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# Human-Machine Partnerships in the Future of Work: Exploring the Role of Emerging Technologies in Future Workplaces

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## ABSTRACT

Technologies in the workplace have been a major focus of CSCW, including studies that investigate technologies for collaborative work, explore new work environments, and address the importance of political and organizational aspects of technologies in workplaces. Emerging technologies, such as AI and robotics, have been deployed in various workplaces, and their proliferation is rapidly expanding. These technologies have not only changed the nature of work but also reinforced power and social dynamics within workplaces, requiring us to rethink the legitimate relationship between emerging technologies and human workers. It will be critical to the development of equitable future work arrangements to identify how these emerging technologies will develop relationships with human workers who have limited power and voice in their workplaces. How can these emerging technologies develop mutually beneficial partnerships with human workers? In this one-day workshop, we seek to illustrate the meaning of human-machine partnerships (HMP) by highlighting that how we define HMP may shape the design of future robots at work. By incorporating interdisciplinary perspectives, we aim to develop a taxonomy of HMP by which we can broaden our relationship with embodied agents but also evaluate and reconsider existing theoretical, methodological, and epistemological challenges in HMP research.

## CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**;

## KEYWORDS

the future of work; partnerships; embodied AI agent; agency; automation

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## 1 BACKGROUND

Technologies in the workplace have been a major focus of CSCW, including studies that investigate technologies for collaborative work, explore new work environments (e.g., boundaryless workplace [33]), and address the importance of the political and organizational aspects of technologies in workplaces (e.g., power dynamics between workers and managers). Emerging technologies, such as AI and robotics, have been deployed in various workplaces [6] (e.g., hospitals, construction sites, public spaces, and offices), and their proliferation is rapidly expanding.

These technologies have not only changed the nature of work but also reconfigured power and social dynamics within workplaces, requiring us to rethink the legitimate relationship between emerging technologies and human workers. What we design for the future of work should conform not only to the expected roles of new work technologies but also to the protocols of the workplace. In particular, identifying how these emerging technologies will develop relationships with human workers who have limited power and voice in their workplaces (e.g., production workers in manufacturing, platform workers [19, 38]) will be critical to developing equitable future work arrangements. How can these emerging technologies develop mutually beneficial partnerships with human workers, when one considers the autonomy of human workers and the power dynamics among workers in organizational settings?

To explore the partnership between emerging technologies and human workers, this workshop bridges the gap between two lines of studies in CSCW, HCI, and HRI: 1) human-robot collaboration (e.g., [17, 31, 35]) and 2) worker-centered technology design (e.g., [8, 11, 18]). As technologies attain more intelligence, their influence on workplaces is also becoming stronger. They not only connect

workers as a platform (e.g., MTurk workers [15], ride-sharing drivers [26]) but also directly collaborate with workers (e.g., warehouse workers working with autonomous mobile robots [29]). Work is distributed between the two groups, which changes workflow, work characteristics, and the level of autonomy of workers. Human-robot collaboration studies [17, 39] have investigated how human workers work with robots in various settings, such as hospitals [2, 21, 23, 25] and manufacturing factories [22, 28]. These works delved into the collaboration between robots and humans; however, the empowerment or autonomy of workers, particularly workers with limited power, have not been the main focus. On the other hand, worker-centered technology design in CSCW explored how technologies empower workers with less power, such as low-wage workers [7], but the actual partnership between these workers and emerging technologies was less discussed.

By bridging these studies, our discussion of the human-machine *partnership* will bring new perspectives. Emerging technologies are designed to have not only more capabilities to perform the tasks of humans, but also a stronger social force to recompose the work flow, the characteristics of workers' tasks, and social dynamics among workers. Hereafter we call this "agency" [36]. In particular, technologically induced job destruction is problematic for workers who have a low educational attainment and a limited voice in their workplaces. This workshop aims to discuss the relationship between workers and emerging technologies including, but not limited to, robots, AI, and voice agents.

## 2 WORKSHOP THEMES

In the workshop, we seek to unpack the meaning of human-machine partnerships (HMP) by highlighting that how we define HMP will shape how we design technologies in/for the future of work. We discuss social and design implications in various professional and organizational settings and explore how we can broaden and redefine HMP. Encouraging interdisciplinary perspectives, we aim to develop a taxonomy of HMP by which we can broaden our relationship with embodied AI agents [5] and also evaluate and reconsider existing theories, methodologies, and epistemologies in HMP research. The following list of themes and questions will be addressed, subject to adjustment based on the interests and perspectives of participants:

### 2.1 Unpacking the Meaning of Partnerships between Humans and Machines

Building on the discourse of human-AI partnerships (e.g., [20]), we revisit the vision of a new human-machine symbiosis (e.g., [16]) to advance the meaning of human-embodied AI agent collaboration. Fifty years ago, J.C.R. Licklider published the paper, "Man-Computer Symbiosis," which anticipated a "very close coupling between the human and the electronic members of the partnership." The stronger agency of emerging technologies in recent years necessitates the reimagination and reestablishment of the meaning of that symbiotic partnership and its implications for the design of emerging technologies. How can this partnership benefit both employers and employees and how can we alleviate the concerns of non-managerial workers about being replaced by new technologies?

### 2.2 Agency and Autonomy of Human and Embodied AI Agents

Emerging technologies have increasingly pervaded our workplaces with new abilities in various domains. For example, new collaborative robots with more sensors and learning capabilities can now work alongside workers, unlike the previous industrial robots that were segregated from workers. They are considered as a core technology that brings the new vision of manufacturing 4.0. As these robots work with workers [9, 22], they are considered co-workers, colleagues, and assistants, posing questions about the evolving roles of human and embodied AI agents in workplaces. How will the divisions of labor between human workers and these technologies be shifted? In the future of work settings, the interaction between humans and embodied AI agents will be a multifold interaction. How does an embodied AI agent's presence affect how humans interact with each other? How do embodied AI agents shape human workers' team and organizational contexts [37], such as power dynamics? How will they differ over short- and long-term interaction? Recent scholarship has focused on human agency in future work settings, such as worker-centered design, managerial vision [12], etc. There is a lack of similar attention to technology agencies [3], particularly our focus on the agency of embodied AI agents.

### 2.3 Political and Ethical Implications of Embodied AI Agent Design

With the increasing implementation of embodied AI agents in workplaces, it is inevitable that the roles of human workers will be re-designed around the augmentation of human capabilities. What are the desired outcomes of a collaboration with machine workers, and how can we empower human workers? Integrating human workers in the process of adopting new technologies is often emphasized in the discussion of empowering workers [4, 40]. How can we provide human workers, who are new to these emerging technologies, with a feeling of integration and participation? How can we support human workers to collaborate with embodied AI agents? How do we ethically create new tasks for human workers and new work distribution between humans and machines (e.g., food delivery robots operated remotely by human workers [13])? How should we redesign contemporary workplace technologies for human-machine collaboration as a social intervention to existing power dynamics between managerial and non-managerial workers?

### 2.4 Epistemological and Methodological Challenges in the Future of Work with Machines

The workplace has been a primary field site for CSCW researchers, and workplace studies have developed the conceptual and technological foundation of CSCW [30, 32, 34]. Given that many workplaces are not already based in stationary places, specifically the unsettled and temporary workplaces of knowledge workers [10, 14], it has been a new challenge to capture practices and experiences of work with embodied AI agents. For example, with what methods can we study workers when a physical workplace no longer exists, as in the case of mobile workers? How can researchers maintain long-term relationships with field sites, when one considers the

**Table 1: Workshop (tentative) Schedule**

Time	Session/Activities
9-9:10	Welcome and Introduction of Workshop
9:10-9:40	The First Keynote Speaker & Discussions: Speaker: David Abbink (Delft University of Technology)
9:40-11:00	Lightening Talks and Panel
11:10-11:40	The Second Keynote Speaker & Discussions: Speaker: Bilge Mutlu (University of Wisconsin-Madison)
11:40-12:10	The Third Keynote Speaker & Discussions: Speaker: Matthew I. Beane (University of California, Santa Barbara)
12:10-1:30	Lunch Break
1:30-1:40	Introduction of the Afternoon Activities
1:40-2:10	The Fourth Keynote Speaker & Discussions: Speaker: Janet Vertesi (Princeton University)
2:10-3:10	Small-Group Activities on Selective Themes
3:25-4:30	Post Small-Group Activities and Wrapping up

power dynamics within organizations? Another challenge is to understand cultural, social, and organizational factors that affect the future of work with new technologies. Previous experimental studies have shown that the presence of robots shapes human performance [1, 17, 27]. How does the embodied non-anthropomorphic presence, shape, or behavior of AI agents [24] influence human performance in collaboration? How can we leverage workers' knowledge into technological design to avoid their de-skillization?

### 3 WORKSHOP PLAN AND ACTIVITIES

We will advertise a call for participation in our workshop through topic-relevant community mailing lists (e.g., HCI, CSCW, Robotics, and STS), social media, and personal invitations. We expect twenty-five participants. Our workshop website (<https://tinyurl.com/human-machine-partnership>) will also be distributed with the call, and prospective participants can access any update information (e.g., dates for the position paper deadline and their acceptance notification). We will also post accepted position papers on the website, so that participants become aware of the works of others and can prepare questions or agendas before the workshop. We detail our workshop schedules in Table 1.

#### 3.1 Audience Participation

Participants will be asked to submit a one-to-four-page position paper related to the future of work with emerging technologies and machine partnerships. The format of the paper could be a case study, a summary of works, a design pictorial, or design fiction, etc. All position papers will be subject to the peer-review process and accepted based on originality and topic relevance. At least one author of an accepted paper will be asked to attend the workshop to present the paper. Contributing authors could be invited to join a panel to share their interdisciplinary perspectives.

### 4 SET-UP AND FUTURE PLANS

We will conduct an online workshop and attempt to be mindful of time zones. We will use Zoom to connect all participants to a common virtual environment; we will use Google Slides and Miro boards for break-out group activities. We will also set up a virtual space, such as Slack or Discord for archiving discussions, materials, and references throughout the workshop. This virtual space will also serve as a community in which the future of work and embodied AI agent researchers can continue to interact and work with other participants after the workshop ends. Based on the outcome of the workshop, we hope to create collaboration opportunities with the participants, such as a follow-up workshop and the submission of a special issue proposal for ACM Transactions on Computer-Human Interaction (TOCHI) or Human-Robot Interaction (THRI).

### 5 WORKSHOP ORGANIZERS

The workshop organizers are CSCW researchers who work at the intersection of Human-Robot Interaction (HRI) and Design and have engaged with the Future of Work (FoW).

**EunJeong Cheon** is an assistant professor in the School of Information Studies at Syracuse University. Her work examines the role of values in the design of emerging technologies, such as robots and IoT, and approaches to make human values more explicit in the design. She is currently working on how collaborative robot manufacturers and their customer companies co-construct the future of work. She has co-organized workshops at HRI 2019, CHI 2020, and CSCW 2020.

**Cristina Zaga** is an assistant professor, speaker, and maker of poetic robots. At the University of Twente, Cristina's research bridges engineering, design, and social science to develop robotic technology responsibly and in a transdisciplinary fashion. She is regularly invited as a keynote speaker at events and she has organized workshops at HRI, Ro-Man and design conferences. Her award-winning work in HRI has received many academic and societal accolades, for instance the Google Women TechMaker Scholarship 2018 for her research quality and her efforts to make STEM more inclusive to women and children.

**Hee Rin Lee** is an assistant professor in the department of media and information at Michigan State University. Her work addresses problems beyond the efficiency and functionality that are often prioritized in the advancement of robotics. Lee designs and evaluates robots for social good with the aim of empowering socially marginalized groups (e.g., production workers). Lee's research has yielded best paper nominations at the premier HCI conferences including CSCW, HRI, UbiComp and CHI.

**Maria Luce Lupetti** is a postdoctoral design researcher working at the intersection of design, AI and robotics. She holds a PhD cum Laude in "Production, Management and Design" from Politecnico di Torino, Italy (2018). Her doctoral research, focused on human-robot interaction and play for children, was supported by the Italian telecommunication company TIM. Prior to this position, Maria Luce was a Research Fellow at Amsterdam Metropolitan Solution Institute (2018-2019).

**Lynn Dombrowski** is an associate professor in the Human-Centered Computing Department at Indiana University - Purdue

University - Indianapolis (IUPUI). Her work looks at social computing technologies to examine and promote social justice in the contexts of work, marginalized communities, rural spaces, and others.

**Malte F. Jung** is an associate professor in Information Science at Cornell University and the Nancy H. '62 and Philip M. '62 Young Sesquicentennial Faculty Fellow. His research seeks to build understanding about interpersonal dynamics in groups and teams and how those can be shaped by machines. He leads the Robots in Groups Lab, which focuses on design and behavioral aspects of human-robot interaction in group and team settings.

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