

# How the Web Will Shape the Hybrid Work Era: A Keynote at WWW 2022

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## Abstract

The web has been a driving force for innovation and transformation in how people work for the past several decades, enabling new forms of collaboration, the ability to collect data at scale, and, eventually, significant improvements in artificial intelligence. The COVID-19 pandemic, however, created a phase change that accelerated this transformation by requiring anyone who could possibly work remotely to do so. In my keynote at the ACM Web Conference 2022, I reflected on the impact of the web and remote work on work practices, and discussed the opportunities and challenges for the coming Hybrid Work Era. As researchers we must intentionally revisit how online and physical spaces interact so that we can create a new – and better – future of work.

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## 1 The Web and Work Practices

I first encountered the web in 1994, the same year as the first WWW conference, and my initial experiences were underwhelming given there was limited content available and it was difficult to discover new content. However, I soon became fascinated by web search, which transformed what was there into something useful by allowing people to find what they were looking for. Web search was one of the first web services that people used at scale, and one of the most interesting things to emerge from that is that search providers quickly figured out how to use the behavioral data generated by users' queries and clicks to improve its performance.

This was the beginning of a feedback loop that has since become ubiquitous in web applications: Engagement produces data, data drives improvement, and improvement drives more engagement. This feedback loop is accelerated by experimentation, where different experiences are compared based on behavioral data, and by artificial intelligence, where the data is fed back into the system to learn from it directly. The results have been impressive, as evidenced by many of the papers presented at the Web Conference and other related venues that build on these loops.

The ability to observe people's interactions at scale has been a foundational shift driven by the web, as it has enabled applications to move to the cloud, collect new types of data from mobile devices and sensors, and make use of the data to drive improvements in AI and experimentation.

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In the process, the web has transformed work practices by enabling new forms of collaboration, communication, and coordination across time and space. For example, the web has supported the emergence of online communities, crowdsourcing platforms, and social media networks that allow people to share knowledge, solve problems, and create value together. The web has also enabled new modes of work, including gig work and open innovation, that challenge traditional boundaries and assumptions about organizations, teams, and careers [Kuttur et al., 2013].

## 2 Remote Work and Collaboration

This shift was then significantly accelerated in March 2020 by the COVID-19 pandemic. A significant portion of the working global population moved from in-office work to working from home, and became, overnight, unwitting participants in a giant, uncontrolled, natural experiment into remote work [Teevan et al., 2021]. As the Chief Scientist for Microsoft’s core productivity products, my job is to use research to drive product innovation. When I first took the role, this was a hard task, despite all of the innovations driven by the web, given the size, scale, and success of Microsoft’s products. The pandemic had many negative consequences, but one positive consequence is that it, ironically, made my job easier by creating a huge demand for research and innovation in our products in order to effectively respond to rapidly changing work practices. As a result, researchers from across the company came together to launch the New Future of Work initiative [Teevan et al., 2021, 2022], which we believe is the world’s largest research effort on post-COVID work practices. We used a variety of methods, including telemetry data, customer panels, surveys, studies of our own employees, and even EEG studies of people’s brains, to study the impact and implications of remote work. Our findings can be found here<sup>1</sup>.

One of the first insights to emerge from this research was that people were still productive while remote, according to self-report data and activity metrics [Teevan et al., 2021]. For example, the number and velocity of pull requests by developers increased slightly, while their size remained consistent. The average time in meetings and the number of emails sent also increased. Although this insight may seem obvious now, few believed this was true prior to the pandemic. And it may be that the technology was not actually ready to support remote work at scale prior. That being said, in 2020 the need for social distancing forced work behavior to become digitally mediated, and we were able to do these things thanks to the web and other technologies.

However, while people were able to remain productive the shift came with many challenges: long hours [WorkLab, 2021], a lack of focus [Cao et al., 2021], blurred boundaries between work and home [Iqbal et al., 2020], and atrophied social networks [Yang et al., 2021]. For example, remote work significantly changed people’s collaboration patterns. In a study by Yang et al. [2021], we looked at large-scale telemetry data to see at how collaboration patterns changed following COVID. We compared the anonymized collaboration patterns of two groups: Microsoft employees who worked remotely before the pandemic and employees who shifted to working remotely during the pandemic. We then used causal analysis to isolate the effects of remote work from the effects of the pandemic.

We found that remote work caused a 5% decrease in synchronous meeting time, and an increase in email and IM messages, indicating a move to asynchronous collaboration. We also found that

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<sup>1</sup><http://aka.ms/nfw>

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remote work increased intra-group connections, but decreased cross-group connections by 25%, suggesting that teams adapted to do more loosely coupled work while remote. These findings show how we can use the massive digital transformation brought about by remote work to see and understand the relationships, the communication modes, and the impacts of our tools and environments on collaboration.

### 3 Supporting People’s Goals

However, we have also seen that web-based systems, as a result of the feedback loops they employ, can have second-order effects on people’s behavior and goals, whether we, as a research community, intended them to or not. For example, engagement-driven systems capture our attention, sometimes at the expense of our wellbeing or our accomplishing our objectives. As researchers, we need to be intentional about the impact the systems we invent have on people’s ability to meet their goals, and create systems that optimize for what people want to accomplish, not just for what they do.

Much of my research has focused on building intelligent systems that explicitly recognize the implicit influence they have on how people act and work to use that to people’s advantage. For example, my early research focused on how people find and refind information [Teevan et al., 2007]. I observed that people’s past interactions influence their future searches, and used that to improve the search experience for refinding queries [Teevan, 2008]. I also explored how the context surrounding a question posted to social media influences the answers other people give [Teevan et al., 2011], and used those findings to build a chatbot that went beyond merely answering people’s questions to actually helping other people provide better answers as well [Hecht et al., 2012]. These are examples of how we can put people at the center of the feedback loops that drive web applications. As large language models become increasingly important, we will need to intentionally create technology that helps them get closer to their goals as they use it.

### 4 The Hybrid Work Era

Now, as we start to introduce physical space back into the equation, we are entering a new era in the geography of work: the *Hybrid Work Era*, where people will work both online and offline. Physical space is an important technology that people have been using for millennia to work together, as it affords collaboration, spontaneous interaction, serendipitous connection, and focus. When space went away, people were required to rely on digital technology to substitute for what they had previously been relying on space for.

Now, we have the opportunity to use both space and digital technology to complement each other and create new and better ways of working. This creates all sorts of fascinating research questions, such as how to design goal-directed AI systems, how to enable new collaborative models, how to leverage personal data for machine learning in a privacy-preserving manner, and how to support personal information management. This keynote was intended to put a call to action to the Web Conference community to think about how the work researchers within that community do applies broadly to the significant disruption to work practices that we are all living through right now. The web enabled people around the world to shift to remote work, and it

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will play an important role in shaping the Hybrid Work Era. It is our responsibility to do this thoughtfully, given the externalities we know exist, and to use our research to drive innovation and transformation.

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