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**Facilitating serendipitous communication,  
interaction and collaborative flow in mixed realities while working remote.**

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Thesis Document for Master of Fine Arts Degree in Industrial Design

Department of Industrial Design

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Rochester, NY

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**Abstract:**

Working remotely can often lead to fatigue and stress which in turn reduces productivity. The author will explore the concept that with proper communication, environments that promote serendipitous meeting and effective collaboration, can result in happier workers. The author will also explore how speculative design can improve remote work and provide vision for future work scenarios. This concept will focus on the development of interaction design for use with mixed realities, 3D capture systems and mid-air haptic technology to create a seamless and engaging remote working environment.

This paper will show how work culture and communication can affect mental health and productivity; why people isolate while working remotely; how interaction and proper feedback is important to work flow; and the importance of meeting face to face while collaborating. The author purposes a possible solution and application in capturing user interaction data to provide a seamless virtual work environment. This system would utilize 3D capture, mid-air haptic control, and mixed reality technology to allow remote workers to fulfill work related tasks while also maintaining healthy communication and mental health. The final outcome is a personal haptics console and an augmented reality (AR) headset with an integrated camera system.

**Keywords:** Mixed realities, Work from home, Interaction design, Haptics, Spatial computing

## **Introduction**

In March of 2020, the United States government declared a national emergency in response to the SARs-CoV-2 outbreak which we have come to know as the 2020 Covid-19 pandemic. This pandemic threw, not only the United States, but countless other countries into lockdown and quarantine states. Businesses were closed with no idea of when they could reopen, many businesses had to suddenly reconfigure work routines and employee's to a remote work setting or what is commonly referred to as working from home. The concept of working from home 100% of the time was new to many people, for many the adjustment revealed new problems while also providing some beneficial perks. From the many issues of working in smaller living spaces, with children or family members, or even with prolonged moments of boredom, the problem that has become the focus of this research has been isolation. In a somewhat paradoxical manner, isolation had become a larger issue than one might expect. The only reason that remote work was possible was from the sheer technological advancement in telecommunications. In a world where people can be more connected in terms of technology many found themselves more isolated than before. Although people can communicate through various technologies these interactions are removed compared to the in-person nature of the office. Over scheduling and limitations of consumer software have left many with fatigue and stress<sup>1</sup>. In short, while remote work provides some with better work life balance many are left in a state of constant confusion and stress from the lack of human presence. This project explored concepts to find a solution to the isolation related stressors of remote work.

## **Problem Statement**

This project aims to solve the lacking of human connectivity while working remotely by providing a design solution that brings humanistic and intuitive experiences to an often dull and stressful work environment and routine. This paper will take readers through the full design process, from early development up to final delivered concepts. This paper goes into detail about psychology of remote work, information communication technologies, and interaction design within virtual environments. This paper and supporting design concept explores future use of mixed reality

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<sup>1</sup> Chamorro-Premuzic, Tomas. "4 Major Long-Term Psychological Effects of Continued Remote Work." Fast Company. Fast Company, August 28, 2020.

and haptic technologies and the human interactions users will have with them to provide better and more humanistic approaches to remote working.

## **Background**

The methodology used to develop this project was a combination of content analysis, interviews, and observations. Content analysis was conducted through initial literature review of scientific journals related to remote work and productivity, interviews with remote workers also gave insight to user conditions and habits during the height of the covid-19 pandemic, while limited observations of immediate users also provided day to day feedback of user conditions. As a result of the covid-19 pandemic, the global workforce is experiencing a major shift and continued growth of remote workers<sup>2</sup>. Previous to the pandemic businesses and employees had been adopting the concept of working remote and even pushing the development of agile working<sup>3</sup>. This showed a growing interest and benefit to allowing workers to determine their own means of productivity. Initial development of ideation explored different immediate concepts for remote work solutions that aimed to solve early problems areas. These identified problem areas included the difficulty of spatially and conceptually dividing working areas and leisure or family space, time management, co-familial living and working, and finding better co-worker communication<sup>4</sup>.

## **Initial Ideation**

Many concepts in the early ideation process revolved around furniture design and how to better utilize spaces within people's homes, as homes or apartments start to be designed for a work from home lifestyle<sup>5</sup>.

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<sup>2</sup> Courtney, Emily. "Remote Work Statistics: Navigating the New Normal (2021): FlexJobs," February 8, 2021.

<sup>3</sup> Eary, John. 2018. Agile Working and the Digital Workspace : Best Practices for Designing and Implementing Productivity. New York: Business Expert Press.

<sup>4</sup> Zetlin, Minda. "7 Reasons People Hate Working From Home and How to Fix Them." Inc.com. Inc., July 7, 2020.

<sup>5</sup> Duncan, Allison. "Top 10 Design Trends of the Next Decade: Meet Your New Home." The Wall Street Journal. Dow Jones & Company, September 10, 2020.

## WFH: SHARING

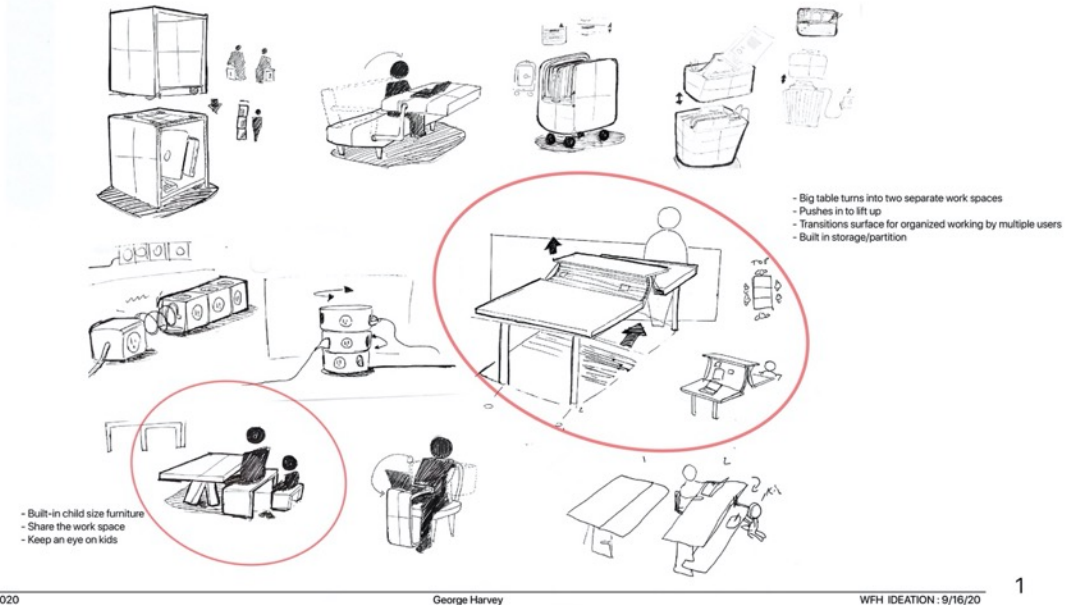


fig. 1

These early ideas ( see fig.1) related to the immediate reports of people's needs for better working from home (WFH) conditions<sup>6</sup>, so this naturally led early concepts to be more focused on living spaces. These early concepts utilized features that allowed for conversion between leisure settings and work or productivity settings. The idea being that this could solve issues of inadequate working space within smaller homes while also providing a physical routine to psychologically get users to differentiate between working and non-working time.

Narrowing the scope of these problem areas presented many different paths to take, in order to come to a certain definable path narrowing the user profile was necessary. Early in development, the problem scope focused on users who have switched to remote work, knowledge based worker, that live with small children or family, and live in relatively smaller homes (ie.  $\leq 1000\text{sqft}$ )<sup>7</sup>. Research has shown that the effectiveness of teams and coworkers comes from their ability to coordinate and anticipate action through each other's activities<sup>8</sup>. It is important in this case that coworkers are able to effectively let each other know of their actions

<sup>6</sup> Steelcase, "Tips for How to Manage Working Remotely," March 9, 2020.

<sup>7</sup> Average home size in the US = 2300 square feet

<sup>8</sup> Effortless Attention : A New Perspective in the Cognitive Science of Attention and Action. Cambridge: MIT Press, 2010. Accessed September 15, 2020.

so to build team coordination. From here the problem scope began to shift its focus more on the aspect of communication between coworkers and the interactions taking place remotely and less about the interactions while working in a shared living space.

## **Concepts**

From the initial ideation process, 3 concepts were developed and chosen to move forward with. These concepts used inspiration from in-office interactions or practices to inform or recreate those interactions within the home and therefore also influenced form and scale. These 3 concepts were as follows. The concept of clocking in and clocking out, relates to the idea of having a physical routine and also letting coworkers know when you are available or currently working. This stems from breakdown of communication while remote and aims to make communication easier with teams and your time more available to those that might need it. This concept manifests itself as a IOT home device, users could tap in and out as they transition between work and non-work periods during the day. This concept also addresses non-traditional working times, remote work may allow for less strict working hours and users are now able to choose when to work, this concept aims to address this issue.

The next two concepts gather inspiration from the interaction from the informal office communications, the first being the idea of the “open door”. In corporate offices some workspaces might utilize partitions or closed off personal offices, often co-workers might have specific seating arrangements that lead to an office culture with subtle interactions and means of non-verbal communication. This was an interest to me and the idea of how co-workers might have an informal chat in the doorway of each other's office as they pass by, struck as an opportunity to explore. This concept of the open door manifests itself as a full-length screened device that would let users talk and see each other in their homes (fig. 2). The concept though uses gestural interactions and tangible control interfaces to mimic the in-office experience. This concept also borrows the practice of keeping a door open to signal to other co-workers that you are available and willing to talk while at work, while also being able to signal as well that you are busy or out of office.



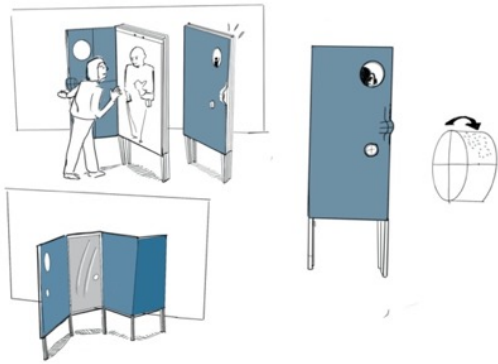


fig. 2, full length concept



fig. 3

The third concept (fig. 3) is a home lighting fixture that allows for visual cues and verbal communication while remote. This concept plays off the classic idea of the water cooler conversation, although possibly stereotypical this activity represents the serendipitous moments in an office environment. Through research I realized the importance of spontaneity and serendipitous<sup>9</sup> interactions playing a unique role to work happiness. The small chat with co-workers that might start off as asking about each other's day or week but often leads to interoffice communication and breakthroughs in work. This activity also acts as a break from the mundane while still remaining in the working psychological mindset. This concept would provide itself in the form of a ceiling or floor lamp, it would include a microphone and directional speaker, and acts as an audio chat room. The directional speaker means users are only able to hear the conversation while sitting directly under the lamp. This lamp would provide light and visual clues to the user in an unobtrusive manner so that it catches their attention to let them know that other staff are conversing. The idea being that it creates a more serendipitous interaction and is not as jarring as receiving unplanned phone calls or video calls. The lamp would also be able to blend in with the home environment.

These three concepts allowed for a stepping point moving into further testing and identifying aspects that work and those that don't. These concepts revealed some of the underlying points that help with remote work. The pain points of communication and tangible interactions with

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<sup>9</sup> Liz Fosslien and Mollie West Duffy. "Managing Stress and Emotions When Working Remotely." MIT Sloan Management Review, March 31, 2020. <https://sloanreview.mit.edu/article/managing-stress-and-emotions-when-working-remotely/>.

humans begins to be realized after these concepts. Moving forward, receiving feedback on these concepts, the project refocused on how to connect people and spaces in a way that is as close to being in person as possible. Research<sup>10</sup> showed that working collaboratively is key to remote work and that much of collaborative work is conducted through non-verbal communication. The design process tried to push past flat screens and looked toward the field of mixed reality technologies to fulfill the goal of having volumetric human face to face interactions, where body language and non-verbal cues can be detected.

## Technology Integration

Mixed reality allows for volumetric and lifelike communication, while also becoming a new virtual space to work in. This becomes a driving technology moving toward the latter half of the design process. The issue of interactions and interacting with virtual objects remains uncertain and the use of controllers can often be cumbersome and or limited in the way users can interact with the virtual environment. This led to research and discovery of the mid-air haptic technology, which is utilized in the final design as a means to interact with the virtual environment without the need for controllers while also still receiving the tactile response that is needed to immerse the user in the mixed reality space.



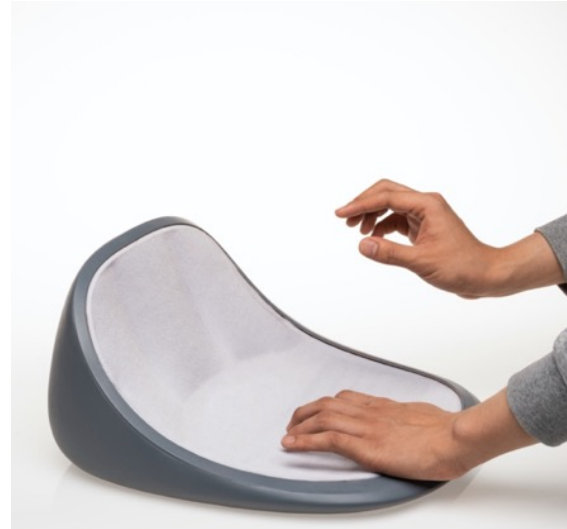
*fig. 4 – Haptic development unit in center of photograph, foam scale model to the right.*

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<sup>10</sup> “How to Increase Remote Team Collaboration.” Steelcase, May 26, 2020.



*fig. 5*



*fig. 6*

## **User Testing**

Testing was conducted with this new concept with visual mockups, scale models, sensation testing utilizing a haptic module (fig. 4). Through these testing events the design was validated and received criticisms that resulted in some changes. These tests validated the form factor and overall system design. The final design would include a portable table top haptic console (fig. 5) that would allow the user to move about their home unencumbered by wires and cables. While also giving them ample interactive space by its large and curved haptic surface (fig. 6). Through testing though it was realized the need for a keyboard and tangible control surfaces was necessary for word processing, as the haptic technology just could not replace the ergonomics and precision that the keyboard provides for typing. This concept would also utilize a reconfigurable surface to provide a multitude of tangible control and interactions including a conventional keyboard. In (fig. 7) we see an example of the reconfigurable surface activated as a keyboard for typing.



*fig. 7*

## **Final Concept**

The final concept allows for interactions in virtual space through the eyewear in concert with the haptic module and live human presence through the 3D cameras. The user experience of this system is seamless, many of the interactions that we have with everyday tangible objects could be replicated allowing for extremely intuitive design while also incorporating those common tangible items in mixed reality.

## **Conclusions:**

This proposed design solution addressed the main points of what is currently wrong with remote work:

1. Lack of human connectivity/presence
2. Tactile interactions
3. Spatial routine

This design presents the future of work, a solution to the pitfalls of current methods for remote work and also presenting a vision for truly universal control while in a virtual space. Through the use of mixed reality in conjunction with live imaging technology users are able to interact and

communicate with each other face to face, this addresses the lack of human connection in current remote work environments. When working remote, users are often limited to only a few tactile interactions with current personal computing devices, this proposed design addresses this lack of variety through the use of mid-air haptics and the use of the technologies previously mentioned. The mid-air haptic console allows for theoretically limitless tactile interactions. Interfaces can now be spatial in design and relieve users from monotonous practices, digital interactions can be more natural. With the use of mixed reality and a vision system using 3D scanning, our everyday items may also have unique characteristics in this new virtual environment. Firstly, users would be able to share 3D representations of tangible objects with each other, in the case of design work, models or mockups are seamlessly shared because of the live stream of 3D data. Household objects may also develop their own set of interactions as well, if the user writes or sketches on a piece of paper the system could automatically save an image for use later or sharing with colleagues. Objects could also have information snapped to their surface in augmented reality, this is shown primarily when interfaces are constrained to the haptic console but could be applied to other common objects. Spatial routine is an important part of working, it prepares users psychologically to begin work<sup>11</sup>. This can be seen previously with commuting to the office, workers would spend a significant amount of time traveling to their work location and in that time contemplate their schedule or goals for the day. It was important to include this type of spatial routine as early on the sudden shift to remote work had users developing anxiety from not leaving the house or going stir crazy. The design concept allows people to move about the home untethered while also transforming the home work environment with the overlaying of a unique virtual space.

Next steps in this project would be further exploration of interface design and to what extent the haptic technology can allow better human computer interaction. Also developing different use cases such as in medicine, engineering, gaming and entertainment, as this project focuses on productivity within a corporate working environment.

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<sup>11</sup> Davis, Loni. "Enacting Work Space in the Flow: Sensemaking about Mobile Practices and Blurring Boundaries." Order No. 3558805, Fielding Graduate University, 2013. p. 129

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