

# The future of work and wellbeing: A preliminary report from a series of conversations

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## Abstract

What is the future of work and wellbeing? How did the COVID-19 crisis affect this future? What can, and what should, researchers and practitioners in the field of human-computer interaction do, as they develop interfaces for work and wellbeing? These are the questions that we explore in a weekly online series of conversations with HCI experts. In this paper we share some of the insights from our first nine conversations of the series.

**Keywords:** Future of work and wellbeing; attention; microtasks; post-work recovery; games; mixed reality; robots; digital assistants

# Introduction

Advances in computing technology are rapidly changing the way we work. Human-computer interaction is a critical aspect of this ongoing change, as workers need advanced HCI to successfully interact with emerging computing devices. Our team has organized an online [series of conversations](#)<sup>1</sup>, where we talk to experts with various backgrounds to explore how advanced HCI will support work in the future and how it will also allow workers to balance productivity with wellbeing. While we are primarily interested in how HCI can support new ways to work, technological solutions are always embedded in societal structures. For this reason, in our conversations we actively strive to explore how the future of work will be shaped by the ongoing relationships between technology and society.

The conversations are open to the public and are usually attended by around 30-40 participants. They include students, researchers, and practitioners. Each conversation is recorded, and the video is posted online.

Here we provide a preliminary report from our first 9 conversations. All of these conversations, at least in part, explored the effects of the COVID-19 crisis on work through the prism of HCI. The COVID-19 crisis resulted in a sudden and dramatic change in how we work. For many of us, the well-known mainstays of work are gone, or drastically different than they were before - this includes the eight-hour workday, the office building, the morning commute, in-person conversations with coworkers, as well as sending children to school or daycare. Some of these changes may be temporary, but COVID-19 might catalyze long-term changes, such as the remote-first policies that companies, such as Facebook and Twitter, have implemented. How can HCI support worker productivity, as well as worker wellbeing, under these new circumstances? Furthermore, how do these new circumstances provide a window into the future of work? These are two of the questions that we hoped to find answers to. In the following we will share some of the insights we gained from these conversations.

## Insights from the Conversations

### Managing Work-Related Tasks

Three of our first 9 conversations focused primarily on the idea that workers face mounting pressures when it comes to managing multiple tasks on multiple electronic devices. Dr. Shamsi Iqbal (our inaugural speaker), Dr. Gloria Mark, and Dr. Anna Cox each addressed this issue from a different angle. Dr. Iqbal is a Principal Researcher in the [Information and Data Sciences \(IDEAS\) group](#) in Microsoft Research, AI. Dr. Mark is a Professor in the Department of

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<sup>1</sup> <http://cs.wellesley.edu/~mobileoffice/conversations/>

Informatics, University of California, Irvine. Dr. Cox is a Professor of Human-Computer Interaction and Vice Dean (Equality, Diversity & Inclusion), UCL Faculty of Brain Sciences. Each of them is interested in how to best support workers as they attempt to balance different tasks, and more broadly as they try to create a healthy work-life balance.

## Attention! Task Switch Ahead!

Dr. Iqbal has explored task switching over a number of years. She has shown that natural breakpoints provide an opportune time for people to switch between different tasks (Iqbal et al. 2005), and has modeled opportune times for switching between tasks or to take a break (Kaur et al. 2020). Dr. Iqbal is also focused on supporting workers who spend some of their working hours away from the desk - these might be workers who are able to use some of their commuting time to catch up on work-related tasks (Janssen et al. 2019), as well as workers who now work from home during (or in the aftermath of) the COVID-19 crisis. Here's what Dr. Iqbal had to say about interruptions when working from home: "When you're working from home... there is nothing called interruption management... So that means that before you interrupt yourself, or you get interrupted, just make sure whatever you were doing was left in a state that you can easily resume it when you come back... I think this is a big... field study for all of us to see how all the theory that we have learned in the past, and maybe in some kind of controlled settings, ... works out in practice."

How can HCI help create tools to support working from home? Dr. Iqbal mentioned two important concepts. One is the idea of interleaving tasks: in settings such as the home office or when driving a car, workers will often be interrupted multiple times while they attempt to complete a long, complex task. It is important for us to realize that users do not simply drop one task and start another - rather, the transition between tasks includes interleaving the two tasks, and our tools need to account for this (see e.g. Janssen et al. 2019 for a discussion of interleaving in the car environment).

The other important concept is the idea of microtasks. Microtasks are short building blocks of longer (macro) tasks -- if we can break up those longer tasks into microtasks, this might allow workers to complete each microtask without interruptions, and thus they can complete complex tasks even if they can only work without interruptions in short bursts of a few minutes at a time (Cheng et al. 2015).

Dr. Mark pointed out that our electronic devices provide numerous visual cues that encourage us to switch from a work-related task to some distracting task, such as a social media post or a text message. Managing these distractions is a challenge that we haven't mastered yet. More generally, the power of devices to control our attention suggests that great care should be given to how device design influences the balance of work and wellbeing.

## Stress and Fatigue

“There’s something about email that triggers stress.” says Dr. Gloria Mark. This might be because email represents work, and work is potentially stressful. Or maybe this is because of the social capital we all try to build: by answering someone’s email now we hope to get a quick email response from that person in the future (Mark et al. 2016). And while email is big business, Dr. Mark says that “we’re in 2020 and without a really good solution to email.” One option is to process email in batches, while another is to continually process email as it comes in. According to the research of Dr. Mark and her colleagues, neither solution is perfect in reducing stress (Akbar et al. 2019).

In our current situation with COVID-19, almost all of our meetings are online. Practically all of our speakers, and many of attendees, mentioned this as a significant problem that adds to the fatigue we all experience after multiple online meetings. There is now even a term for this: [Zoom fatigue](#). Dr. Mark, as well as Dr. Anna Cox, pointed out that part of the problem is that online meetings are often scheduled back-to-back with no breaks in between. This seems reasonable at first -- after all, we only need to click a button and we are already present in another meeting! Note that this is different from physical meetings, because participants at a physical meeting most often need a finite amount of time to reach the meeting place. The time to reach the meeting location is much longer than the time needed to sign on to an on-line meeting. As it turns out, we now miss this additional time, which allowed us to detach from one activity, take a mental break, and reattach to another activity (represented by another meeting). With this in mind, all of us should aim to schedule meetings with buffers between them. Our team is trying to follow this advice, although we are only partially successful: we schedule some of our meetings with buffers, but some of these meetings run over time, and the buffer disappears.

## Staying Healthy

While all of our conversations in one way or another touched upon the idea of staying healthy, both mentally and physically, three of our guests focused a great deal of attention on these issues - Dr. Anna Cox, Dr. Regan Mandryk, and Dr. Albrecht Schmidt. Dr. Mandryk is a professor in Computer Science at the University of Saskatchewan. Dr. Schmidt is professor for Human-Centered Ubiquitous Media in the computer science department of the Ludwig-Maximilians-Universität München in Germany.

## The Importance of Boundaries

Dr Anna Cox leads the [E-WORKLIFE](#) team - a team of “experts in digital distraction and work-life balance to provide you with evidence-based strategies to support remote working.” She points out that our modern work-life leads to workers having problems with keeping work and personal life separate, partly due to the technology we use: “We see how the technology really blurs those boundaries... you find that you go onto a technology perhaps to respond to a

message from a friend, and then you notice, oh there's my email, and ... you find yourself working when you hadn't really intended to be working."

With the COVID-19 crisis the blurring of work and personal lives has become even worse. People use technology to work from home where "one minute this is my dining table and the next minute it has to be my desk" and "at any moment one of my children might appear with a question."

So what can we do to regain control over our personal lives? Dr. Cox is not someone who will tell you to just turn your devices off. Rather, she points out that if you change your practices, you can create boundaries using your technology and maintain these boundaries using particular practices. "You might think, oh the thing I need to do is switch off from my technology, but actually I think our technology can really help us here... there are all sorts of leisure activities that we can engage in using our technology... we need to recognize that we need that down time and then specifically insert some kind of routine or activity... or arrange a chat with people..." One interesting suggestion for how to use technology to create boundaries: use different devices for work and for leisure activities. And of course, you should play. Dr. Cox and her colleague Dr. Emily Collins, found that first person shooter games can really help recovery after work (Collins and Cox 2015).

## The Importance of Games

Recovery is in fact a focus area for Dr. Regan Mandryk. She's interested in how games can help us recover from stress. To understand how this can happen, we need to understand what stress is, and what types of actions can help us recover from it. First, as Dr. Mandryk points out, "there are two main characteristics of stress: one is that you're invested in the situation that's going on (ego involved), and the second is that [the] situation feels uncontrollable." This can often happen at work. With COVID-19 "the whole world is one big stress induction!"

As for recovery from stress, four things can help: (1) psychological detachment, (2) relaxation (bringing down arousal), (3) feeling of mastery, and (4) being able to exert control over our environment. Games, if they are designed well, can help with all four of these. We can detach from the world, which can also reduce our arousal. We can master the game, which gives us the feeling of mastery over a task. And we can be in control - perhaps only over small things like the clothes of our avatar, but still, it is us in control and not some external power. The result of all of this is that games do in fact help us recover from stress. Importantly, games can help with social connection as well (Depping et al. 2018). When people connect with each other in the digital world of games, these connections can be just as meaningful and valuable as those in the physical world. This is important to know, especially during a crisis such as COVID-19 when many people might be experiencing loneliness, and the place where they can find connections is in the digital world of games.

## The Importance of a Good Design for Physical and Mental Health

How about our physical health? If we follow the suggestions of Dr. Cox and Dr. Mandryk, this can still leave us with the possibility that working from home, and especially staying home during the COVID-19 crisis, we miss out on physical exercise. As Dr. Albrecht Schmidt told us, our current way of work is “a very unnatural way of working... getting tired by doing work is something we have been used to over many generations.” We miss the walks and the chats between meetings. But, even beyond our current crisis, walks and in-person chats are endangered since “a lot of the design we do in HCI are really designing them out.” The challenge that Dr. Schmidt sees (Haliburton and Schmidt 2020) is relevant to our current crisis when we can’t move outside much, but it is broader - are we as HCI researchers trying too hard to fit in as much work into the day as possible, and ignoring the need for breaks (thus Zoom fatigue) and the need for physical exercise?

Dr. Schmidt sees three opportunities for our community to improve the physical, as well as mental health of workers, and especially information workers. First we should design for movement in everyday work. At this point our technology takes it for granted that information workers work indoors. For example, we use LCD and TFT screens that cannot easily be used outdoors because of glare. But, what if we could use e-paper devices? This would allow us to spend more time outside. Second, we should prioritize face-to-face over asynchronous communication to reduce stress induced by the pressure of email (this connects us to the ideas discussed by Dr. Mark). Finally, we should make work visible - carpenters and farmers see the results of a day's work, but information workers don't easily get the same sense of achievement. This sense of achievement can help us feel in control over our work environment (and we know from Dr. Mandryk that not feeling in control is a major contributor to stress).

## Technology Landscape - Agents, Robots, and Mixed Reality

Several conversations highlighted fundamental changes in the landscape of technology and their impact - both promise and peril, on the future of work. In particular, our speakers painted a future where the technology landscape consists of a vast ecosystem of intelligent, connected devices, ranging from mobile and wearable devices, to cars, robots, and medical devices (Norouzi et al. 2019). In the words of Dr. Ed Doran, “technology based on a massive set of [distributed] devices, a ubiquitous set of networks, and a deeply powerful set of services [accelerated by machine learning].”

### Digital Assistants and Conversational Agents

Dr. Ed Doran and Dr. Gregory Welch discussed the role of conversational agents and digital assistance combined with artificial intelligence in supporting workers. Dr. Doran is Principal Program Manager, MSR Labs Management. Dr. Welch is Pegasus Professor and the

AdventHealth Endowed Chair in Healthcare Simulation at the University of Central Florida College of Nursing.

Dr. Doran identified several challenges and opportunities for research in the area of digital assistance including contextualizing conversations to different modalities and settings such as home, car, outside or in the office, alone or in a group; achieving a level of nuance which is closer to that of a human assistant based on additional signals and novel types of inferences; and identifying use scenarios and services that empower users and solve important problems. He also highlighted the importance of tailoring products to domains and problems, suggesting that a thriving product that is well adapted to a particular niche “almost seems inevitable.”

Dr. Welch shared his vision of utilizing conversational agents in the domain of nursing. In particular, collaborating closely with nurses, he identified two areas where conversational agents could assist nurses. One is retrieving just-in-time information about skills, for example instructions for operating a particular medical device, steps of a specific procedure, or advice for dealing with a sensitive situation. The second area is providing emotional support by allowing and encouraging nurses to reflect on the events which transpired throughout their work day. Similarly to Dr. Doran, Dr. Welch highlighted challenges related to the inference of context - for example how to identify when an agent should initiate conversation with a nurse, and how to identify which information to provide in a particular context. He also discussed the importance of using different modalities for different contexts - voice interaction might be suitable for certain situations, while a private text-based chat might be more appropriate for others. Dr. Welch also examines the use of wearable augmented-reality displays to provide just-in-time information in a hands-free format.

Both Dr. Doran and Dr. Welch addressed concerns regarding trust, privacy, and security. Within the domain of nursing, privacy is obviously of critical importance, as concerns encompass both the patients and their families, as well as nurses and other care providers. Additional concerns involve questions of agency and cognitive capacity. As a starting point for thinking about privacy in the context of conversational agents for nurses, Dr. Welch suggests examining existing practices: “I think that there are a lot of things with agents that are very parallel to things with humans, so it could well be that there's a lot that we already do, that's already in place for humans.” He also emphasizes the importance of establishing trust, through transparency and the use of human social cues, between nurses and the conversational agents they share information with. These issues of social cues and trust were echoed in the conversation about interacting with robots in tomorrow's society (see below).

More generally, Dr. Doran advocates for incorporating thinking about privacy and security into the design process early rather than as an ad-hoc addition: “There is an opportunity in the very early stage of this explosion of devices and services to [integrate] privacy and Security [from the inception], adding that as a post-hoc [add] to a product - almost never works. Instead we have to think pretty carefully about privacy, about security, and [even] civil liberties from the beginning.”

## Working in Mixed-Reality

Dr. Stephen Brewster FRSE is a Professor of Human-Computer Interaction in the Department of Computing Science at the University of Glasgow, UK. Dr. Brewster discussed the advantages of working in mixed-reality environments. He emphasized the ability to create a multi-monitor or large collaborative working space independently from the constraints of the physical environment, and at a relatively low cost. For example, he suggested that using a head mounted virtual reality (VR) display in small spaces, such as on public transportation or in a small home office space, could allow workers to access large interactive and collaborative spaces. Dr. Brewster is also exploring the use of VR and augmented reality (AR) in the car, starting with use by passengers (McGill et al. 2019). Referring to the Zoom call in which the conversation took place, he described the possibilities of using VR to create a shared environment which might feel “more like being together in a real space.”

Such use scenarios require the development of novel interaction techniques for VR that overcome physical restrictions of small spaces. Dr. Brewster and his group have been investigating how to integrate high throughput interactions such as typing on a keyboard into the virtual world, as well as how to navigate between multiple spatially arranged virtual monitors when movement or large gestures are not possible. They also explore multimodal and multisensory interactions in mixed-reality including the use of ultrasound haptics in VR and audio augmented reality (Freeman et al. 2019, McGill et al. 2020).

## Interacting with Robots in Tomorrow’s Society

Dr. Christian Janssen moderated a panel discussion about the increasing role of automation and robotics in tomorrow’s society. The panel consisted of human-robot interaction experts Dr. Maartje de Graaf, Dr. Wendy Ju, and Dr. Holly Yanco. Dr. Janssen is an assistant professor (tenured) at Utrecht University (The Netherlands) in experimental psychology. Dr. de Graaf is an assistant professor at Utrecht University (The Netherlands) in Information and Computing Sciences. Dr. Ju is an Associate Professor of Information Science in the Jacobs Technion-Cornell Institute at Cornell Tech in New York City. Dr. Yanco is a Distinguished University Professor, Professor of Computer Science, and Director of the New England Robotics Validation and Experimentation (NERVE) Center at the University of Massachusetts Lowell.

From serving mostly trained experts in constrained environments like factories, automated technology has evolved to also be used by non-experts in their homes, offices, and during their commute (Janssen et al. 2019). Recent articles suggest that the Covid-19 pandemic promotes the application of robots, utilizing them for tasks that carry risk for people such as cleaning high-risk areas, handling infecting samples, and caring for sick patients (Murphy et al. 2020; Thomas 2020). The panel discussed the following questions: What do people expect of robots and how do they react and interact with them? How do their reaction and interaction change when robots violate our expectations?



Dr. de Graaf who studies people's social, emotional and cognitive responses to robots found that people need only little cues such as facial expressions to see robots as social entities with intentional actions (de Graaf and Allouch 2017). Dr. Ju added that people “expect robots to have some understanding of social proxemics, timing and interruption, and social hierarchy.” Dr. Yanco highlighted that having the ability to quickly understand what a robot is trying to do helps people to develop trust (Drury et al. 2003). In her words: “that kind of legibility or understanding of what the system is doing allows people to develop a trust of the system, if the system does something that's completely unexpected you're not going to want to be near it or interact with it.” However, Dr. de Graaf warns that when people personify a robot they sometimes tend to over trust it as well as to transfer stereotypes from human society.

Dr. Ju also described some of the novel instruments she developed over the years to study how people react to and behave in future scenarios. Such instruments include: field studies with robots - for example, deploying a robotic trash can that approaches tables in the cafeteria (Fisher et al. 2015); simulating the deployment of automated systems - for example, driving around campus with a “self-driving” car where the driver is disguised by wearing a car seat costume (Rothenbücher et al. 2016); and using virtual reality to examine how people behave in future scenarios - for example driving autonomous vehicles. Dr. de Graaf and Dr. Yanco, also stressed the importance of learning about how people perceive and react to robots and automation in advance of actually having the technology fully designed, developed, and deployed.

## Current Implications

Reflecting and reporting on these conversations, we highlight several implications for both researchers and practitioners.

First, the conversations demonstrate the need for basic research to address a series of questions. For example, which work tasks are appropriate under a variety of circumstances? How do we support work in imperfect environments? What are the pain points for workers from different backgrounds and in different industries? Which factors promote trust in novel technologies? And, which factors might cause over-trust?

Second, in terms of product development, there is a clear need to balance productivity with autonomy, creativity, and wellbeing. A diet of microtasks might lead to high levels of productivity on some metrics by preventing mind wandering and other distractions. The focus on short-term productivity might undermine long-term innovation and creativity. As we learn more about how to manage attention we should consider the cost function we seek to optimize and empower people to influence this cost function. This becomes particularly important as technology erases the boundaries of work and life.

Third, the conversations highlighted a need to develop novel experimental instruments to reveal

how people will interact with, and will be impacted by, various future scenarios. It is critically important to learn about the impact of future technologies on human behavior, safety, autonomy, and creativity, prior to development and deployment of such technologies. Lessons learned using these instruments should feed back and inform the design of future technologies.

Finally, it is said that necessity is the mother of inventions. The COVID-19 crisis created the necessity for novel and more effective tools for supporting workers, as well as for the development and implementation of new policies, which mitigate the increasing demands faced by workers. This necessity also highlights the importance of [convergence research](#)<sup>2</sup> - research that brings together experts from multiple disciplines to develop new approaches and inform both the development of tools and innovative policies for the future of work.

## Conclusion

The HCI community has a central role to play in creating the future of work. We invite you to join our [conversations](#)<sup>3</sup> with leading experts about how we can best do this.

## Acknowledgements

This work was supported in part by NSF grants CMMI- (University of New Hampshire: 1840085; Wellesley College: 1840031; Harvard Business School: 1839870; University of Washington: 1839666; University of Wisconsin-Madison: 1839484). We also want to thank our guests who joined us for the nine conversations we discuss here: Dr. Shamsi Iqbal, Dr. Anna Cox, Dr. Stephen Brewster, Dr. Gregory Welch, Dr. Regan Mandryk, Dr. Albrecht Schmidt, Dr. Gloria Mark, Dr. Maartje de Graaf, Dr. Wendy Ju, Dr. Holly Yanco, Dr. Christian Janssen, and Dr. Ed Doran. We reached out to each of our guests and gave them the opportunity to review this article and provide feedback. We also want to thank Manfred Tscheligi for co-organizing the conversation series. Finally, we are grateful to Diana Tosca for managing the website for the conversation series.

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<sup>2</sup> <https://www.nsf.gov/od/oia/convergence/index.jsp>

<sup>3</sup> <http://cs.wellesley.edu/~mobileoffice/conversations/>

## References

Akbar, Fatema, Ayse Elvan Bayraktaroglu, Pradeep Buddharaju, Dennis Rodrigo Da Cunha Silva, Ge Gao, Ted Grover, Ricardo Gutierrez-Osuna et al. "Email makes you sweat: Examining email interruptions and stress using thermal imaging." In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, pp. 1-14. 2019.

Cheng, Justin, Jaime Teevan, Shamsi T. Iqbal, and Michael S. Bernstein. "Break it down: A comparison of macro-and microtasks." In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, pp. 4061-4064. 2015.

Collins, Emily, and Anna L. Cox. "Switch on to games: Can digital games aid post-work recovery?." *International Journal of Human-Computer Studies* 72, no. 8-9 (2014): 654-662.

Depping, Ansgar E., Colby Johanson, and Regan L. Mandryk. "Designing for friendship: Modeling properties of play, in-game social capital, and psychological well-being." In *Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play*, pp. 87-100. 2018.

Drury, Jill L., Jean Scholtz, and Holly A. Yanco. "Awareness in human-robot interactions." In *SMC'03 Conference Proceedings. 2003 IEEE International Conference on Systems, Man and Cybernetics. Conference Theme-System Security and Assurance (Cat. No. 03CH37483)*, vol. 1, pp. 912-918. IEEE, 2003.

Fischer, Kerstin, Stephen Yang, Brian Mok, Rohan Maheshwari, David Sirkin, and Wendy Ju. "Initiating interactions and negotiating approach: a robotic trash can in the field." In 2015 AAAI Spring Symposium Series. 2015.

Freeman, Euan, Dong-Bach Vo, and Stephen Brewster. "HaptiGlow: Helping Users Position their Hands for Better Mid-Air Gestures and Ultrasound Haptic Feedback." In *2019 IEEE World Haptics Conference (WHC)*, pp. 289-294. IEEE, 2019.

de Graaf, Maartje Margaretha Allegonda, and Somaya Ben Allouch. "The influence of prior expectations of a robot's lifelikeness on users' intentions to treat a zoomorphic robot as a companion." *International Journal of Social Robotics* 9, no. 1 (2017): 17-32.

Haliburton, Luke and Albrecht Schmidt. 2020. Technologies for healthy work. *interactions* 27, 3 (May - June 2020), 64–66. DOI: <https://doi.org/10.1145/3386391>

Iqbal, Shamsi T., Piotr D. Adamczyk, Xianjun Sam Zheng, and Brian P. Bailey. "Towards an index of opportunity: understanding changes in mental workload during task execution." In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pp. 311-320. 2005.

Janssen, Christian P., Shamsi T. Iqbal, Andrew L. Kun, and Stella F. Donker. "Interrupted by my car? Implications of interruption and interleaving research for automated vehicles." *International Journal of Human-Computer Studies* 130 (2019): 221-233.

Janssen, Christian P., Stella F. Donker, Duncan P. Brumby, and Andrew L. Kun. "History and future of human-automation interaction." *International journal of human-computer studies* 131 (2019): 99-107.

Kaur, Harmanpreet, Alex C. Williams, Daniel McDuff, Mary Czerwinski, Jaime Teevan, and Shamsi T. Iqbal. "Optimizing for Happiness and Productivity: Modeling Opportune Moments for Transitions and Breaks at Work." In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, pp. 1-15. 2020.

Mark, G., Iqbal, S.T., Czerwinski, M., Johns, P., Sano, A. and Lutchyn, Y., 2016, May. "Email duration, batching and self-interruption: Patterns of email use on productivity and stress." In *Proceedings of the 2016 CHI conference on human factors in computing systems* (pp. 1717-1728).

McGill, Mark, Julie Williamson, Alexander Ng, Frank Pollick, and Stephen Brewster. "Challenges in passenger use of mixed reality headsets in cars and other transportation." *Virtual Reality* (2019): 1-21.

Mark McGill, Stephen Brewster, David McGookin, and Graham Wilson. 2020. Acoustic Transparency and the Changing Soundscape of Auditory Mixed Reality. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (CHI '20)*. Association for Computing Machinery, New York, NY, USA, 1–16.

Murphy, Robin R., Justin Adams and Vignesh Babu Manjunath Gandudi. "[How Robots Are on the Front Lines in the Battle Against COVID-19.](#)" SMITHSONIANMAG.COM, APRIL 22, 2020

Norouzi, Nahal, Gerd Bruder, Brandon Belna, Stefanie Mutter, Damla Turgut, and Greg Welch. "A systematic review of the convergence of augmented reality, intelligent virtual agents, and the internet of things." In *Artificial Intelligence in IoT*, pp. 1-24. Springer, Cham, 2019.

Rothenbücher, Dirk, Jamy Li, David Sirkin, Brian Mok, and Wendy Ju. "Ghost driver: A field study investigating the interaction between pedestrians and driverless vehicles." In *2016 25th IEEE international symposium on robot and human interactive communication (RO-MAN)*, pp. 795-802. IEEE, 2016.

Thomas, Zoe. "[Coronavirus: Will Covid-19 speed up the use of robots to replace human workers?](#)" BBC.COM, 19 April 2020