Advances in Connected Worker Technology in the Aftermath of the Pandemic

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INTRODUCTION

As the COVID-19 pandemic unraveled in early 2020, the majority of businesses around the globe were forced to radically adjust their operations to minimize person-to-person interactions. Companies whose business were deemed non-essential were mandated to halt in-person gatherings, sometimes for extended periods of time, resulting in severe socio-economic hardships.

Meanwhile, competing forces had been reshaping work environments well before the pandemic hit, and the recent health crisis only accelerates a trend that's been long in the making. As the pace of change continues to accelerate, disruption often meets opportunity for technological innovation. In 2020, the need for a more connected workforce has gone from a 'nice-to-have' to an absolute necessity.

Employers are also grappling with the need to maintain operational efficiency while supporting remote work, not only from a health and safety standpoint, but also because their employees are now expecting such flexibility. The combination of both enhanced connectivity and flexible work expectations is leading to the emergence of new technology tools that complement existing ones and that enable a more seamless and physically remote interaction with the physical world.

Some of these tools can be described as wearable IoT edge devices with capabilities for sustained bandwidth and seamless connectivity. While essential in 2020 for business continuity, we propose that these tools are merely just a starting point that will deeply affect how business is conducted for years to come and that will contribute to a re-imagined "future of work."

In this discussion, we first provide additional context and set the stage for our "call to action." We then dive into a technology overview and review the state of available tools. Subsequently, we highlight and review three business use cases to bring the concept to life, before concluding with a post-2020, future-state outlook.

BACKGROUND

Historically, there have been many vectors influencing the transformation of the workforce and disrupting the way we work, such as organizational behaviors, business objectives, geopolitical environments, customer preferences, diversity and inclusion, process digitizations and automations, and so on. However, as technology has become an increasingly important part of our day-to-day lives over the last twenty years, business leaders are wrestling with workforce disruptions that are now accelerating. In 2020, as a result of the COVID-19 health crisis, we are living through yet another fundamental transformation in the way we work. In that context, the future of work asks us to consider what may be the biggest question of our age: *what influence*

will the continuing march of technology, automation and seamless connectivity have on where we work and how we work?

Tech-Led Workforce Transformation

The potential for digital platforms underpinned by breakthrough technologies – such as the Internet of Things (IoT) or Artificial Intelligence (AI) – to expand the world of work is unbounded. New products and tech-led business models have been developing at lightning speed in the last two decades, often more quickly than regulators can even control. In its Workforce of the Future 2030 outlook[1], PwC describes a "Red World" in which rewards are high for those who offer ideas and skills that best meet what companies and consumers want, a perfect incubator for innovation.

Even while new technologies may replace some jobs, they are also creating new work in industries that most of us cannot even imagine, and new ways to generate income. However, the value of digitization does depend on how many people and businesses have access to it, and more than four billion people[2], or over half of the world's population, is still offline.

One can only imagine what our global society will look like as we continue to close this gap by digitizing companies and connecting people. While information and communications technology have historically played a crucial role in disrupting workforces, their impact on the "future of work" post-2020 is widely expected to increase even further. A key trend that business leaders should be watching is remote connectivity, whereby ubiquitous online access allows for work to be conducted anywhere, at any time, and by almost anybody.

Remote Connectivity

In a white paper[3] published in 2011, Cisco wrote that "technologies such as teleconferencing, telepresence, mobile communications, and groupware applications" had gone a long way toward "helping employees collaborate across time and distance." Their research also predicted that "new technologies yet to be invented were poised to facilitate the amorphous information spillover that will animate collaboration, diffuse good ideas, and encourage innovation" over the following decade. Looking back, it's difficult to imagine a more accurate depiction of the environment we live in today.

[1] https://www.pwc.com/gx/en/services/people-organisation/workforce-of-the-future/workforce-of-the-future-the-competing-forces-shaping-2030-pwc.pdf

[2] http://dln.jaipuria.ac.in:8080/jspui/bitstream/123456789/1891/1/MGI-Future-of-Work-Briefing-note-May-2017.pdf

[3] https://www.cisco.com/c/dam/en_us/training-events/employer_resources/pdfs/Workforce_2020_White_Paper.pdf

Virtual meetings have become the norm, video conferencing is used more and more to reinforce human connection, and in-person meetings have given place to online alternatives. As we look to the future, the global market for remote connectivity solutions is forecast[4] to continue increasing to reach USD ~72B by 2027, mostly owing to advancements in technology and cellular networking.

While the term "remote work" evokes the idea of employees working from home, it should be noted that there are a vast number of use cases involving not only office employees, but also field workers (e.g., energy, mining, logistics, etc.) or mobile workers (e.g., utilities, telecommunications, manufacturing, etc.). In fact, working remotely is a 'de facto' practice in some of these cases and the share of such roles has been steadily increasing to where they were already a third of the total workforce back in 2013[5].

These types of workers have a different set of needs, both in terms of remote connectivity and usability. In many instances, they need to communicate while conducting a troubleshooting task and needing both hands for safety (e.g., on a ladder). Usage of laptops, tablets or phones is ruled out in such cases. Additionally, the expectations of reliability and resiliency of remote communications is a lot higher in these cases than that of a home-office worker.

For the purpose of this discussion, we define remote connectivity as the ability to conduct the due business process outside of usual work premises through the use of connected devices. In light of COVID-19, remote work has evolved from a perk, sometimes used to facilitate ad-hoc flexible work arrangements, to a necessity for business continuity and employee retention. Yet, with technology being so embedded in today's economy, simply sending employees home and relying on teleconferencing is not enough.

A myriad of challenges came to light earlier this year, including issues with effective virtual collaboration, hardware and software limitations, data privacy and security, or connectivity. Subpar technology can clearly hinder remote workers and make it challenging to effectively collaborate or access resources, specifically when work ought to be conducted across disparate geographic locations, including across national (and regulatory) boundaries. Companies of all sizes have jumped at the opportunity to expand their existing solutions or develop new ones to address these problems.

Large technology companies are competing head-to-head with small up-and-coming startups in an environment where speed-to-market and user growth often supersede tech maturity or privacy. However, given the expected continued growth in market size and the breadth of existing challenges, one has to feel confident that a diverse set of winners will emerge with technology innovations that will benefit end consumers and facilitate better remote connectivity.

[4] https://www.reportsanddata.com/report-detail/remote-connectivity-solution-market

[5] http://www.pocketfm.com/general/field-workers/

Next, we explore a set of technologies that are not only maturing, but also converging to enable business value across industries. We illustrate this trend by focusing on a concept we describe as "connected workers."

CONNECTED WORKER TECHNOLOGY

Remote connectivity allows for seamless interactions between individuals that may not be co-located, opening opportunities for a more connected workforce, both from a relational and technological standpoint. As it relates to technology, connected workers are enabled through a combination of hardware and software innovations. In the following sections, we explore two technology innovations that make the concept of connected worker possible.

Internet of Things

The term Internet of Things, or "IoT," was first coined in 1999[6] and has since been widely adopted, but its definition differs depending on who is asked, from academicians, researchers, practitioners, innovators, developers, or corporate stakeholders. The field of IoT is commonly over-simplified into just "sensors" or "smart devices," but it is more appropriate to apply a systemic viewpoint. The vast amount of data generated in today's world not only needs capturing, but it also requires processing, transporting, securing, analyzing, and visualizing, just to name a few functions.

In particular, the compute functions, when localized to a site and/or when distributed across a network are commonly known as "edge compute," as opposed to a centralized compute function in the cloud. Having compute, storage, and some intelligent processing at the "edge" allows for the overall IoT network to be resilient, scalable and more amenable to growth for both devices and the network traffic. In this paper, we refer to IoT as the entire system that allows for data to be turned into insights.

For the purpose of this discussion, we accept the definition of IoT as an "open and comprehensive network of intelligent objects that can auto-organize, share information, data and resources, and react in face of situations and changes in the environment." From that definition, we focus on intelligent wearable devices with an ability to share information and data. These tools are also entry points; i.e., edge devices for digital data to be fed into other systems, such as ERPs, Asset Management Systems, CRMs, etc.

Extended Reality

Over the last five years, significant progress has been achieved in a field commonly referred to as "extended reality", or "XR." Figure 1 provides an overview of the continuum ranging from real

[6] https://www.scirp.org/pdf/JCC_2015052516013923.pdf

to digital world, as well as the associated technology concepts.[7] While virtual reality (VR) replaces the real world with a fully immersive digital experience, other technologies provide a digital experience overlaid on top of reality, so the user maintains ground in her surroundings.

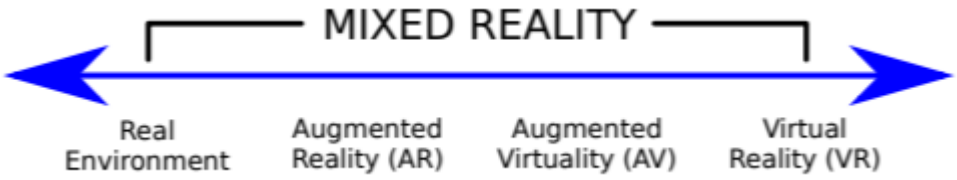

Fig. 1: Mixed Reality Continuum, adapted from Milgram and Kishino, 1994

When considering various XR technology options, one may benefit from thinking of it as whether the tool provides a "reality-first" or "digital-first" point of view. Well-documented use cases often stress the latter, which is likely where future innovation will continue to converge. For instance, virtual reality headsets can be worn to learn soft skills by interacting and practicing with virtual humans. However, innovation can sometimes get in the way of practicality and we're witnessing the increased adoption of practical solutions that may not be as sophisticated, or highly-marketed, as others, but that are focused on solving specific use cases with fit-for-purpose technology.

In the next section, we explore how such solutions can enable a more connected workforce, by combining elements of both IoT and XR into innovative wearable technology.

Connected Worker

Conceptually, connected workers are enabled through technology innovations that enhance their ability to conduct the due business process by providing a more seamless interaction with their environment. It is, however, not a new concept. The digital revolution that began in the latter half of the 20th century has progressively been shifting workloads from mechanical to digital platforms, in turn enabling more connected workforces.

For instance, PwC describes "industry 4.0" as encompassing end-to-end digitization and data integration of the manufacturing value chain: offering digital products and services, operating connected physical and virtual assets, transforming and integrating all operations and internal activities, building partnerships, and optimizing customer-facing activities[8].

For the purpose of this discussion, we focus on a specific type of technology that provides new semi-immersive experiences for connected workers. We're witnessing the emergence of head-mounted devices (HMDs) that allow employees to be hands-free and conduct tasks while being

[7] https://arxiv.org/pdf/1804.08386.pdf

[8] https://www.strategyand.pwc.com/gx/en/insights/industry4-0.html

remotely connected with other stakeholders. In addition to providing a low friction connected experience, these devices can also interact with the external environment, such as machines or sensors, which offers enhanced capabilities for workers.

Before diving into three business use cases, it is important to note how both IoT and XR, among other technologies, are indeed converging to enable this connected worker concept.

Fig. 2: Examples of HMDs, Various Sources

The HMDs are intelligent wearable devices, or "sensors", with an ability to tap into various connectivity protocols depending on the vendor; the most commonly supported protocols being WiFi or cellular. While connectivity remains a common challenge, technology is maturing rapidly and contingency plans are being developed, such as allowing devices to seamlessly switch from one protocol to another. Also, tangential industry advances such as 5G or Mobile Edge Computing are paving the way for a more continuous connectivity experience.

Additionally, these devices often have the ability to capture inputs from the external environment, such as QR scanning or picture/video recording, and process those according to pre-defined logic. As such, they allow businesses to capture data closer to its source, also called the edge. Ultimately, outputs such as annotated pictures or machine data can be shared between stakeholders through various means, such as visual or audio cues. This feedback loop is typical of IoT systems.

Furthermore, as opposed to traditional IT assets such as laptops, the HMDs are often treated uniquely from a configuration and provisioning, security, or asset management perspective. They have unique features that create an unprecedented set of challenges and considerations (e.g., data privacy, form factor, etc.) for organizations. Additionally, irrespective of HMD types and whether they prioritize the "digital" or "real" world, they all provide end-users with multi-mediated perspectives; i.e., they digitally enhance what our eyes can see and brains can process. This mixed reality point-of-view creates efficiencies by reducing friction between the real and the digital world.

In summary, it is the combination of advances in connectivity and IoT, coupled with innovations such as XR, that are driving the emergence of these tools and supporting a more immersive experience for distributed workforces. Next, we explore three use cases to illustrate our concept.

BUSINESS USE CASES

In this section, we provide an overview of three connected worker business applications: remote training, virtual site inspections, and inventory observations.

Remote Training

Remote training, or assistance, enables trainers and experts to virtually guide and collaborate with customers or field technicians. The concept historically involved the use of a remote connection to temporarily take control of an IT asset, such as a laptop, to resolve software-related issues. As mobile technology evolved, video and audio-conferencing using smartphones have provided a way to expand beyond software troubleshooting and into issues involving hardware or physical assets. For example, a customer can use a mobile device to interact over voice and video with an insurance inspector who is responsible for verifying the accuracy of a claim.

However, despite the usefulness of consumer-centric video conferencing using smartphones, many use cases require more sophisticated technology to meet business requirements. For instance, field technicians seeking remote assistance often need both hands for safety and movement flexibility, which means the device must not need to be hand-held. With that in mind, image stability and a clear field of vision are important criteria, among others, to consider when evaluating technology vendors.

For example, so-called “smart glasses” offer a true user point-of-view, but they remain nascent in technology maturity for some applications. Indeed, many industrial environments require more rugged tools than just glasses to be able to handle environmental hazards, so other HMDs may be better fit-for-purpose. So, while having the ability to “see what the technician sees” is a key requirement in most cases, it is highly recommended that businesses spend meaningful efforts to clearly define the specific use case and its unique technical requirements, and evaluate the vendor ecosystem with those lenses in mind.

For instance, several vendors are offering solutions that allow remote experts to not only be semi-immersed in the technician’s real-time working environment, but also provide the ability to exchange annotated images or documents, access and visualize data from external information systems, etc. Accordingly, organizations should ask themselves whether such features are “must-haves” or “nice-to-haves,” and apply a pragmatic evaluation framework to ensure innovation doesn’t hinder business value realization.

Fig. 3: Remote Assistance, Microsoft Dynamics

Virtual Site Visits

As opposed to tours, which can and have been virtualized for many years to allow interested parties (e.g., students, visitors, etc.) to experience a site, there are many traditional visits that still require physical travel to a location to conduct the due business process. Examples include consulting engagements, operational diligences, senior executive visits, quality inspections, or equipment maintenance or troubleshooting.

However, recent events such as the COVID 19 pandemic have illustrated the pressing need to enable the virtualization of these visits for executives, consultants, investors, or suppliers. While it is unclear whether this unprecedented environment will extend for the long-term, virtual site inspections provide an effective alternative to visit locations that may not be otherwise possible due to access or time constraints.

From a technology standpoint, connected HMDs with video and audio streaming capabilities provide an excellent tool to conduct virtual site inspections. Among others, business requirements often include one-to-many conferencing, user point-of-view, reasonable cost profile, ambient noise cancellation, hands-free frictionless form factor, reasonable image resolution, etc.

The connected worker wearing the HMD can be free to focus on the external environment, which is particularly important in manufacturing sites for instance. She can walk through the location, record or even live stream the event, stop at designated points of interest, and follow instructions provided by the stakeholders who are joining virtually.

Of note, HMDs for connected workers are sometimes referred to incorrectly as virtual reality headsets. VR headsets are fully immersive, as noted above, which would not be appropriate as it is critical that the worker remains acutely aware of her surroundings for safety. Once again, this example illustrates the importance of understanding business and technical requirements for the use case at-hand before recommending an appropriate technology solution.

The effectiveness of these virtual site visits can not only reframe the traditional approach of in-person visits, but they can also unlock a number of new efficiencies. They provide stakeholders the ability to see more locations in a shorter amount of time. This could mean visiting multiple sites in one day or visiting smaller ones that may not have been visited due to time constraints. They eliminate the need for extensive and costly travel required to visit international sites for instance. They facilitate the inclusion of more parties in the visit itself (e.g., senior executives, etc.). Finally, they can serve as precursors to in-person visits if the virtual one uncovers the need for physical presence on-site.

Inventory Observations

Physical observation of inventories is a generally accepted auditing procedure, requiring an independent party to travel to a site and conduct a count of inventory items. The observations made are reflected on financial statements as part of standard reporting procedures. Recently, companies have developed inventory controls and methodologies that include statistical sampling, which are effective in determining reliable quantities and do not require a physical count of all inventory items.[9] However, it is still common for the auditor to be present on-site.

As the ongoing pandemic continues to challenge in-person interactions, connected worker technology can equip independent auditors with intelligent HMDs that allow for faster and more cost-effective physical inventory observations. From a process standpoint, independent auditors usually deploy team members to various sites to conduct the counts.

While travel can be minimized by optimizing the deployment schedule, the end-to-end process remains time-consuming and costly. Team members must first go through a site walkthrough or orientation, which takes time for not only the auditor, but also for the client stakeholders. The count can sometimes occur over several days. Once the observation is completed, the independent auditor needs to consolidate results for incorporation into financial statements, or reconcile any observed discrepancies.

In a technology-enabled future state the auditor could ship an approved connected HMD to the client with a user-friendly onboarding guide. Once onboarded, the client can conduct the inventory count while the auditor connects remotely via video and audio conferencing, guiding the client through the procedure. Although the same can be achieved with a smartphone or tablet, inventory observations are often conducted in remote and sometimes hazardous environments, requiring the user to maintain a clear line of sight and be hands-free. Finally, applications can also be developed and integrated with HMDs such that image and object recognition software allows for automated counts as the client walks through the site and points the camera to the items.

[9] https://pcaobus.org/Standards/Auditing/Pages/AS2510.aspx

Overall, connected worker technology can benefit the process of inventory observations by providing health and safety benefits, enabling less travel and in-person interactions through the use of hazard-proof solutions. It can also provide significant process innovation and efficiencies, while reducing costs incurred for all parties involved.

Fig. 4: Inventory Count, Multi-Channel Merchant

CONCLUSION

Today's innovation happens at an unprecedented rate and continues to accelerate as technological advancements emerge. The last year has presented its unique set of challenges as the COVID-19 pandemic unraveled. However, a recent PwC survey[10] revealed that while 52% of companies plan to cut or defer investments because of COVID-19, just 9% of those surveyed will make cuts in digital transformation.

In fact, businesses who have successfully established or solidified their digital leadership over the years have done so by staying consistent with their innovation thesis, both in good and more challenging times. They have built resilient cultures that don't fear crises, mandated change, invested more than others, and focused on people.[11] While predicting the future of work post-pandemic and beyond is extremely challenging, it is likely that not only digital business models will continue to prevail, but also that workforce interactions will look a lot different.

The examples presented in this discussion highlight one avenue in which we can expect workforce-related tech innovation to continue. We're witnessing business-critical tasks that have historically required several people to co-locate being maintained, despite travel and health-related restrictions, thanks to connected technology that allows a more seamless interaction between the digital and the real world.

[10] https://www.pwc.com/gx/en/issues/crisis-solutions/covid-19/global-cfo-pulse/may-11.html

[11] https://www.pwc.com/DiQ2020

Leading technology vendors in this diverse ecosystem also understand that there's no "one-size-fits-all" tool to solve all challenges. In turn, businesses are increasingly recognizing that a thorough understanding of the problem statement is fundamental to identifying the right emerging technology solutions. In most cases, those solutions will leverage several individual technologies, such as IoT and extended reality, to yield business value that is greater than the sum of their parts.

While intelligent wearable devices, such as connected HMDs, are only the "tip of the spear," one can expect the "connected worker" concept to mature over the next few years, address near-term challenges, and likely unlock brand new business models for the future.

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