and Cybernetics, Part C: Applications and Reviews 34 (2)*, 138-153.
11. Neustaedter, C., Venolia, G., Procyk, J., & Hawkins, D. (2016). To Beam or not to Beam: A study of remote telepresence attendance at an academic conference. *In Proceedings of CSCW*. 418-431. NY: ACM Press.
12. Sauppé, A., & Mutlu, B. (2015). The social impact of a robot co-worker in industrial settings. *Proceedings of CHI 2015*. 3613-3622. NY: ACM Press.
13. Shah, J., Wiken, J., Williams, B., & Breazeal, C. (2011). Improved human-robot team performance using chaski, a human-inspired plan execution system. In *Proceedings of HRI 2011.* 29-36. NY: ACM Press.
14. Short, E., & Mataric, M., (2016). Towards autonomous moderation of an assembly game. *Workshop on Groups in Human-Robot Interaction at RO-MAN 2016*.
15. Takayama, L., and Go, J. (2012). Mixing metaphors in mobile remote presence. In *Proceedings of CSCW*, 495-504. ACM Press.