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PORTAL: A TELEWORKING TOOL FOR TEAM COLLABORATION IN THE WORKPLACE

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Abstract

Communication is vital to teams in the workplace, especially for design teams that work remotely. This project aims to enhance the efficiency and effectiveness of remote communication between design team members who work in different locations. The decisions throughout the design process will be guided by the literature, by the information collected in the survey, by the suggestions given by the outside committee member, and by ideas and feedback that emerges during design development testing. The final design of this project includes a large screen named Portal. This design could encourage more communication between team members and provide people a feeling that their team members are working next to them. Moreover, this design also considered humanity by allowing people to display a digital door on the screen to establish a level of privacy.

Key Words: telecommunication, teleworking, team collaboration, body language, transportation, Generation Z.

PORTAL: A TELEWORKING TOOL FOR TEAM COLLABORATION IN THE WORKPLACE

by

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1. Preface

Traffic congestion is a huge issue in many megacities. People spend a lot of time and energy traveling every day. Many organizations and companies have been trying to solve this issue with restrict policies, new services, and products for a long time, but the congestion in those cities doesn't seem to reduce. According to Black (2010), teleworking is a potential solution for this issue (p. 259).

In addition, communication is vital to teams in the workplace. An efficient communication tool is especially crucial for design teams. With the development of globalization, it is increasingly popular that people need to communicate with other team members and other teams who are in different cities or counties. Therefore, this project focused on improving the efficiency and effectiveness of remote communication between design team members.

Moreover, at the moment of the global pandemic of the novel coronavirus (COVID-19), teleworking is required as necessary as never before. Teleworking has become a new norm. After trying to implement teleworking into their work agenda, many people will consider continuing work remotely even when the pandemic ends. This project takes part in this larger trend and prepares for the new way of working as well as the living.

2. Problem Statement

Although teleworking is needed for lots of design teams, there is no product or service for them to communicate and collaborate very efficiently. It is almost impossible for many design teams to permanently work remotely. Therefore, how to enhance the efficiency and effectiveness of remote communication between design team members who work in different locations is vital.

3. Review of Knowledge

Telecommunication

Telecommunication 4.0

Li (2016), the chief manager of China Mobile, claimed in his book, Telecommunication 4.0, 5G technology is coming; and there is a huge gap in the current industry. The author said that many industries right now have not implemented the 5G technology and could take advantage of it (Li, 2016). With 5G technology, current industries could achieve the functions that are just recently thought of as impossible (Li, 2016). The author claimed that with 5G technology, energy efficiency will be increased by a hundred times, and the bit cost will be reduced by a hundred times (Li, 2016, p. 92). Therefore, the future scenario that "everything connected closely and information exchanged easily" could be possible (Li, 2016, p. 92).

This reading indicated that 5G is a definite direction toward the future. This project could take advantage of 5G technology. This article can be used to define what 5G and its potential are.

Best Jobs for Telecommuting

As Pinola (2019) mentioned in the article, Best Jobs for Telecommuting, almost all kinds of jobs are ideal for working remotely. The author also mentioned that self-motivated and self-time-manage skills are vital to people who want to work remotely (Pinola, 2019). Moreover, the article claimed that jobs that are suitable for telecommunication are the most needed by employers (Pinola, 2019).

This project will try to enhance the communication between team members so that more forms of work could be done remotely.

Communication: The Heart of Team Relationships

In the article, Communication: The Heart of Team Relationships, written by CMOE Design Team (2019) claimed that good communications are vital to all teams' productivity. With effective communication, team members would be able to understand each other

(CMOE Design Team, 2019). If all the team members could understand each other, they would respect each other (CMOE Design Team, 2019). When team members respect each other, they could build trust between them (CMOE Design Team, 2019) . After the team has established trust, they will achieve more productive outcomes (CMOE Design Team, 2019).

This article conveys that communication is vital to team relationships and collaboration. Therefore, this project looks to enhance communication between team members.

Training to improve virtual team communication

This article proposed that when people communicate via computers, the more channels available within the medium, the more interactions will emerge between the participants (Warkentin & Beranek, 2001, p. 274). The author also shows that with some appropriate training, trust and other relational links could be developed between remote team members after a period of time (Warkentin & Beranek, 2001, p. 274). Further, if people get more socioemotional information from each other, their task performance will be enhanced (Warkentin & Beranek, 2001, p. 276).

One of the key concept of this project is trying to improve the productivity of remote teams by developing social relationships between team members. Delivering more types of medium that are suggested in this article should be considered in this project.

Exploring effectiveness of team communication

This article compared and contrasted different synchronous communications, such as dialogues, meetings, phone calls, video calls, and instant messaging, and asynchronous communications, such as paper mail, e-mail, SMS, project websites, etc. (Otter & Emmitt, 2007). Moreover, this article was researched in the design team's perspective. The author mentioned that synchronous communications are always used in early design phases to reach consensus among the team, while asynchronous communications are usually happening in the overview, exchanging, and sharing design information to improve the effectiveness (Otter & Emmitt, 2007, p. 411). The author also indicated that although video conferencing has

many advantages, the lack of a collective framework for meaning makes the team communication harder (Otter & Emmitt, 2007, p. 415).

In the early phase of this project, different electronic communication tools were compared. Some of them are synchronous and some are asynchronous communication. As the author mentioned, a balance of synchronous and asynchronous communication is necessary. This project will design a method that allows people to get instant feedbacks from others, and at the same time, people could wait for others if they are currently not available.

Transportation

Sustainable Transportation: Problems and Solutions

This book discussed various problems and solutions in sustainable transportation. In the last chapter, Chapter 21, the author proposed that if there is a perfect travel tool, which is fast, comfortable, convenient, safe, and cheap, it might generate additional travel (Black, 2010, p. 259). The demand for travel will increase because of all the advantages; therefore, the best solution for the traffic issues might be not traveling at all (Black, 2010, p. 259). Moreover, the author suggested that teleworking could be the right direction to go to (Black, 2010, p. 259).

The initial idea of this project is trying to solve the traffic congestion in megacities. This book influenced the direction of this project.

Analysis of telecommuting behavior and impacts on travel demand and the environment

This reading, Analysis of telecommuting behavior and impacts on travel demand and the environmen, claimed that by implementing teleworking to 50%, the total daily vehicle miles traveled (VMT) and vehicle hours traveled (VHT) will be reduced up to 0.69% and 2.09% (Shabanpour, Golshani, & Tayarani, 2018). The authors also proposed that people prefer to get a more flexible working time and working location (Shabanpour et al., 2018).

The idea of this project came from trying to reduce traffic congestion by teleworking. According to the results shown in this reading, this project would have a positive impact on

traffic congestion and provides helpful math/statistics. The total daily vehicle miles traveled and vehicle hours traveled are reduced. Although the impact is not very big, it might be the right direction to go.

Teleworking

A Descriptive Study on University Students' Perspectives and Opinions on Teleworking Method For Human Resource Policies of Businesses

In Kuyucu's (2019) study on university students showed that a large percentage of Generation Z, today's university students, want to choose a job in which they are able to work remotely. The authors also claimed that Generation Z believes teleworking could optimize their business performance (Kuyucu, 2019). In addition, this article also mentioned that teleworking could also be beneficial to older employees since they may have a hard time commuting to their job site constantly yet they want to maintain their job (Kuyucu, 2019). Finally, the article said that implementing a teleworking model could have many other benefits, such as reducing the real estate and office costs of the company (Kuyucu, 2019).

This article indicated that Generation Z is more interested in teleworking jobs; therefore, this project will mainly focus on Generation Z (supports my method of approach). During the processes of this project, the researcher will explore how their business productivity improves when they work remotely. The benefits of elderly employees could be a very good direction for the future plan for this project.

Understanding Construction's Productivity Gap and how it can be Overcome

Preuss (2019), the author the article, Understanding Construction's Productivity Gap and how it can be Overcom, claimed that the productivity of the construction industry has not increased as much as the rest of the global business for many years. There is a productivity gap in the construction industry (Preuss, 2019). The stakeholders spend too much time and money on traveling to the job site; and this must be solved as soon as possible (Preuss, 2019). The author claimed that using a VR headset could be a good solution for those stakeholders (Preuss, 2019).

This article showed that there seems to be a problem with productivity in the construction industry right now. This project could target the construction industry and other similar job types. This would support a decision to target this industry for this project.

Apple @ Work

Chambers (2019) said in his video, Apple @ Work: What's the state of enterprise communication tools?, email is still being used by many businesses because it is based on an open standard, and available for both internal and external people. He also mentioned that the archive function of messages is vital for many situations (Chambers, 2019). Second, although iMessage has an end to end encryption, it is only available to Apple devices (Chambers, 2019). Next, the author said that he wants to have a tool that can set Do Not Disturb or Out of Office mode as well as send the message when the people you contact with is back to the office (Chambers, 2019). He also mentioned that 71% of people would prefer to use a tool or platform that combines email and messages together (Chambers, 2019).

This project might need to create a communication tool or a platform. All the pros and cons mentioned in this article would be considered in the design development process.

VR, AR, and MR Technology

4 Tips to Get Started With Virtual Reality in Architecture

The author of the article, 4 Tips to Get Started With Virtual Reality in Architecture, claimed that VR (virtual reality), AR (augmented reality), and MR (mixed reality) are coming (O'Connell, 2016). The architecture industry, in particular, can be beneficial by VR, AR, and MR technology (O'Connell, 2016). With MR, an architect and a structural engineer can work in a virtual building together, even though they are in different countries (O'Connell, 2016). The author also indicated that today's VR technology is focusing on gaming and not so much targeting architecture (O'Connell, 2016). The author believed that VR companies should consider more on architects than gaming or everyday consumers so that they can be more active in the future of the marketplace (O'Connell, 2016).

This article provides a clear direction about the VR technology that needs to be considered.

Study: Body language of both speaker and listener affects success in VR communication

This article, Study: Body language of both speaker and listener affects success in VR communication, proposed that the biggest drawback of communication in virtual reality is that both participants in a conversation cannot get gestural information (2011). Both the speaker and listener had a hard time to communicate effectively due to the lack of various body language in the VR environment (Study: Body Language, 2011). Therefore, Body language must be improved in the VR environment in order to help the participants to communicate effectively.

This project wants to provide users a natural and efficient way to communicate with their team members. Body languages are the most important elements in communications. Therefore, this project might not consider VR technology because of this drawback.

Body Language

The 8 Aspects of Body Language

According to the article, the 8 aspects of body language are face, eye, gestures, posture, movement, voice, touch, and appearance (Amos, 2017). All of these elements are vital to communications between people.

This project will focus on communication between team members. Body languages are the most important thing in people's communication. These 8 aspects would be considered in the design development process.

4. Method for Discovery

First, an online anonymous questionnaire will be distributed to a sample of university students (who are Generation Z). The survey will collect both quantitative and descriptive data. Data will be collected only if the individual consents to the survey and verifies that they are 18 years or older. The questionnaire will focus on learning about the work experiences and preferences of college students and how their productivity could be optimized. At the end of the survey, participants will be asked whether they are willing to participate in further research for this project, which is a focus group for design prototyping and testing. The design prototyping and testing will be limited to questions that inquire about design legibility, having participants perform tasks with the design, suggestions for design changes, and opinions about whether or not the design would work. The decisions throughout the design process will be guided by the literature, by the information collected in the survey, by the suggestions given by the outside committee member, and by ideas and feedback that emerges during design development testing.

The design development section will be divided into three distinct generations of prototypes. The first prototype generation will be guided by the literature. The second prototype generation will be guided by the literature, by the information collected in the survey, and by ideas and feedback that emerges during design development testing. The third prototype generation will be guided by the literature, by ideas and feedback that emerges during design development testing, and by the suggestions given by the outside committee member.

After the third prototype generation, physical models will be built. The interface of the device will be designed and shown on the screen for user testing.

Finally, the final design will be guided by ideas and feedback that emerges during the user testing, and by the suggestions given by both the inside and outside committee member.

5. Design Process

First Prototype Generation

Transparency of Initial Design Decisions

From the articles, many of Generation Z want to choose a job that they can work remotely (see Figure 1). Also, VR Technology nowadays is focusing on gaming and not so much targeting productivity (see Figure 1). When comparing some existing products, many communication tools lack productivity function and could not provide an immersive experience; productivity tools, on the other hand, do not fully embed communication (see Figure 2). Therefore, creating a virtual-linked work environment for real-time collaboration and production for Generation Z could be the right direction to go (see Figure 3).

Iterating Towards a Prototype Generation

The first design includes a rectangular table (see Figure 4). On each corner of the table, multiple cameras are settled to capture the image of people and
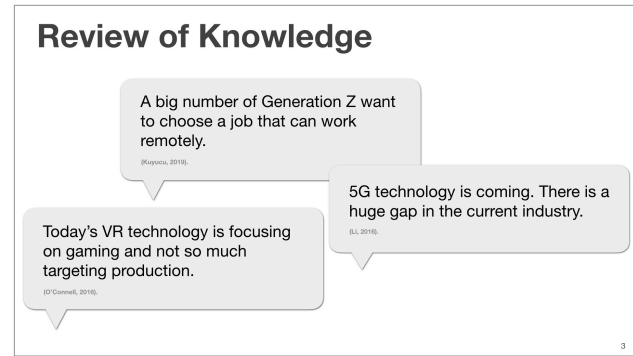

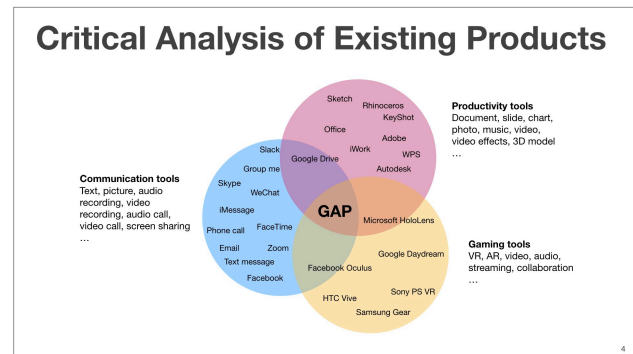*Figure 1.* First Prototype Generation Report, p. 3.

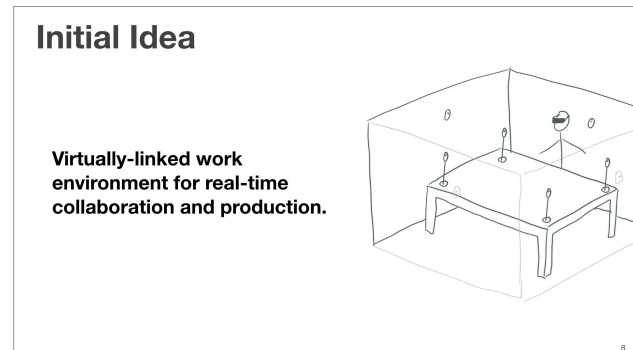*Figure 2.* First Prototype Generation Report, p. 4.

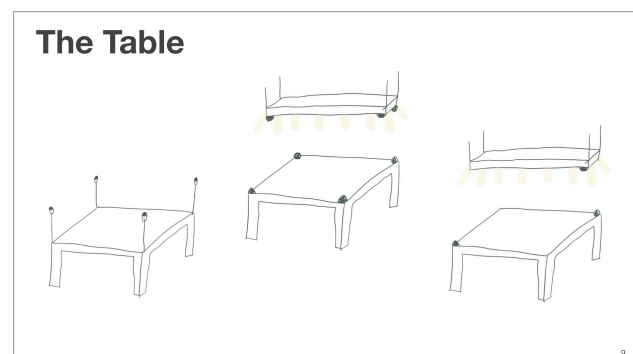*Figure 3.* First Prototype Generation Report, p. 8.

Figure 4. First Prototype Generation Report, p. 9.

the whiteboard (see Figure 5). The cameras could be separate from the table or embedded into the table (see Figure 6). When the user wears the AR glasses, the sensors inside the glasses will capture the facial expressions of the user (see Figure 7). With the development of 5G Technology, the glasses would be thin and light. The reason for choosing AR glasses, not VR goggles, is because AR glasses allow people to not only see other people but also see their own bodies and the objects in the real environment. According to an article, the archive function is important for working applications (see Figure 8). As Figure 9 shows, a user can see other people's bodies and their post-its on the whiteboard through his or her glasses. The cameras in the user's room capture his or her body as well as the post-its on

Figure 5. First Prototype Generation Report, p. 10.

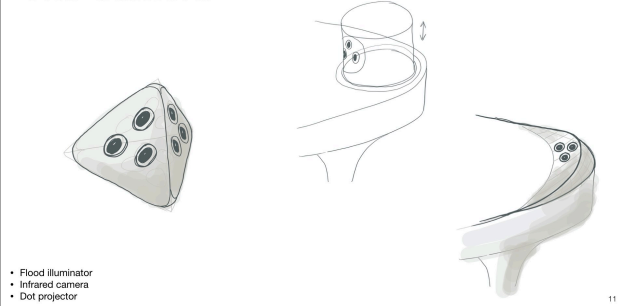*Figure 6.* First Prototype Generation Report, p. 11.
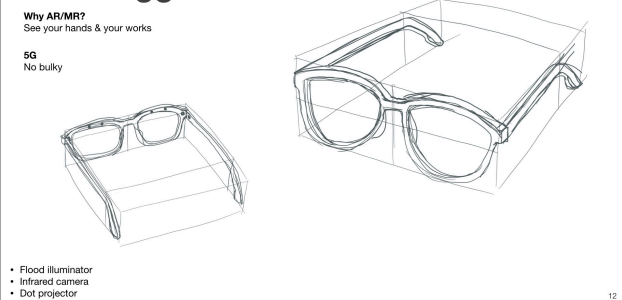
Figure 7. First Prototype Generation Report, p. 12.

Figure 8. First Prototype Generation Report, p. 13.

Figure 9. First Prototype Generation Report, p. 16.

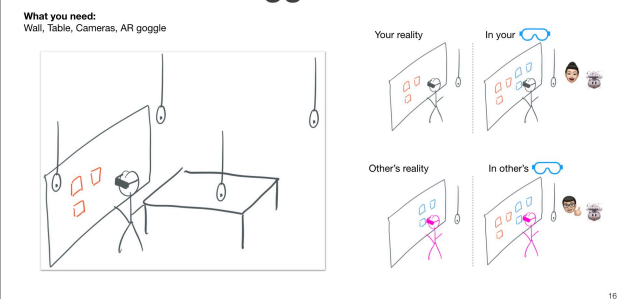the whiteboard so that the other people could see them in their glasses (see Figure 9).

In the second design, a digital table that equips a big foldable screen is designed because not everyone is used to wearing glasses (see Figure 10). Different materials, scales, and shapes of the table are explored in Appendix E page 18 to page 20. Because there are four cameras on each corner of the vertical screen, the position of the user's eyes is captured (see Figure 11). The software will use the four images captured from each corner to create a 3-dimensional figure of the other person (see Figure 11). Therefore, when the user moves his or her head, the user would be able to see 3-dimensional people and prototypes on the 2-dimensional display (see Figure 12). This design allows users to see the side of the other person when the users move their heads (see Figure 12).

Moreover, the same setups are located everywhere so that team members in different places could work remotely and collaboratively (see Figure 13).
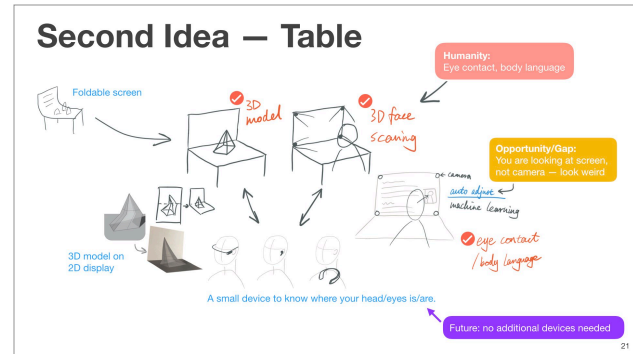

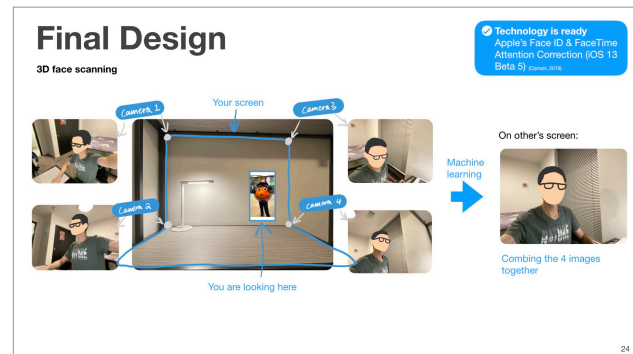*Figure 10.* First Prototype Generation Report, p. 21.

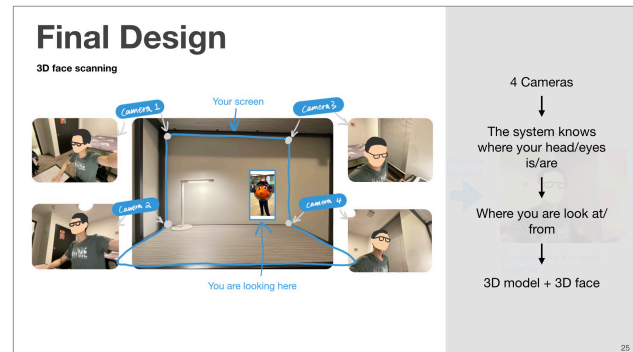*Figure 11.* First Prototype Generation Report, p. 24.

Figure 12. First Prototype Generation Report, p. 25.

Figure 13. First Prototype Generation Report, p. 26.

Translating Meaning

The second design allows people to have face-to-face interactions (see Figure 14). Besides, the user could see digital prototypes in a 3 dimensional way (see Figure 14). Also, this design doesn't require any glasses or goggles (see Figure 14).

However, the second design is in a new area where not so many references could be found (see Figure 15). Second, the technology of combining four images into one image might be too hard to achieve (see Figure 15). Finally, haw to make sure the true eye contact between people is still a question (see Figure 15).

The opportunity of this design is that it fulfills the gap between communication tools, productivity tools, and gaming tools (see Figure 16). Users are able to see themselves, their environment, the prototypes in their hands, and the whiteboard in an immersive way (see Figure 16).

Recommending Future Development

As an article mentioned, informal communications could be crucial in many
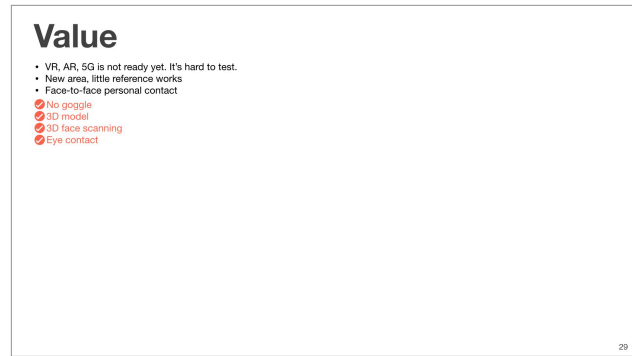

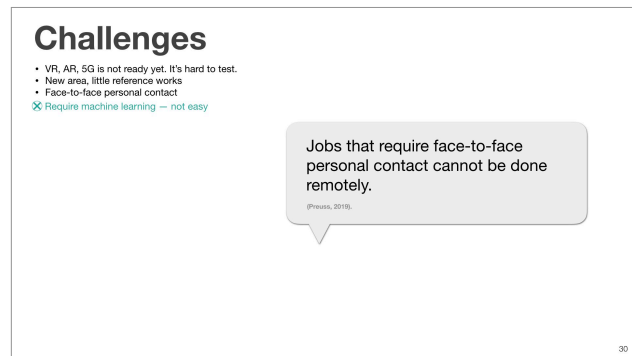*Figure 14.* First Prototype Generation Report, p. 29.

Figure 15. First Prototype Generation Report, p. 30.

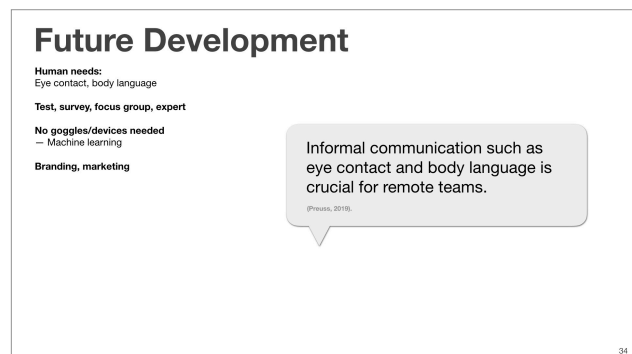*Figure 16.* First Prototype Generation Report, p. 31.

Figure 17. First Prototype Generation Report, p. 34.

situations (see Figure 17). For the next step, eye contact, body language and other vital elements to communications need to be considered (see Figure 17). Besides, questionnaires and a focus group after that need to be done soon so that the feedback from them could guide the design into the second prototype generation (see Figure 17).

Second Prototype Generation

Transparency of Initial Design Decisions

In the mind map shown in Figure 18, body language is crucial to communication or conversation. Besides, other people's availability is vital in many situations (see Figure 19). Sometimes, people don't need an immediate response but do prefer real-time interaction with people. This is where this design wants to consider (see Figure 19). When it comes to the users, this design will target the designers in Generation Z, current college students and potential employees in the near future, because many of Generation Z believe that teleworking could optimize their business productivity (Kuyucu, 2019).

Based on the feedback of the questionnaire, many participants believe that communication is important to their works (see Figure 20). When the participants are asked about why they
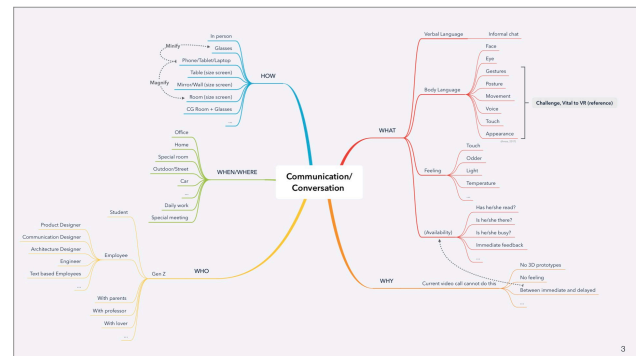

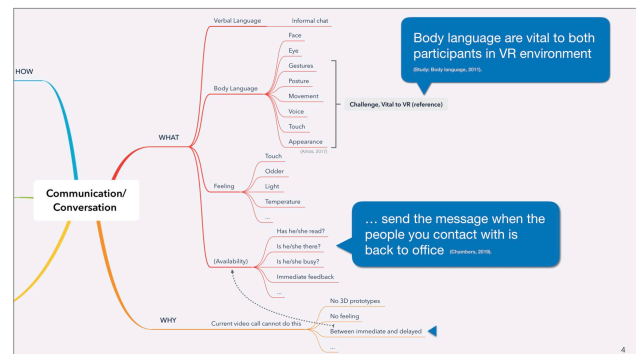*Figure 18.* Second Prototype Generation Report, p. 3.

Figure 19. Second Prototype Generation Report, p. 4.
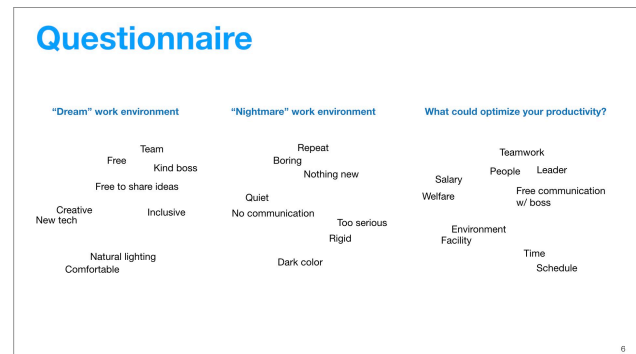
Figure 20. Second Prototype Generation Report, p. 6.

think telecommunication is not good for team collaboration, a lot of them claimed that they need face-to-face interactions with people (see Figure 21). Also, a big number of them said they need personal places for working (see Figure 21).

Iterating Towards a Prototype Generation

The first prototype generation tries to provide users a 3-dimensional feeling, which allows users to see the side of the other person when the users move their heads. However, this 3-dimensional feeling might not really matter in real communications (see Figure 22). Moreover, combining four images into one 3 dimensional figure might need complicated software that couldn't be achieved today (see Figure 22).

Considering that it might be acceptable to use a 2-dimensional image of the other people, the first design of the second prototype generation is explored. As shown in Figure 23, the user sits in front of a table in a room. A camera in the second user's position captures the image of the user (see Figure 23). In the second user's room, a camera is located in the

Figure 21. Second Prototype Generation Report, p. 8.

Figure 22. Second Prototype Generation Report, p. 12.
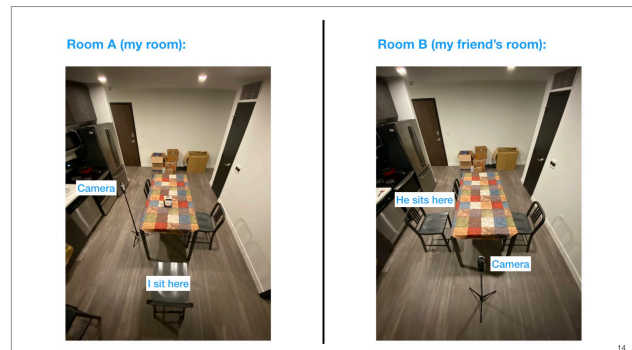
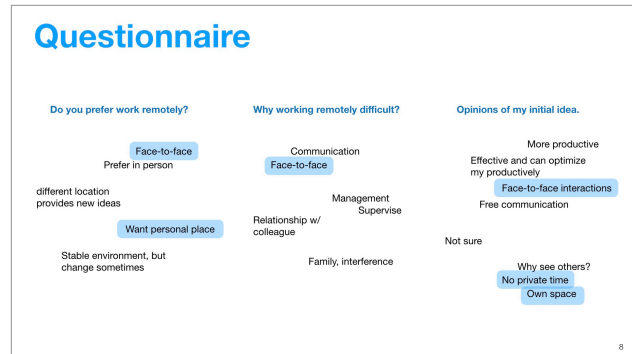*Figure 23.* Second Prototype Generation Report, p. 14.

Figure 24. Second Prototype Generation Report, p. 16.

first user's position to captures the second user (see Figure 23). These two rooms are exactly the same and connected through the Internet (see Figure 23). The first user is able to see the second user through a VR goggle (see Figure 24). Because it is only a 2-dimensional image of the second user, when the first user moves, the second user will look like a flat surface (see Figure 25). In order to see the second user from a different perspective, multiple cameras are settled in the second room (see Figure 26). Moreover, the situation of more than one user sits in the same room, whether to use goggles or screens, the scales of the room, the locations and mechanism of the cameras, and different meeting formats are discussed in Appendix F from page 21 to page 28. In summary, this design uses standard third place rooms and VR goggles to provide users a feeling of face-to-face communication (see Figure 27).

To avoid using any goggles and considering multiple people meeting scenario, the second design of this prototype generation is explored. As shown in Figure 28, a curved screen with a camera array and a part of a table is
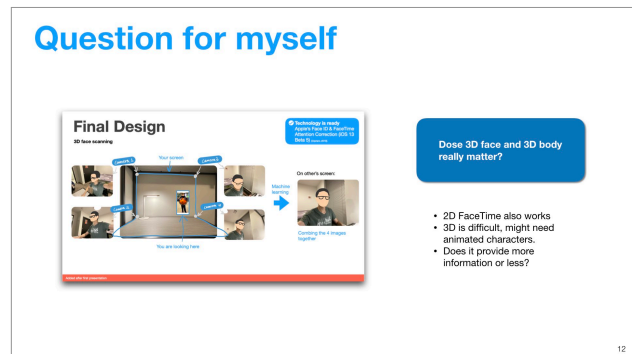

Figure 25. Second Prototype Generation Report, p. 18.

Figure 26. Second Prototype Generation Report, p. 19.
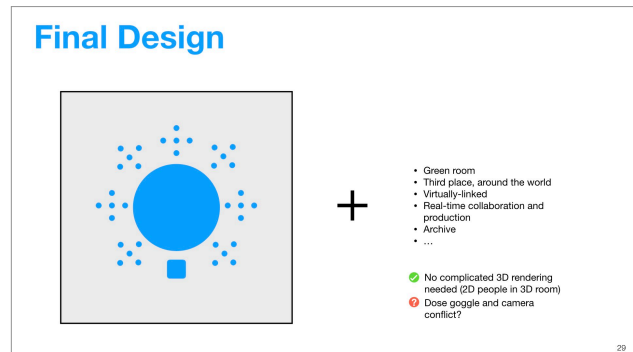
Figure 27. Second Prototype Generation Report, p. 29.

Figure 28. Second Prototype Generation Report, p. 33.

designed. In this design, the user is able to see other people on the screen (see Figure 29). When the other people chatting with each other, the user would see the side of the other people's faces (see Figure 30). It would look like that they are face to face, while actually they are in different locations and using the same product as the first user does (see Figure 30).

Translating Meaning

The second design provides users a feeling of sitting next to the same table without using any goggles (see Figure 31). Besides, people are able to have face-to-face communications through this design (see Figure 31).

Although this design doesn't require complicated software algorithms, how to test this design is still a challenge (see Figure 32).

The opportunity of this design is that it conveys people's body language in an easier way (see Figure 33). It provides more details of the people without implementing a sophisticated algorithm.

Recommending Future Development

For the next step, the design needs

Figure 29. Second Prototype Generation Report, p. 32.

Figure 30. Second Prototype Generation Report, p. 31.
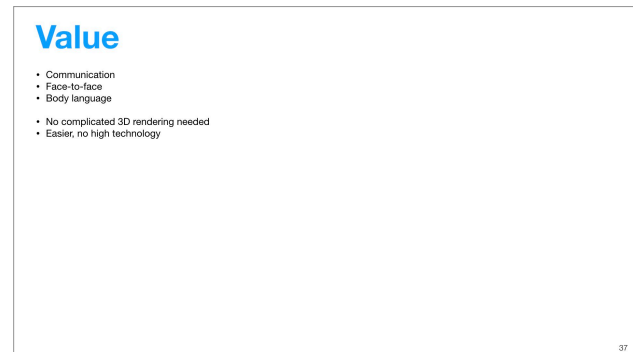
Figure 31. Second Prototype Generation Report, p. 37.

Figure 32. Second Prototype Generation Report, p. 38.

to be tested to see whether it works (see Figure 34). Also, humanity needs to be considered in further development (see Figure 33). For instance, how to start a new conversation (see Figure 33)? Should this be a private space or an open area (see Figure 33)? Besides, the opinions and suggestions from the outside committee member could be helpful to the development of the third prototype generation.

Third Prototype Generation

Transparency of Initial Design Decisions

During the interview with the committee member, Meyer Giordano, the instructor of the Computer Art and Animation at Syracuse University, whether or not the VR or AR Technology should be used is discussed (see Figure 35). In the comparison between VR communication tools, AR/MR communication tools, and common video calls, many kinds of body languages that are hard to achieve by the VR, AR, or MR Technology could be provided by normal video calls easily (see Figure 36). The software has to use animated characters to
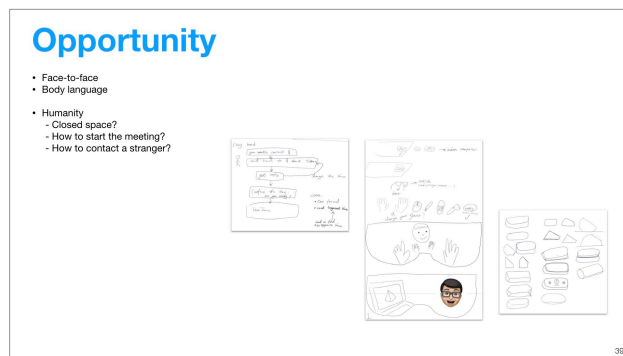
Figure 33. Second Prototype Generation Report, p. 39.
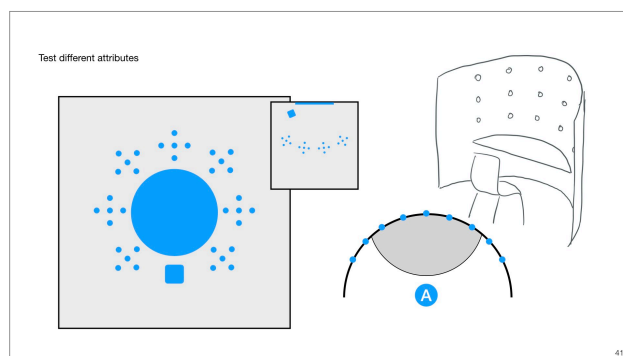
Figure 34. Second Prototype Generation Report, p. 41.

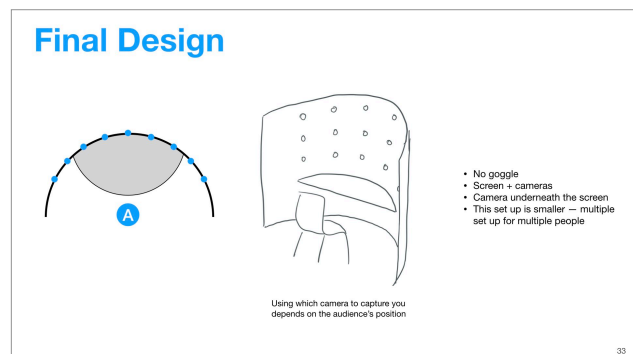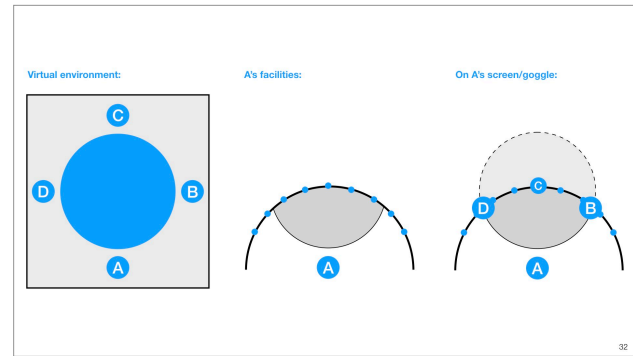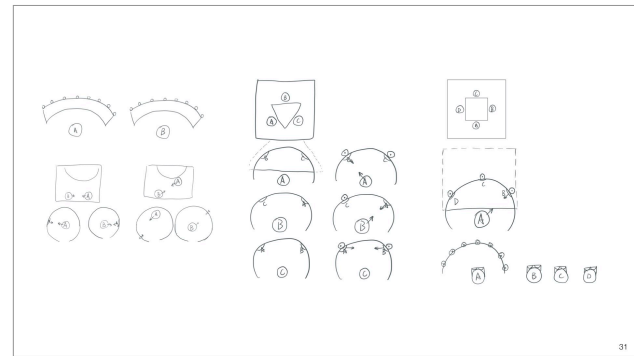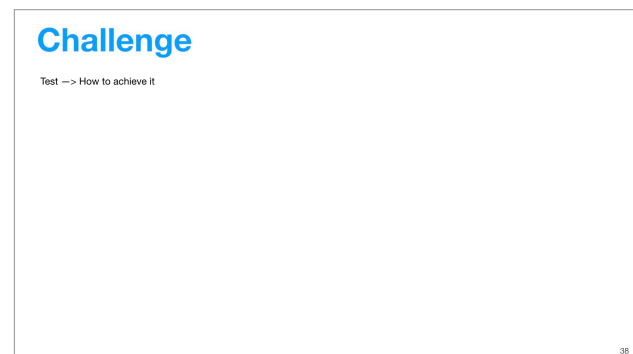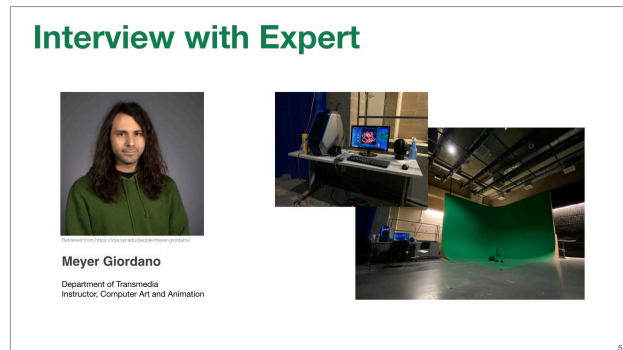*Figure 35.* Third Prototype Generation Report, p. 5.
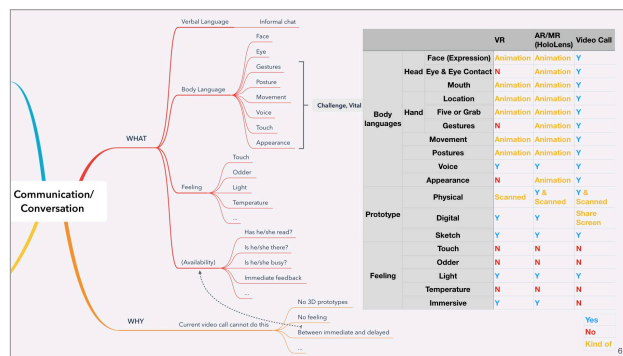
Figure 36. Third Prototype Generation Report, p. 6.

represent other people (see Figure 36). Using Microsoft HoloLens 2 as an example (see Figure 37). HoloLens 2 is an MR headset. People could see 3D models, images, whiteboards, as well as their own bodies and the real environment through the headset (see Figure 37). Users could also interact with the digital models naturally by just using their hands (see Figure 37). Moreover, users could see avatars of the other people and talk to them as if they are face to face (see Figure 37). The committee member also mentioned that people could use a big camera array system similar to the image

Figure 37. Third Prototype Generation Report, p. 7.
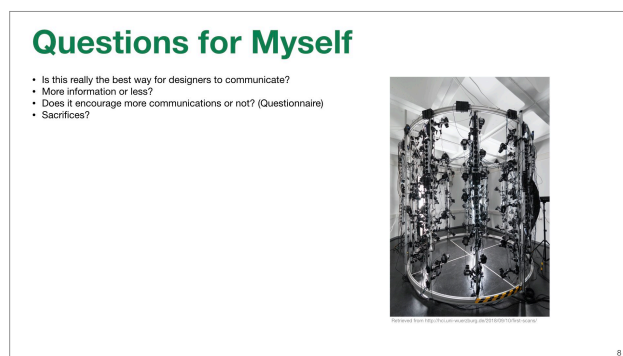
Figure 38. Third Prototype Generation Report, p. 8.

shown in Figure 38 to get high fidelity avatars of themselves.

However, does VR, AR, or MR goggles really the best way for designers to communicate? —— Maybe not. The ability to see digital models and interacting with them through the headset is fascinating, but it sacrifices too much (see Figure 38). First, people need to wear a headset whenever they want to see models or other people. Not everyone is comfortable wearing the headset and being shut off from their immediate surroundings. What's more important is that it requires extra action before people start to communicate. It will obstruct communications, especially informal chats. Second, instead of seeing the real image of other people, users can only see their avatars. The avatar negates so many details of the person, such as their posture, body movement, gestures, and subtlety of appearance. If the users want to create a higher fidelity avatar of themselves, they need to use a big camera array to capture themselves; and do it again if they change their appearance. People might reduce the number of times they communicate, let alone informal chats. This kind of goggles

significantly increases the cost of communications. Therefore, this project will not use any goggles.

This project aims to increase the efficiency and effectiveness of communications between team members; and therefore, encourage more communications (see Figure 39).

Figure 39. Third Prototype Generation Report, p. 10.

Iterating Towards a Prototype Generation

To achieve the goal of this project, the third prototype generation is designed. As shown in Figure 40, a big screen on a wall could display a whiteboard and some digital models (see Figure 40). The person standing in front of the screen is able to see the other person, who is standing in front of the same screen in another place (see Figure 40). Because this screen live-streams both sides, people could see their team members as long as they are in their offices (see Figure 40). This design is

Figure 40. Third Prototype Generation Report, p. 13.
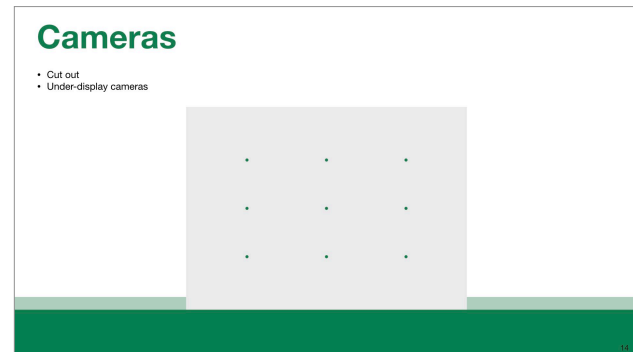
Figure 41. Third Prototype Generation Report, p. 14.

separate from people's personal space, they could have their own private place (see Figure 40). In addition, because this screen is taller than a normal door, people could see other people in their life-size (see Figure 40). To make the perspective of the camera as natural as possible, a camera array is implemented in the display (see Figure 41).

Because many people need to work in a private room, digital doors could be shown on the screen (see Figure 42). If the person decided to set a window on the door, other people

would be able to see their availability without interrupting them (see Figure 42). If a person thinks that it is a good time to interrupt the person, he or she could knock the door or ring the bell to get their attention (see Figure 42). People could also "slip" something under the door so that the other person would see it when they arrived at the office (see Figure 42). Moreover, the scale of the screen, multiple offices scenarios, the design of the door are discussed in Appendix G from page 16 to page 18.

When people are not interacting with each other, the blank space on the screen could be used as a whiteboard (see Figure 43). When presenting the whiteboard to others, the order of the information on the whiteboard might need to be flipped (see Figure 44).

This design tries to provide an immersive, real-time communication for people (see Figure 45). People are able to interact with digital models and real people (not avatars of people) through the screen (see Figure 45). Users could set a door on the screen to protect their privacy (see Figure 45). Other people could knock the door if they want to chat with the
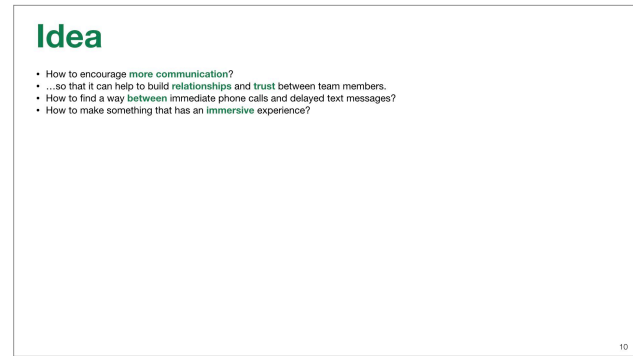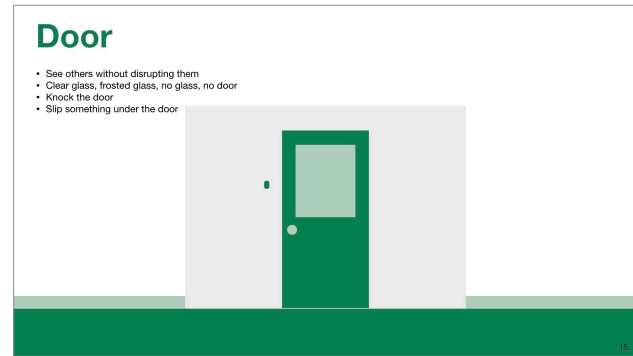

Figure 42. Third Prototype Generation Report, p. 15.
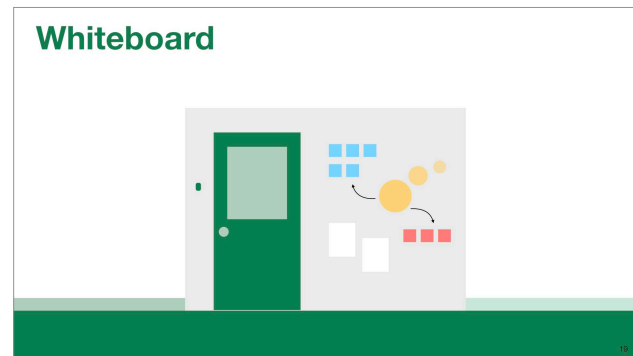
Figure 43. Third Prototype Generation Report, p. 19.
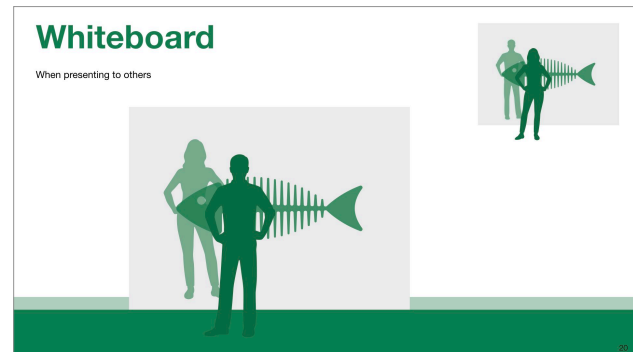
Figure 44. Third Prototype Generation Report, p. 20.

Figure 45. Third Prototype Generation Report, p. 23.

person (see Figure 45).

Value

- Immersive
- No goggle
- Encourage more communication, small informal talks
- Other's availability, humanity

25

Figure 46. Third Prototype Generation Report, p. 25.

Translating Meaning

This design not only provides people an immersive experience to communicate with each other but also considering social and cultural aspects (see Figure 46). People would be encouraged to have more communication with this design (see Figure 46).

However, how to implement the cameras to get the best perspective when people looking at each other is an issue (see Figure 47). It requires further testing in the development of this design.

Challenge

- Cameras
- White board
- Energy consumption (LTPO OLED)

26

Figure 47. Third Prototype Generation Report, p. 26.

The ability to set doors on the wall allows people to interact with each other naturally. It fulfills the gap between phone calls, which you have to answer it immediately, and emails or messages, which you don't know when or whether they will reply (see Figure 48).

Opportunity

- Between immediate and delayed — — Gap

Informal communication such as eye contact and body language is crucial for remote teams.

(Preuss, 2019).

27

Figure 48. Third Prototype Generation Report, p. 27.

Recommending Future Development

The test of the cameras is needed. More relative articles related to this design need to be reviewed. The suggestions from the committee member are also valuable to this project. More details about this design such as the interface of the screen and how to interact with the device need to be considered in the next step.

User Testing after the Third Prototype Generation

The Screen

The concept after the third prototype generation was to create an 8' by 8' screen. After looking up the hight of different partition whiteboards, the hight of office doors, and considering the average height of people, the size of the screen was changed to 7 feet by 4 feet.

Because it is almost impossible to get a display of this size, a projector is needed for prototyping. Also, this design needs to use the rear projection so that when people stand in front of the screen, they won't intervene in the light from the projector. Therefore, a frame with no support inside it was built.

Figure 49. The Installation of the First Version of the Physical Model.

To build the screen as quickly as possible, 1/2 inch diameter PVC tubes and plastic elbows were used to assemble the frame. Then, the frame is covered by a big piece of paper for projection. As shown in Figure 1, the size of the frame is 7' by 5'.

The goal of creating this prototype was to live-stream people working from different places through the screen. In order to know whether people could have a feeling that the people on the other side was working next to them and whether they could get used to having a big screen in their office after a period of time, one screen was installed in the studio shown in Figure 49. Another screen was then installed in the researcher's apartment with a camera set up.

The screens were connected through video for 4 days. During the test, people took classes in the studio, worked on their projects, and they were able to chat with each other. After the test, people were asked various questions about the setup.

The results were positive and one participant said that she had the feeling that the person on the other side (the researcher) was with them. She also mentioned that whenever they called the researcher's name, they could get the researcher's attention. Therefore she

believes that this screen could connect people together. Another person said that at first, she thought the screen and the video call would interrupt them; however, after a few minutes, they got used to it.

On the researcher's side, the feeling of being connected with others was a little bit weak due to the lack of the big screen. Because there is no big screen in the researcher's apartment, he projected the screen on a wall. Moreover, the projector needs to be put about 13 feet away from the wall to get a big projection area. The feeling is not as good as it was for the people in the studio. Therefore, the researcher would always stand closer to the screen to see others clearly. This might be the reason why some people in the studio expressed that sometimes the researcher's body appeared too large on the screen (see Figure 50).

Figure 50. A Photo During the Video Test.

Figure 51. The Second Version of the Physical Model.

Next, "2 by 4" wood logs were used to build a frame for a higher fidelity model. The frame was covered by a grey rear projection material from 3M (see Figure 51). The size of the wood frame is 50 $^1/_4$" by 87". The display area is 47 $^1/_4$" by 84". A new laser projector was used to shorten the projection distance.

The Interface

The interface integrated four main functions at the beginning: Home, Contact, My Door, and Folder (see Figure 52). By considering the physical reachability of people who stand in front of the screen as well as people sitting on a chair (or a wheelchair), the touch area is centralized in the middle of the screen. As shown in Figure 52, a sliding bar on the left of the screen allows people to move the whole interface up or down. People could see themselves on the top right corner of the screen. The center and the right side of the screen displays the images from other people's offices.

During the test of the interface, people in the focus group were asked whether they could understand the function of all the buttons. They also gave input as to

Figure 52. The Home Screen of the First Version of the Interface.

whether the size of the text and buttons were appropriate as well as whether the location of each element was easy to reach.

As shown in Figure 53, two people mentioned that at first, they didn't know the meaning of the third button on the right part of the screen. When they tap that button, they

see the background is blurred. They said that they can get the idea of the button after tried it.

Another participant mentioned that people might think the function of the red button with a white cross was used to hide to the buttons above it, instead of hanging up the calling. Therefore, this button should also be reconsidered in future design.

Figure 53. The Buttons on the Interface When People Tap the Screen.

When people tap the Contact button, a pop-up window will show up (see Figure 54). One participant indicated that the pop-up window might be a little bit small if you stand too far away from the screen. However, other people thought the size of the window was ok because people need to use their fingers to touch the screen.

There was also an "Add to my team" button in the Contact window under one person's name. One participant indicated that maybe some people will not want to be added to the team. Therefore, a notification and confirm button on that person's side could be added.

Besides, one person mentioned that other people's names might be more important than their locations. Therefore, instead of showing the city of their location, the screen should show the person's name or their group name.

As shown in Figure 55. A participant is trying to find where the pop-up window should be to provide people a more comfortable position. Based on this, the sliding bar on the left of the screen could be removed and a handle or two handles could be added next to the four main function buttons so that people could just move the four main function buttons and the pop-up windows up or down, instead of moving the whole screen up or down.

Several people in the test proposed that they want to work in a more private space and the ability to display a closed-door on their screen might be an acceptable solution. When it comes to the
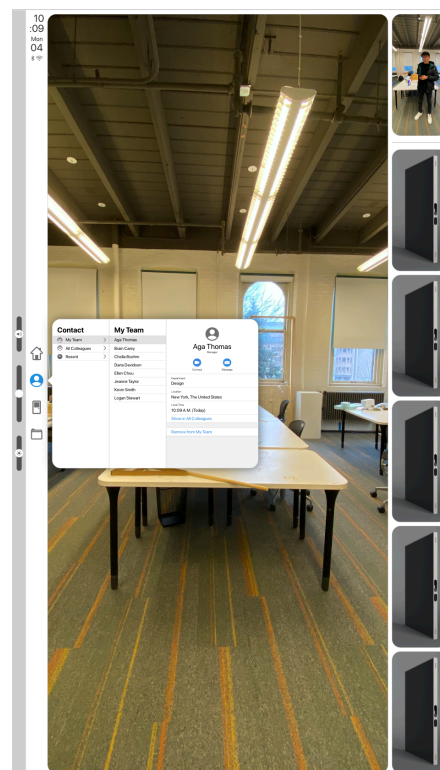
Figure 54. The Contact Screen of the Interface.

Figure 55. A Picture of Testing the Size and the Location of the Pop Up Window.

customization of the door, one participant pointed out that it might present too many choices in this section (see Figure 56). She doesn't care about how her door looked and would prefer more simple options. However, another person said that the doors are cool. Especially the one that looks like the door in a spaceship!

In addition, how to select the windows on the right side of the screen was also discussed during the test.

Figure 56. The My Door Window on the Interface.

Besides, because the size of the mute button is small, in addition to the change of the color of the button itself, adding some visual effects to the image might also be helpful.

Next Steps

Some scenarios have been discussed but not fully explored. For instance, what would happen if a person is trying to contact another person but that person is talking to a third person? Or, how could two people add other people to their conversation? These scenarios involve more than two participants. It might be complicated for users to control their availability to different people. Also, could people set up a "heads down" time when they just want to focus on what they are doing and don't want interruptions? If the person is not involved in any teams, what would show on their screen? In addition to the local time of other people, would local weather or other information be helpful for users? These questions will be considered in the next step of this project.

6. Final Design

Please scan the QR code or visit https://youtu.be/SbzS6t90MXI to watch an introduction video.
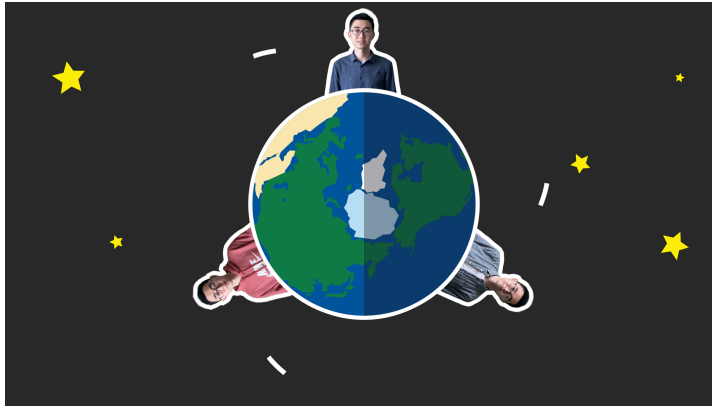
Figure 57. A Screenshot from the Introduction Video.

Who

The target users of this project are young designers and people who are willing to try something new, especially Generation Z. The main users of this product would be product designers who need to work remotely. Maybe they need to collaborate with people from different cities. Maybe they have to connect teams all over the world. Maybe their offices are separated in different places but they eager seamless team collaboration. They are the users.

Besides, this is not a personal device. They are bought and owned by companies or teams who hire these people. Therefore, potential buyers are this kind of company and team.

Where

This product is used in the workplace. It should be installed in offices, meeting rooms, or open spaces inside a company. The devices could be put in front of a wall or in the center of a room. People should be able to see the screen all the time. This device should not face a wall or where people will barely notice.

Because these devices are connected via the Internet, they could also be installed in third place offices that are located in different places around a country or around the world. These third place offices could be rent for companies or teams for temporary use.

When

This product is used in the workplace. Therefore, as long as people are in the offices, this product is used. These devices will live-stream multiple places at the same time, even when people are not talking. If only one person is in the room, he or she could still use this device.

What — The Hardwares

Portal (the screen)

The screen is named Portal because you can use it to connect to your team members' work environments —— as a portal.

The size of the Portal is 50 ¹/₄" by 87". The display area is 47 ¹/₄" by 84". It is a 96.4‒inch (diagonal) Multi‒Touch display, 5880-by-3307-pixel resolution at 70 pixels per inch (ppi) with support for millions of colors. Its aspect ratio is 9 by 16. (See Figure 58.)

As shown in Figure 59, speakers, microphones, and a shelf to store the Pencil are located on the sides of the Portal. The quad speakers around the Portal can deliver decent stereo sound. Also, the quad microphones can record in stereo and be used to reduce the background noise.

Figure 58. A Rendering Image of Portal.
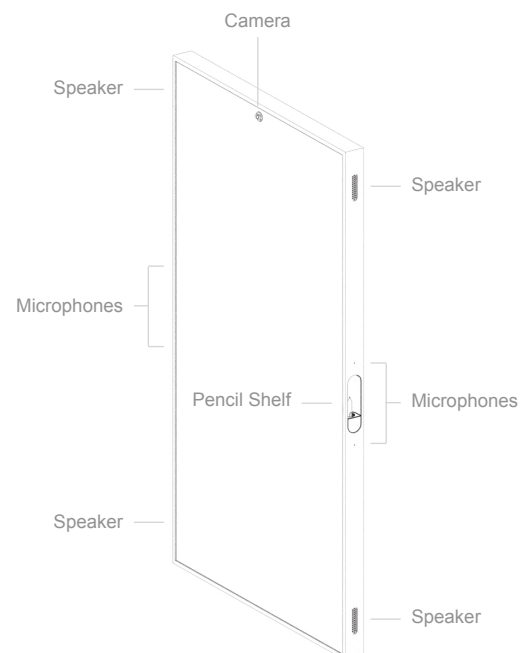
Figure 59. This figure illustrates the locations of speakers, microphones, and Pencil shelf on the Portal.

The Camera

Body language is at the heart of communication between people. Therefore, a good perspective of the camera is crucial. To help users get a better viewing perspective, the camera is designed as an external camera. It uses Bluetooth to connect to the Portal. Moreover, it uses magnets to attach to the screen. (See Figure 60.) Therefore, users are able to move and attach the camera around the screen. They can also flip the top part of the Camera to adjust the viewing angle. (See Figure 61.)

Figure 60. A Rendering Image of the Camera.

Figure 61. This Rendering Shows that Users Can Flip the Camera to Adjust the Viewing Angle.

When the Camera runs out of its battery, a pop-up window will show up on the screen to remind people to charge it up. (See Figure 62.) A wireless charging coil is built underneath the display. When users place the Camera on that location on the screen, it will automatically start to charge up.

Figure 63. This Rendering Shows that Users Can Charge the Camera Via A USB-C Cable.

Figure 62. The Pop-Up Window When the Camera Needs to Be Charged.

Because the wireless charging spot is on the top part of the screen, not every person can reach that easily. Therefore, users can also charge the Camera via the USB-C port on the Camera. (See Figure 63.)

The Pencil

The diameter of the Pencil is $3/4$ inch. The length of the Pencil is $5^1/2$ inches. (See Figure 64.) Users can use the Pencil to write and draw on the screen.

A shelf is designed on the right side of the Portal to store and charge the Pencil. (See Figure 65.) When the Pencil runs out of its battery, a pop-up window will show up on the screen to remind people to charge it up. (See Figure 66.)
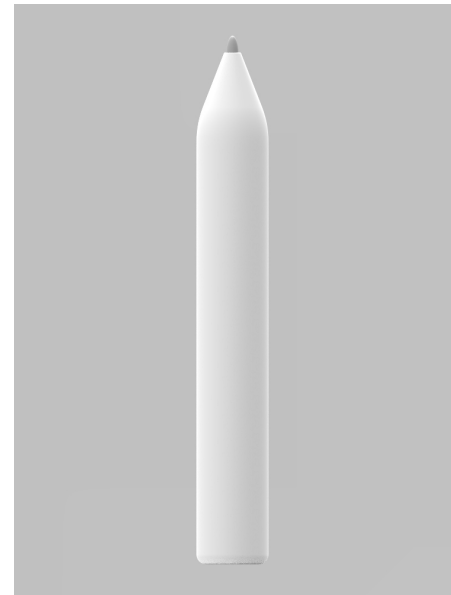
Figure 64. A Rendering Image of the Pencil.
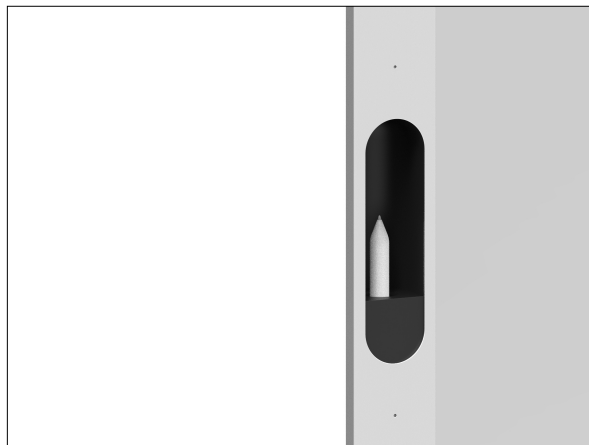
Figure 65. A Close Up Rendering Image of the Pencil Shelf on the Portal.

Figure 66. The Pop-Up Window When the Pencil Needs to Be Charged.

What — The Software

Physical Accessibility

As Figure 67 shows, two slide bars are displayed above and under the five function buttons. Users can use either the top or the bottom slide bar to move the

function dock up or down. Once the function dock was moved up or down, the pop-up window from each function would follow the function buttons. (See Figure 68.)

　　To select the five small windows on the right part of the screen, simply tap one of them and then they will centralize to the height of the function dock. (See Figure 69.) Users can also see others' locations and local time as well as hided buttons such as "Take a screenshot", "Leave a message", "Hang up the call", "Mute my audio", "Disable my background", etc.

Figure 67. The Home Screen of the Portal.

Figure 68. The Pop-Up Window Will Follow the Function Bar When It Was Moved.

Figure 69. The Interface When User Tap On the Window.

Home

On the Home screen, the function dock is displayed on the left part of the screen. Five buttons, including Home, Contact, Whiteboard, Folder, and Settings, are in the function dock. On the top left corner of the screen is some basic information for the user: the time, date, Bluetooth, Wi-Fi, and the battery of the Camera and the Pencil. In the middle of the screen is the main window of other people's work environment. On the top right corner, users can see what shows on others' screens about themselves. In addition, five small windows of other offices are displayed on the right part of the screen.

the device lives streams multiple places at the same time. As long as people are in the offices, they can see other people. They will have the feeling that their team members are sharing the same office as working next to them. This design aims to encourage more communication between team members, especially some informal conversations. For example, when people walk into their office in the morning, they can say "Hi" to each other. If someone has a quick question about what the leader has said last time, they can just ask everyone through the Portal out loud. Doing this, relationships between team members can be enhanced, and their productivity will be boosted (CMOE Design Team, 2019).

When people decided to have a formal conversation, they could just walk to the screen and talk. Because the Portal is about 7 feet tall, People can see others at life-size scale. Therefore, they won't miss visual cues such as body language or the mood within each team members' work environment. Moreover, because the users see the real image of people, not an avatar of them, they can see others' appearances and all the other body language. (See Figure 70.)

Figure 70. Two People Are Chatting Through the Portal.
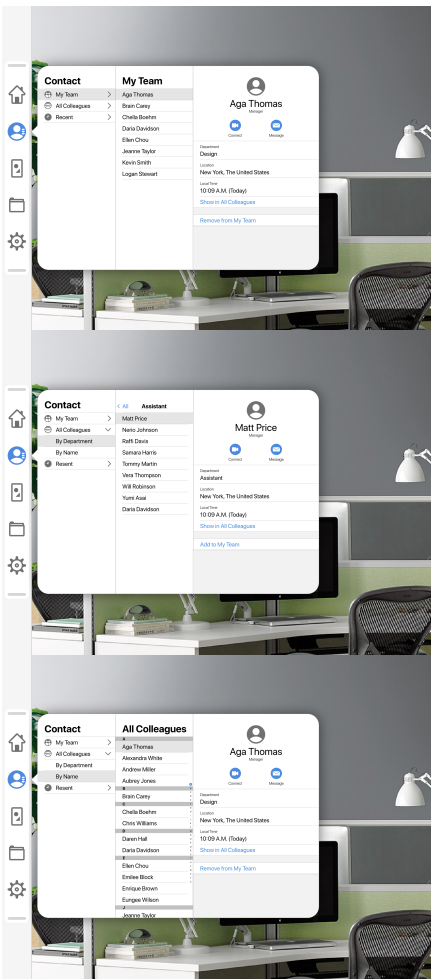
Figure 71. The Pop-Up Windows of Contact.
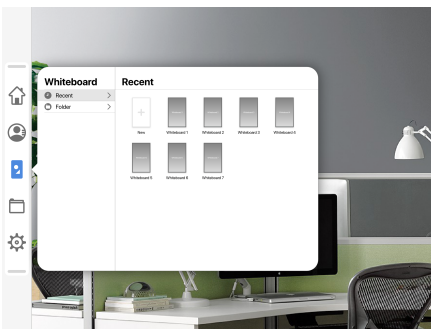
Figure 72. The Pop-Up Window of Whiteboard.

Contact

As Figure 71 shows, users can view their contact information from their team, form all colleagues, or from their recent callings. In the All Colleagues section, users can sort their colleagues by department or by name.

When users find the person they want to contact, they can directly connect to their office, or leave a message from this pop-up window. They can also see other information about the person, such as their department, location, and local time. Besides, they can add the person to their team or remove the person from their team.

Whiteboard

Figure 72 shows the pop-up window of Whiteboard. Users can open a whiteboard from recent files or form their folders. They can also open a new whiteboard. On the interface of Whiteboard, users can select different tools from pencil, marker, eraser, and lasso tool. Users can also add a post-it note on the whiteboard. In addition, sliding the slide bar on the right part of the whiteboard, users can move the whole whiteboard up and down. (See Figure 73.)
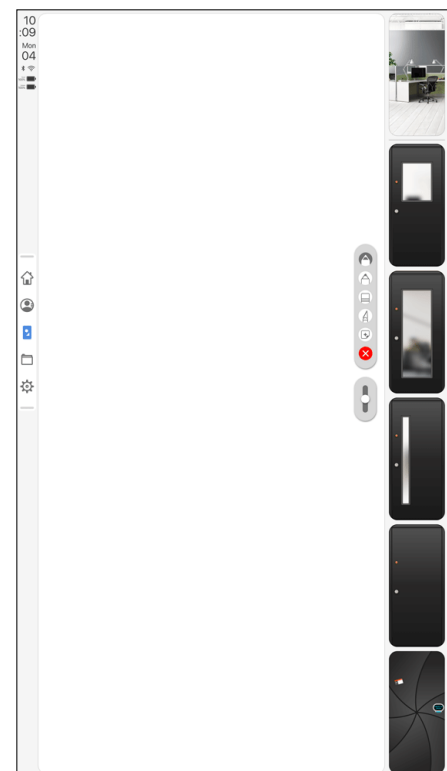
Figure 73. The Interface of Whiteboard.

Folder

Figure 74 shows the pop-up window of Folder. Users can browse their files from their Recent files, My Files, Shared Folders, and Trash.

Users can drag and drop files from the pop-up window to their chatting window or message window to show the files to others.

Settings

In the Settings pop-up window, users can login or logout their account in My Account. Users can also set the language and time of the device as well as view the Bluetooth and Wi-Fi settings.

In the My Door section on the Settings pop-up window, users can set a digital door on their screen to keep their privacy when connecting to others. (See Figure 75.) Users can set a door without a window, a door with a transparent window, a door with a frosted glass window, or a transparent door, etc. They can also choose a doorbell and set the sound of the doorbell. Besides, they can add their name card and other decorations on the door as well as set a filter to their voice.

Figure 74. The Pop-Up Windows of Folder.
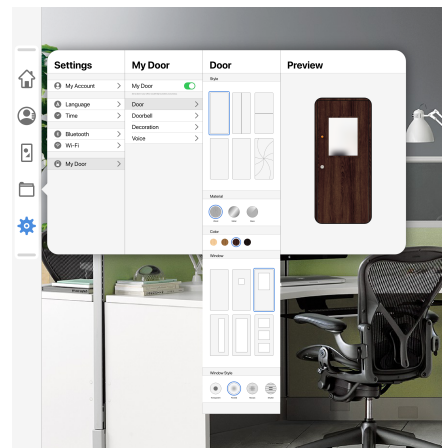
Figure 75. The Pop-Up Window of Settings.

On the Home screen, people can see other's availability through the window on the door. If the other person is free, they can ring the doorbell. The sound of the doorbell will be played on the other side. They can chat with each other after opening the door. If the other person is busy, they can leave a message or come back later.

7. Synthesis

Problem Response

Traffic congestion is a huge issue in many megacities. Traffic congestion appears in both ground transportation and subways very often. People have a hard time traveling in the city. People spend a lot of time and energy traveling every day. Many organizations and companies have been trying to solve this issue with restrict policies, new services, and products for a long time, but the congestion in those cities doesn't seem to reduce.

As Black (2010) mentioned in the book, if there is a perfect travel tool, which is fast, comfortable, convenient, safe, and cheap, it might generate additional travel (p. 259). The demand for travel will increase because of all the advantages; therefore, the best solution for the traffic issues might be not traveling at all (Black, 2010, p. 259). Moreover, the author suggested that teleworking could be a potential solution for that (Black, 2010, p. 259). In recent research, the total daily vehicle miles traveled and vehicle hours traveled are reduced due to the implementation of teleworking (Shabanpour, Golshani, & Tayarani, 2018). Therefore, this project focused on improving the teleworking experience.

Nowadays, teleworking is not a common phenomenon. It is almost impossible for many design teams to permanently work remotely because there is no product or service for them to communicate and collaborate very efficiently. Therefore, this project aims to enhance the efficiency and effectiveness of remote communication between team members who work in different locations.

Using the Portal, people can communicate with their team members more efficiently and effectively. Therefore, more design teams could consider work and collaborate remotely.

Analysis

Based on the results of the user testing, this design can provide an immersive feeling. People can have the feeling that the person on the other side is sharing the same office as working next to them. Moreover, people will get used to having a large screen in their offices after they use it for a few minutes.

Although some informal communication has emerged during the user test, the communication didn't evolve into long conversations. Most informal communication was calling others' name and say hi to each other. The participants did it just for curiosity. They didn't continue their conversations. According to Otter and Emmitt (2007), synchronous communications are always used in early design phases to reach consensus among the team, while asynchronous communications are usually happen in the overview, exchanging, and sharing design information to improve the effectiveness (p. 411). One possible reason might be the participants were doing individual works during the test. They did not have to collaborate with others. Another possible reason could be that the participants had met with each other just before the test. They had not got many thinkings to share.

Due to the pandemic, this project was only tested between the designer's classmates in the middle of the design development process. If there is no pandemic, the design will be tested in real design teams in a real situation.

As an alternative plan, external experts related to this area were interviewed for feedback on this project. In one of the interviews, the expert gave a positive evaluation of this project. The expert believes that this project has huge potential. The design of future offices will be changed significantly. "This opened up an opportunity for walled offices to make it feel that they are not walled (J. Liddy, personal communication, April 29, 2020)." The expert also mentioned that he likes the design of the slide bar, which allows people to move the function buttons up or down to reach them easily, and the concept of the door.

8. Summary and Conclusions

Summary

Today, the need for teleworking is increasing. This project aims to enhance the efficiency and effectiveness of remote communication between team members. Through the large-screen based design named Portal, people can see and interact with others at their life-size scale, so visual cues such as body language or the mood within each team members' work environment won't be missed. The size and location of each element on the screen has been carefully designed so people can easily interact with the device even if they are sitting on a chair. Because the Portal lives streams multiple places at the same time, people have the feeling their team members are sharing the same office while working next to them. To establish a level of privacy, users can display a digital door on their screen. They can see the availability of other team members through the window in the door, so they can decided to ring the doorbell, leave a message, or come back later. Using the Portal, informal communication between team members can enhance relationships and enhance the productivity of the team (CMOE Design Team, 2019).

Significance

First, thanks to teleworking, people could spend less time and energy on traveling to their offices. Because they can decide where they want to work, they could save travel time and spend that time on something else. Moreover, according to Shabanpour, Golshani, and Tayarani (2018), the total daily vehicle miles traveled (VMT) and vehicle hours traveled (VHT) will be reduced by implementing teleworking (p. 573). This is good for both the team members and the environment.

Second, teams can reduce the cost of renting offices. Because of the Portal, it is possible for design teams to permanently work remotely. They don't have to come to the same office to work. They can find smaller offices around the city. Since the choices of offices are more flexible, they can find much cheaper options instead of spending a high price rent a big office in the center of a city.

Besides, collaborating with other teams can be more efficient than before, even if the other team works in another city or country. Communicating with other teams has become more and more important in many industries. Because communication is vital to every design teams, and body language is crucial to communication, this design focused on delivering as much body language as possible to other users through a large screen. Moreover, due to the large size of the screen, people can see others at their life-size scale. They can have a feeling that their team members are working next to them. Using the Portal, people won't have any physical barriers. They can connect and collaborate with other teams from other companies whenever they want.

Next, Portal encourages more communication between team members, especially small informal talks. Today, many people who work remotely only have formal meetings with their teams in a scheduled time. Besides, most of the current communication tools don't encourage more communication for teams in the workplace. With the Portal, people can have informal chat as long as they are in their office. This is especially beneficial for enhancing the relationship and increase the task performance of the team (CMOE Design Team, 2019).

Finally, life after the pandemic will be different significantly. Teleworking has become a new norm. After trying to implement teleworking into their work agenda, many people will consider continuing work remotely even when the pandemic ends. This project takes part in this larger trend and prepares for the new way of working as well as the living.

Limitations

Because of the size of Portal, it is not a portable device. It can only be installed in offices. People cannot use it on the go.

Next, due to the current pandemic of COVID-19, this project was only tested between the designer's classmates in the middle of the design development process. This project has not been tested in real design teams in a real situation. As an alternative plan, some external experts related to this area were interviewed for feedback on this project.

Future Work

First, although the size of the screen is one of the main features of this design, a smaller version or a bigger version of the screen could also be explored. Different screen sizes can provide more choices for people to fit in different work environments.

Second, so far, this project mainly focuses on design teams. However, other kinds of teams could be considered in the next steps. More research about the demand for other kinds of teams needs to be done.

Third, what teleworking has changed is not just a single device, the design of future offices, homes, furniture, and public spaces will also be changed significantly. In order to better integrate into this new trend, the design of this project should also consider these aspects.

Finally, can this design work for family usage? Because this device can deliver the feeling that the other people are staying next to them, maybe parents want to see their children who study abroad; maybe couples who live in different cities want to chat with each other; maybe some people want to check out whether their grandparent is doing well in their own home, etc.

9. Appendices

Appendix A: IRB Approval

IRB #: 19-262

SYRACUSE UNIVERSITY

INSTITUTIONAL REVIEW BOARD
MEMORANDUM

TO: Jody Nyboer
DATE: October 11, 2019
SUBJECT: **Determination of Exemption from Regulations**
IRB #:   19-262
TITLE: *Teleworking Design for Generation Z*

The above referenced application, submitted for consideration as exempt from federal regulations as defined in 45 C.F.R. 46, has been evaluated by the Institutional Review Board (IRB) for the following:

1.   determination that it falls within one or more of the eight exempt categories allowed by the organization;
2.   determination that the research meets the organization's ethical standards.

It has been determined by the IRB this protocol qualifies for exemption and has been assigned to category **2**. This authorization will remain active for a period of five years from **October 10, 2019** until **October 9, 2024**.

CHANGES TO PROTOCOL: Proposed changes to this protocol during the period for which IRB authorization has already been given, cannot be initiated without additional IRB review. If there is a change in your research, you should notify the IRB immediately to determine whether your research protocol continues to qualify for exemption or if submission of an expedited or full board IRB protocol is required. Information about the University's human participants protection program can be found at: http://researchintegrity.syr.edu/human-research/. Protocol changes are requested on an amendment application available on the IRB web site; please reference your IRB number and attach any documents that are being amended.

STUDY COMPLETION: Study completion is when all research activities are complete or when a study is closed to enrollment and only data analysis remains on data that have been de-identified. A Study Closure Form should be completed and submitted to the IRB for review (Study Closure Form).

Thank you for your cooperation in our shared efforts to assure that the rights and welfare of people participating in research are protected.

Tracy Cromp, M.S.W.
Director

DEPT: VPA – School of Design, 350 W. Fayette St., Syracuse, NY 13202   **STUDENT:** Han Zhao

Research Integrity and Protections | 214 Lyman Hall | Syracuse, NY 13244-1200 | 315.443.3013 | **orip.syr.edu**

Appendix B: Consent Form

Hello!

My name is Han Zhao. I am a graduate student pursuing a master's degree in the MFA Design Program at Syracuse University. I am inviting you to participate in my thesis research study. This study tries to optimize productivity of tomorrow's employees. My hope is to figure out the core elements of the productivity of Generation Z so an innovative design intervention for teleworking can be developed.

Please read this consent form carefully. If you agree to participate, a short anonymous survey will be launched in your browser. Some questions will ask you to provide short answers. Others might ask you to select a response or provide a rating. All questions are designed to gather information about your individual perceptions and experiences related to work productivity. This will take approximately 15 minutes of your time.

At the end of the survey, you'll be asked whether you have an interest in participating in design development testing that will allow you to give feedback or your opinions concerning the design prototypes. If interested, please access the link at the end of the survey; a separate form will launch and you can fill out your contact information. This procedure is to preserve the anonymity of responses in the questionnaire. This design development phase will take approximately 3 times, 30 minutes each time of your time. All selected participants for product development testing will be compensated with a gift card (see the section on compensation below). Our contact information will appear at the end of the survey.

Compensation

This research has funding to support participant incentives for product development testing. If selected, you will be compensated with a $5.00 gift card to Starbucks to show my appreciation as a participant..

Risks and Benefits of Participating in the Study

The study poses minimal risks. The survey asks you to share your experiences, ideas, and perceptions. However, you may refuse to answer questions that make you feel uncomfortable.

Voluntary Nature of the Study

Participation in this study is voluntary. The decision of whether or not to participate will not affect your relationship with Syracuse University. If you decide to participate, you are welcome to refuse any answer or withdraw your participation at any time without affecting the aforementioned relationship.

Confidentiality

Any recorded information you provide on the online survey will be anonymous. The data, observations, notes, and documents related to this study will be kept confidential and will be securely stored in a locked room at Syracuse University or password protected on a computer. All data, reports and presentations that emerge will be scrubbed to remove individual identities. Whenever one works with email or the internet there is always the risk of compromising privacy, confidentiality and/or anonymity. Your confidentiality will be maintained to the degree permitted by the technology being used. It is important for you to understand that no guarantees can be made regarding the interception of data sent via the internet by third parties.

Contacts and Questions

All questions or concerns regarding this study should be directed to the researcher Han Zhao at hzhao12@syr.edu. Should you have questions for the supervising professor of this study, please contact Dr. Jody Nyboer at jlnyboer@syr.edu. Apart from the team, please voice any other questions or concerns to the Office of Research Integrity and Protections at 214 Lyman Hall, Syracuse, NY 13244, or (315) 443.3013.

Consent

To consent to the procedures of this study please click "agree to participate" below and your browser will be directed to the online questionnaire. Note: you must be 18 years or older to participate.

- ⭕ I agree to participate and am 18 years or older
- ⭕ I do not agree to participate

Appendix C: Survey Questions

> ***Anonymous Questionnaire: The Work Experiences and Preferences of Generation Z***

- How old are you?

- What's your gender?

- What school do you attend?

- What's your major?

- What kind of job are you considering or hoping to get after your graduation?

- Describe your "dream" work environment?

- Describe your "nightmare" work environment?

- What factors do you think could optimize your productivity?

- Do you prefer working remotely? (For example, working in different buildings/cities/ countries with the other team member?)

- Follow up question: Please explain why you answered yes, no, or maybe.

- What factors do you believe make it difficult for people to work remotely?

- I'm planning to design an environment or a table that allows you to see others' faces and things in front of them in a 3 dimensional way. Right now, it's just an initial idea. It's not fully explored yet. What's your opinion about it? Do you think it could optimize your productivity? Do you think this could allow people to work remotely? Do you like or hate this kind of design? Why do you think so?

- Any other comments?

The questionnaire is almost done... however, this is just the beginning of this research about optimizing the productivity of Generation Z. The anonymous feedback that you have shared today will be used to develop several prototypes of a design (product or service). If you would like to participate in the design development phase, please access the link that appears at the end of the survey (you'll see it after you press submit).

All questions or concerns regarding this study should be directed to the researcher Han Zhao at hzhao12@syr.edu. Should you have questions for the supervising professor of this study, please contact Dr. Jody Nyboer at jlnyboer@syr.edu. Apart from the team, please voice

any other questions or concerns to the Office of Research Integrity and Protections at 214 Lyman Hall, Syracuse, NY 13244, or (315) 443.3013.

Now, select "Submit" to finish up. Thank you!

Contact Information for Design Development

Thank you for your response! If you would like to participate in the design development tasting phase that will allow you to give feedback or your opinions concerning the design prototypes, please provide your contact information. This procedure is to preserve the anonymity of responses in the questionnaire. This design development phase will take approximately 3 times, 30 minutes each time of your time. This research has funding to support participant incentives for product development testing. All selected participants for product development phase will be compensated with a gift card. If selected, you will be compensated with a $5.00 gift card to Starbucks to show my appreciation as a participant..

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○ Yes. I would like to participate in the design development phase.

- Name
- Email
- Phone

Appendix D: Product Development Testing Protocols

- Talk to me about the design. Do you like it? Do you think it would work?

- How does this design support an engaging working experience?

- Do you believe you could be more productive in this environment?

- What do you think would enhance this telework experience?

- Which part of the design that you hope could be improved?

Appendix E: First Prototype Generation Report

The First Prototype Generation Report is also available at https://drive.google.com/file/d/1Tu1POHkASNCtGl75vlp5PxomkxVbQwwG/view?usp=sharing or scan the QR code

First Prototype Generation Report

Han Zhao | 10.15.2019

Transparency of Initial Design Decisions

2

Review of Knowledge

A big number of Generation Z want to choose a job that can work remotely.
(Kuyucu, 2019).

5G technology is coming. There is a huge gap in the current industry.
(Li, 2016).

Today's VR technology is focusing on gaming and not so much targeting production.
(O'Connell, 2016).

3

Critical Analysis of Existing Products

Communication tools
Text, picture, audio recording, video recording, audio call, video call, screen sharing
...

Sketch, Rhinoceros, KeyShot, Office, Adobe, iWork, Google Drive, WPS, Autodesk, Slack, Group me, Skype, WeChat, iMessage, FaceTime, Phone call, Email, Zoom, Text message, Facebook Oculus, Facebook, HTC Vive, Samsung Gear, Google Daydream, Microsoft HoloLens, Sony PS VR

GAP

Productivity tools
Document, slide, chart, photo, music, video, video effects, 3D model
...

Gaming tools
VR, AR, video, audio, streaming, collaboration
...

4

Initial Idea

- AR goggles
- Space scanning cameras
- Could set up anywhere
- Duplicated offices
- Third places work environments
- Collaborative work
- Gen Z Designers

5

Iterating Towards a Prototype Generation

6

Designers' Working Environment

Post-it wall
Notes, Images, Materials, Drawings

Table
Prototypes, Laptop

7

Initial Idea

Virtually-linked work environment for real-time collaboration and production.
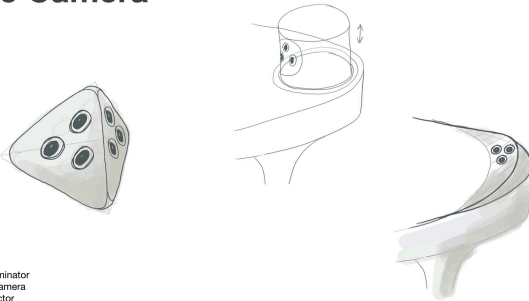
8

The Table

The Camera

- Flood illuminator
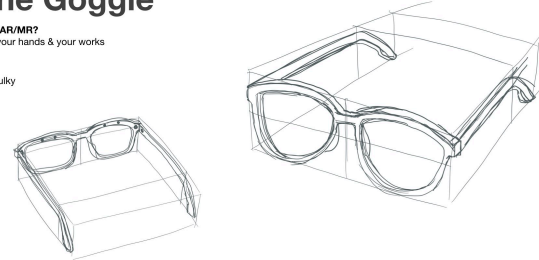- Infrared camera
- Dot projector

The Camera

- Flood illuminator
- Infrared camera
- Dot projector

The Goggle

Why AR/MR?
See your hands & your works

5G
No bulky

- Flood illuminator
- Infrared camera
- Dot projector

The Software

- Archive
- Do Not Disturb
- Other's availability

Archive function is vital for many situations
(Chambers, 2019).

First Idea — Goggle

What you need:
Wall, Table, Cameras, AR goggle
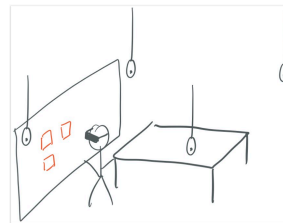
First Idea — Goggle

What you need:
Wall, Table, Cameras, AR goggle
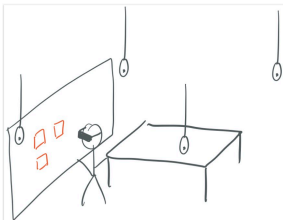
1 person put ▮ on the wall

Cameras capture the ▮ + 🧍

AR goggle captures 😀

↓ 5G

Process data on cloud

↓ 5G

Show on AR goggle

Everyone can see the notes and other people

First Idea — Goggle

What you need:
Wall, Table, Cameras, AR goggle

Your reality — In your

Other's reality — In other's
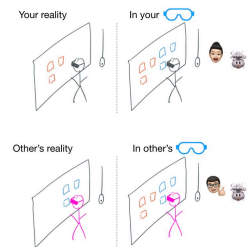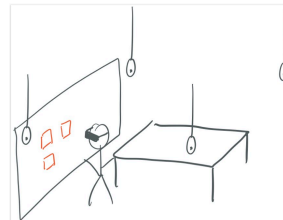
First Idea

What you need:
Room, Wall, Table, Cameras, AR goggle

Your reality

What you can see

The Table

Material

Wood

Value

- Close to life
- Warm
- Not durable

Screen

- Content display
- Easy to change
- Expensive

Metal

- Steady
- Cold

Glass

- Beautiful
- Mat/Glossy finish
- Slippery

Digital

- Carry every where
- 3D content
- Super hige-tech
- Super expensive

The Table

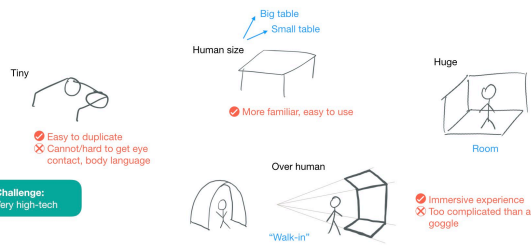Scale

Tiny

Big table
Small table

Human size

Huge

✅ Easy to duplicate
❌ Cannot/hard to get eye contact, body language

Challenge: Very high-tech

✅ More familiar, easy to use

Over human

"Walk-in"

Room

✅ Immersive experience
❌ Too complicated than a goggle

19

The Table

Shape

Foldable

projector

post-it

prototyps

Glass?

View for two sides ✅

✅ Good for group work
❌ Not good for content display

✅ Too complicated

✅ Good for health

Foldable screen

❌ Too complicated
Worse than a goggle

20

Second Idea — Table

Foldable screen

3D model

3D face scaning

Humanity: Eye contact, body language

Opportunity/Gap: You are looking at screen, not camera — look weird

camera
auto adjust
machine learning

3D model on 2D display

eye contact / body language

A small device to know where your head/eyes is/are.

Future: no additional devices needed

21

Describing the Final Design for the Generation Design

22

Final Design

3D model (on 2D display)

Your reality:

On the screen:

Screen

You can see:

It's a 2D display

23

Final Design

3D face scanning

✅ **Technology is ready**
Apple's Face ID & FaceTime Attention Correction (iOS 13 Beta 5) (Clarion, 2019).

Camera 1

Your screen

Camera 3

Machine learning

On other's screen:

Camera 4

You are looking here

Combing the 4 images together

24

Final Design

3D face scanning

Camera 1

Your screen

Camera 3

Camera 4

You are looking here
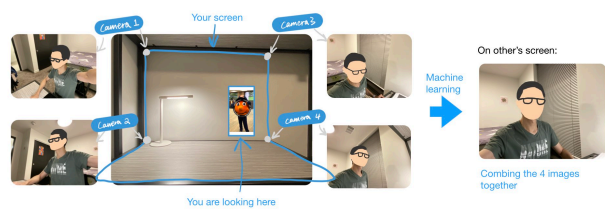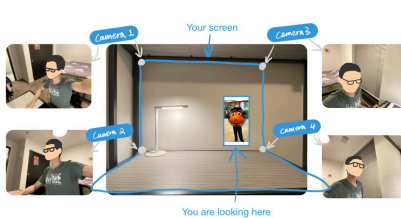
4 Cameras
↓
The system knows where your head/eyes is/are
↓
Where you are look at/ from
↓
3D model + 3D face

25

Final Design

Standard third place:
All same
Available every where: different buildings, different cities, different countries

📍 Beijing

📍 Smith Hall

📍 Warehouse

📍 Shanghai

📍 New York City

📍 Syracuse

26
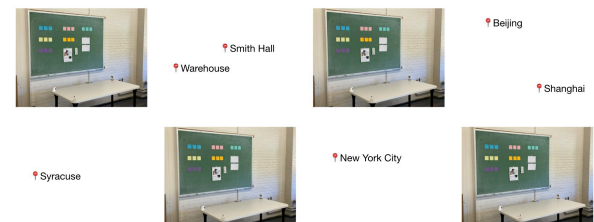
Translating Meaning

27

Value

Generation Z believes teleworking could optimize their business performance.
(Kuyucu, 2019).

The true 3D telepresence is the future of the AEC (architecture, engineering, construction) industry.
(Preuss, 2019).

The architecture industry can be beneficial by VR, AR, and MR technology.
(O'Connell, 2016).

28

Value

- VR, AR, 5G is not ready yet. It's hard to test.
- New area, little reference works
- Face-to-face personal contact
- No goggle
- 3D model
- 3D face scanning
- Eye contact

29

Challenges

- VR, AR, 5G is not ready yet. It's hard to test.
- New area, little reference works
- Face-to-face personal contact
- Require machine learning — not easy

Jobs that require face-to-face personal contact cannot be done remotely.

(Preuss, 2019).

30

Opportunities

Productivity tools
Document, slide, chart, photo, music, video, video effects, 3D model, Real prototypes, post-it ...

Communication tools
Text, picture, audio recording, video recording, audio call, video call, screen sharing, You & your environment ...

My project

Gaming tools
VR, AR, video, audio, streaming, collaboration Mix reality ...

31

Opportunities

- VR, AR, 5G is not ready yet. It's hard to test.
- New area, little reference works
- Face-to-face personal contact
- True eye contact in video calling

32

Recommending Future Development

33

Future Development

Human needs:
Eye contact, body language

Test, survey, focus group, expert

No goggles/devices needed
— Machine learning

Branding, marketing

Informal communication such as eye contact and body language is crucial for remote teams.

(Preuss, 2019).

34

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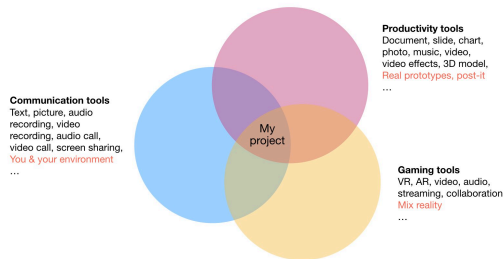
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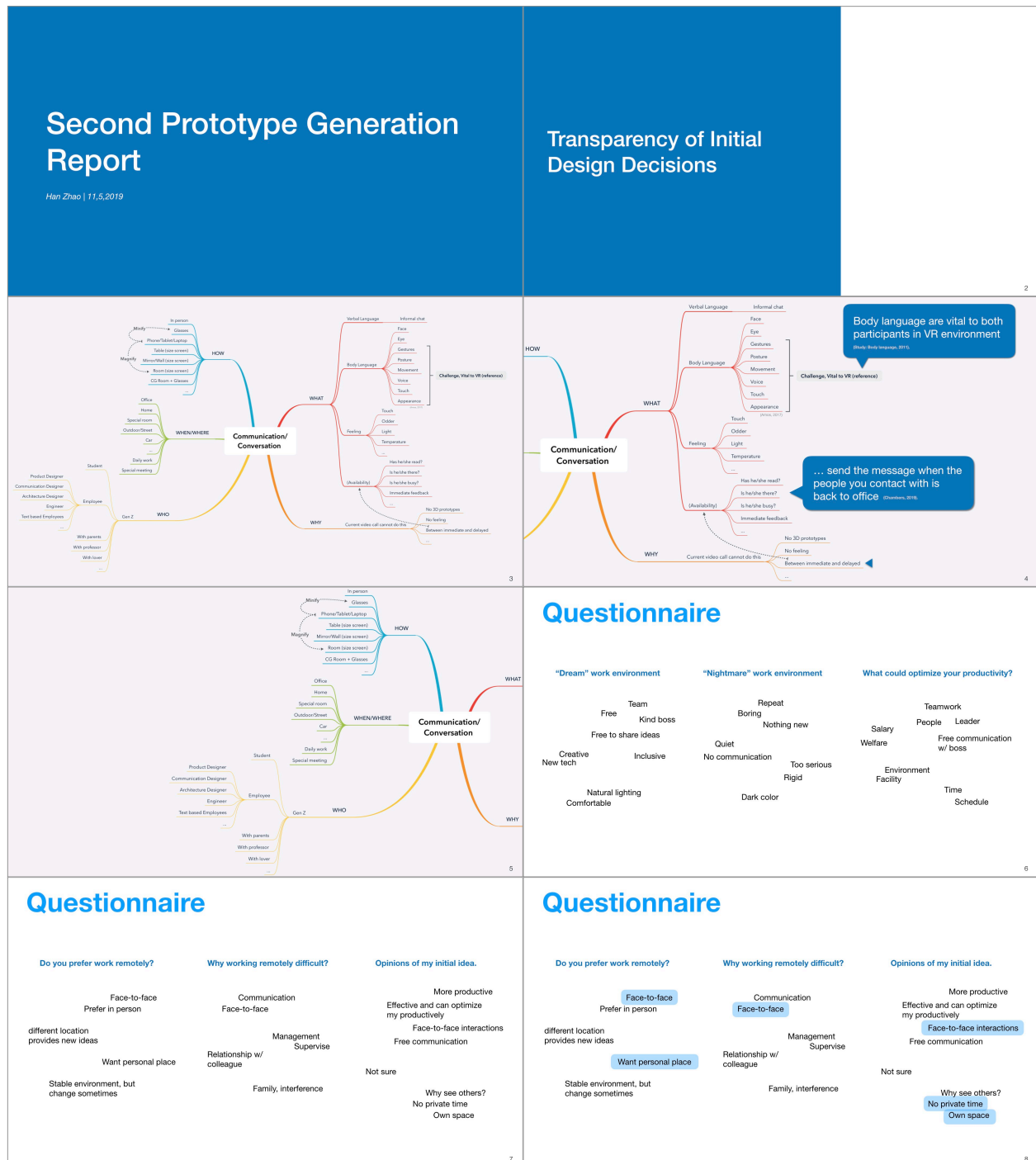
35

Thank you!

36

Appendix F: Second Prototype Generation Report

The Second Prototype Generation Report is also available at https://drive.google.com/file/d/1sP7tsnhRc1bzJFo37jQwl5Tz3NlpA_Ra/view?usp=sharing or scan the QR code.

Second Prototype Generation Report

Han Zhao | 11,5,2019

Transparency of Initial Design Decisions

Slide 3 (mind map): Communication/Conversation — HOW, WHAT, WHEN/WHERE, WHO, WHY

HOW: In person — Mindly — Glasses, Phone/Tablet/Laptop, Table (size screen), Magnify — Mirror/Wall (size screen), Room (size screen), CG Room + Glasses

WHAT: Verbal Language — Informal chat; Body Language — Face, Eye, Gestures, Posture, Movement, Voice, Touch, Appearance — Challenge, Vital to VR (reference); Feeling — Touch, Odder, Light, Temperature; (Availability) — Has he/she read?, Is he/she there?, Is he/she busy?, Immediate feedback

WHEN/WHERE: Office, Home, Special room, Outdoor/Street, Car, Daily work, Special meeting

WHO: Student; Product Designer, Communication Designer, Architecture Designer, Engineer, Text based Employees — Employee; Gen Z; With parents, With professor, With lover

WHY: No 3D prototypes, No feeling, Between immediate and delayed, Current video call cannot do this

Slide 4: Body language are vital to both participants in VR environment (Study: Body language, 2011).

... send the message when the people you contact with is back to office (Chambers, 2019).

Slide 6 — Questionnaire

"Dream" work environment: Team, Free, Kind boss, Free to share ideas, Creative, New tech, Inclusive, Natural lighting, Comfortable

"Nightmare" work environment: Repeat, Boring, Nothing new, Quiet, No communication, Too serious, Rigid, Dark color

What could optimize your productivity?: Teamwork, People, Leader, Salary, Welfare, Free communication w/ boss, Environment, Facility, Time, Schedule

Slide 7 — Questionnaire

Do you prefer work remotely?: Face-to-face, Prefer in person, different location provides new ideas, Want personal place, Stable environment, but change sometimes

Why working remotely difficult?: Communication, Face-to-face, Management, Supervise, Relationship w/ colleague, Family, interference

Opinions of my initial idea.: More productive, Effective and can optimize my productively, Face-to-face interactions, Free communication, Not sure, Why see others?, No private time, Own space

Slide 8 — Questionnaire

Do you prefer work remotely?: Face-to-face, Prefer in person, different location provides new ideas, Want personal place, Stable environment, but change sometimes

Why working remotely difficult?: Communication, Face-to-face, Management, Supervise, Relationship w/ colleague, Family, interference

Opinions of my initial idea.: More productive, Effective and can optimize my productively, Face-to-face interactions, Free communication, Not sure, Why see others?, No private time, Own space

Communication/Conversation

HOW
In person
Glasses
Minify
Phone/Tablet/Laptop
Magnify
Table (size screen)
Mirror/Wall (size screen)
Room (size screen)
CG Room + Glasses

WHAT

WHEN/WHERE
Office
Home
Special room
Outdoor/Street
Car
Daily work
Special meeting

WHO
Student
Product Designer
Communication Designer
Architecture Designer
Engineer
Text based Employees
Employee
Gen Z
With parents
With professor
With lover

WHY

9

Iterating Towards a Prototype Generation

10

Question for myself

Final Design
3D face scanning

Technology is ready
Apple's Face ID & FaceTime
Attention Correction (iOS 13
Beta 3)

Your screen
Camera
Camera

On other's screen

Machine learning

You are looking here

Combing the 4 images together

Dose 3D face and 3D body really matter?

- 2D FaceTime also works
- 3D is difficult, might need animated characters.
- Does it provide more information or less?

12

A. Office   B. Subway

body x
face animation x

Can't
see
(perspective) next face

body ✓
face ✓

A: Employee   B: Boss

11

Room A (my room):

Camera

I sit here

Room B (my friend's room):

He sits here

Camera

14

13

My reality:

His reality:

15

What I can see (through goggle):

His reality:

16

If he moves:

His reality:

17

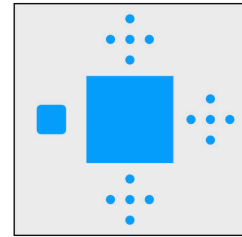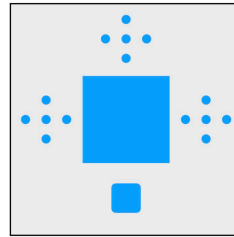**If I move:**
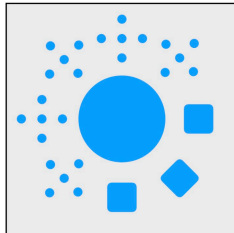
His reality:

18

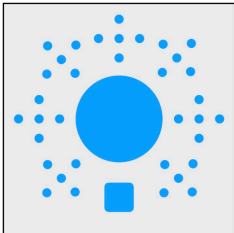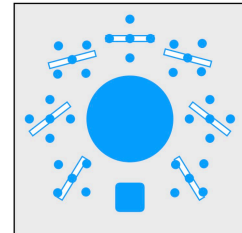**When I move, it is better:**
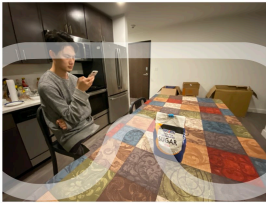
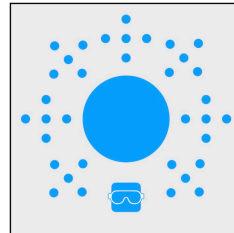**If I put multiple cameras in his room:**
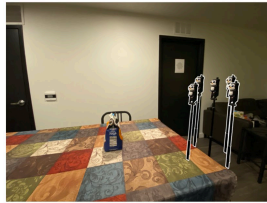
19

The Room

20

More people?

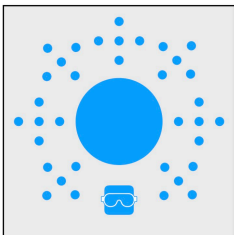21

Goggle or Screens?

22
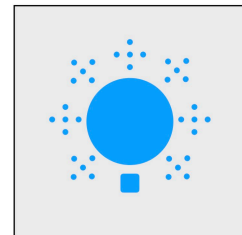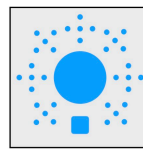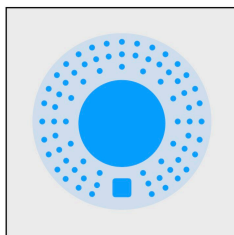
Goggle or Screens?

- Too complicated
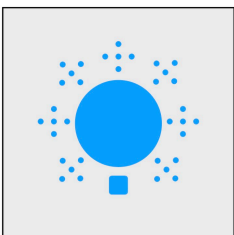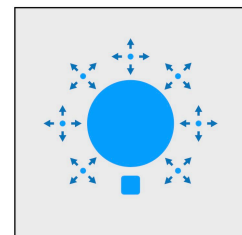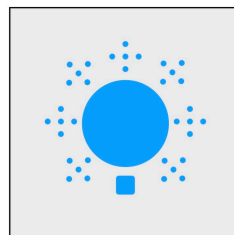- Cannot work if two or more people sit in one room
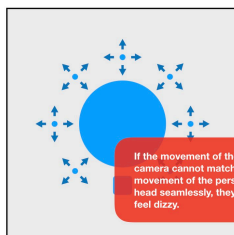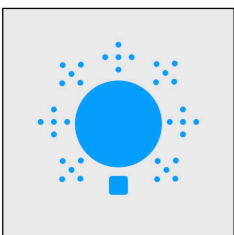

23

Scale?

24
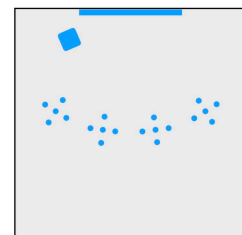
Even more cameras?

25

Moveable cameras?

26

Moveable cameras?

If the movement of the camera cannot match the movement of the person's head seamlessly, they will feel dizzy.

27

Different format of meeting?
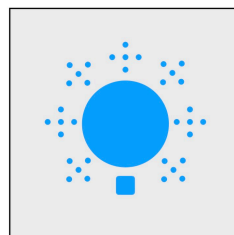
28

Final Design

+
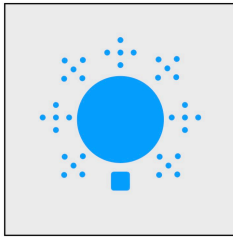
- Green room
- Third place, around the world
- Virtually-linked
- Real-time collaboration and production
- Archive
- ...

✅ No complicated 3D rendering needed (2D people in 3D room)
❓ Dose goggle and camera conflict?

29

Wait a minute!
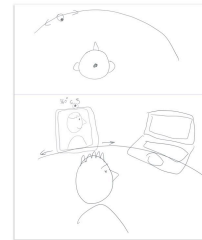
30
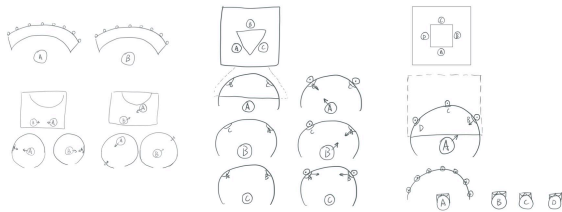
31

Virtual environment: **A's facilities:**   **On A's screen/goggle:**
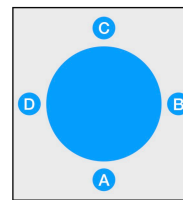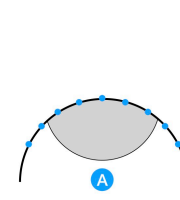
32

Final Design

- No goggle
- Screen + cameras
- Camera underneath the screen
- This set up is smaller — multiple set up for multiple people
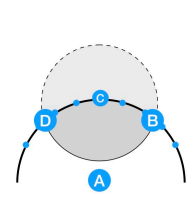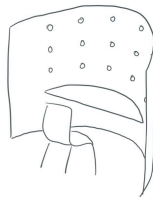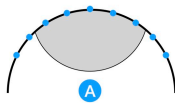
Using which camera to capture you depends on the audience's position

33

Describing the Final Design for the Generation Design

34

Final Design
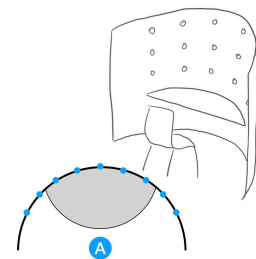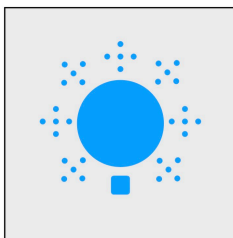
35

Translating Meaning

36

Value

- Communication
- Face-to-face
- Body language

- No complicated 3D rendering needed
- Easier, no high technology

37

Challenge

Test —> How to achieve it

38

Opportunity

- Face-to-face
- Body language

- Humanity
  - Closed space?
  - How to start the meeting?
  - How to contact a stranger?

39

Recommending Future Development

40

Test different attributes

41

42

Be Careful

"TNT"
Touch N' Talk
"Quiet! I'm using my TNT."
Humanity

感谢告知 我刚给他打了个电话

Figure 1. A person is using the "TNT". Retrieved from https://tv.sohu.com/v/dXMeMjU1ODE4NDEwLzEwMjkxMjQ0NC5zaHRtbA==.html

43

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44

Thank you!

45

Appendix G: Third Prototype Generation Report

The Third Prototype Generation Report is also available at https://drive.google.com/file/d/1Mn0Ol-EEvz7TWbNfRGucFvFlK-LMDOz0/view?usp=sharing or scan the QR code.

Third Prototype Generation Report

Han Zhao | 11,19,2019

Transparency of Initial Design Decisions

2

Review

Final Design
3D model (on 2D display)

Your reality:

On the screen:

You can see:

I'm a 2D display

Final Design

A

3

Ideas

WHAT PRODUCT DESIGNERS DO:
- Meeting — one to one / group
- Research — White board — post-it / Brainstorming / Storyboard
- Presentation
- Build prototypes — 3D Printing / physical / 3D rendering — Rhinoceros / Sketch up / CAD / DRAFTING
- Test
- Build final product

PRODUCT DEV. TESTING + USER EXP: TESTING

4
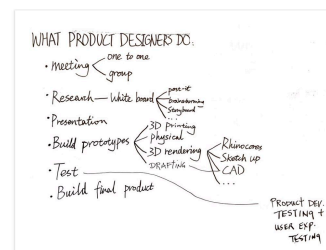
Interview with Expert

Meyer Giordano

Department of Transmedia
Instructor, Computer Art and Animation

5

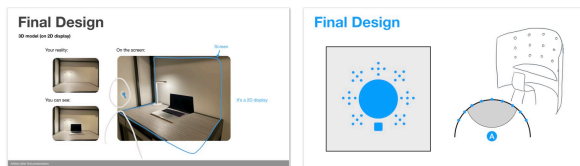|			VR	AR/MR (HoloLens)	Video Call
		Face (Expression)	Animation	Animation	Y
		Head Eye & Eye Contact	N	Animation	Y
		Mouth	Animation	Animation	Y
	Hand	Location	Animation	Animation	Y
		Five or Grab	Animation	Animation	Y
Body languages		Gestures	N	Animation	Y
		Movement	Animation	Animation	Y
		Postures	Animation	Animation	Y
		Voice	Y	Y	Y
		Appearance	N	Animation	Y
Prototype		Physical	Scanned	Y & Scanned	Y & Scanned Share Screen
		Digital	Y	Y	Y
		Sketch	Y	Y	Y
		Touch	N	N	N
Feeling		Odder	N	N	N
		Light	Y	Y	Y
		Temperature	N	N	N
		Immersive	Y	Y	N
					Yes / No / Kind of

6

Microsoft HoloLens 2

Released in February 2019

Jellyfish

7

Questions for Myself

- Is this really the best way for designers to communicate?
- More information or less?
- Does it encourage more communications or not? (Questionnaire)
- Sacrifices?

8

No Goggles!

9

Idea

- How to encourage **more communication**?
- …so that it can help to build **relationships** and **trust** between team members.
- How to find a way **between** immediate phone calls and delayed text messages?
- How to make something that has an **immersive** experience?

10

Iterating Towards a Prototype Generation

11

Idea

12

Idea

- Always on (live stream, in office)
- White board, digital prototypes, etc.
- Real image of people
- Life size
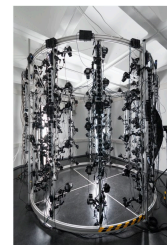- Screen (wall) in different places
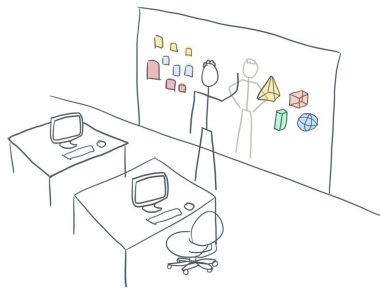
13

Cameras

- Cut out
- Under-display cameras

14

Door

- See others without disrupting them
- Clear glass, frosted glass, no glass, no door
- Knock the door
- Slip something under the door
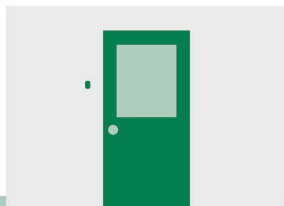
15

Scale

16

Multiple People

17

Design of the Door

Sliding door?
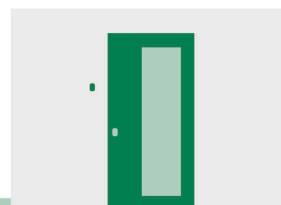
18

Whiteboard
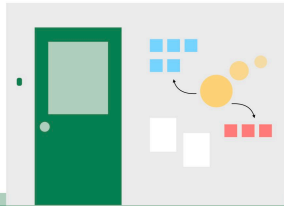
19

Whiteboard

When presenting to others
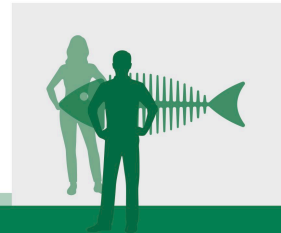
20

Test

21

Describing the Final Design
for the Generation Design

22

Final Design

- Big screen
- No goggle
- Immersive
- Live streaming
- Door
- Whiteboard
- Around the world/building/city
- Only available to your team members/
colleagues
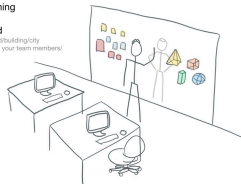
23

Translating Meaning

24

Value

- Immersive
- No goggle
- Encourage more communication, small informal talks
- Other's availability, humanity

25

Challenge

- Cameras
- White board
- Energy consumption (LTPO OLED)

26

Opportunity

- Between immediate and delayed —— Gap

Informal communication such as
eye contact and body language is
crucial for remote teams.

(Pmeuto, 2019).

27

Recommending Future
Development

28

Cameras

- Test
- Ask Meyer
- Pix4Dcapture, drone, 3D mapping

29

Design of Door

- Test
- Humanity

30

Interface

31

Reference

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http://info.imajion.com/blog/how-does-imajion-make-remote-work-workÂ

32

Thank you!

33

Appendix H: Comparison Between Current Communication Tools

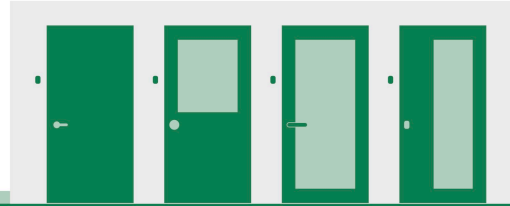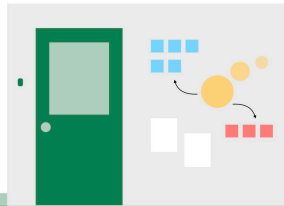| Communication Tool | Audience | | | | Degree of Reciept | | | Presentation | | | | | | | | | |
	1 to 1 chat	Group chat	Internal people	External people	Immidiate	In the middle	Delayed	Text	Stickers	Picture	Audio Recording	Video Recording	File	Audio call	Video call	Screen Sharing	VR/AR
Email	v	v	v	v			v	v		v	v	v	v				
Text message	v	v	v	v		v	v	v		v							
Cell phone	v		v	v	v										v		
iMessage&Facetime	v	v	v	v	v	v		v	v	v	v	v	v	v	v	+Google Drive	
WeChat	v	v	v	In group	v	v		v	v	v	v	v	v	v	v	+Google Drive	
DingTalk (钉钉)	v	v	v	v	v	v		v	v	?	?	?	v	v	?	?	
Facebook			v	v													?
What'sApp	v	v	v	v	v	v		v	v	v	v	v	v	v	v		
Messenger	v	v	v	v	v	v		v	v	v	v	v		v	v		
Group me	v	v	v	v		v		v	v	v		v	v				
Slack	v	v	v	v		v											
Zoom	v	v	v		v			v			v	v		v	v	v	
Spike	v	v	v	?		v		v	v	v		v		v	v	v	
Instagram				v			v	v	v	v		v					
Twitter				v			v	v	v	v	v	v					
Snapchat			v	v				v	v	v	v	v					?
Linkedin	v		v	v			v	v		v	v		v				
Skype	v	v	v	v	v	v	v	v	v	v			v	v	v	v	
Google hangout	v	v	v	v	v	v	v	v	v	v			v	v	v		

| Communication Tool | Other | | | | | |
	Mobile	Desktop	Archive	Do Not Disturb	Others' Avalability	Other
Email	v	v	v	v		Classification
Text message	v					
Cell phone	v					/
iMessage&Facetime	v	v			some	Payment, Location, Encryption, Animoji, FIlters, Apple devices only
WeChat	v	v				Payment, Game, Location
DingTalk (钉钉)	v	v	?	?	v	Attendance, Calendar, Encryption, Real Name, Classification, Cloud, Enterprise Contact
Facebook	v	v				
What'sApp	v	v			v	Location
Messenger	v			v	v	Payment, Game, Location
Group me	v		v			
Slack	v	v		v		
Zoom	v	v				Virtual background, filter
Spike	v	v				Conversational email, all in one, Encryption, Calendar, FIle management
Instagram	v					
Twitter	v					
Snapchat	v					
Linkedin	v	v				
Skype	v	v				Payment, Location
Google hangout	v	v				

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Vita

Personal Biography

Originally from Beijing, China, Han Zhao's studies in fine art, engineering, and design lend a unique perspective to his design work. Zhao's early interest in industrial design let him to a Bachelor's degree in Water Science and Engineering from Taiyuan University of Technology.

In his studies in the M.F.A. Design program at Syracuse University, Zhao combined his knowledge of engineering with studies in collaborative, product, and communication design. He has an interest and expertise in prototyping, testing, and modeling with professional software such as Photoshop, Illustrator, Rhinoceros, Final Cut Pro, and programming languages such as HTML, CSS, and JavaScript.

Central to Zhao's design practice is his belief that a good designer puts the user at the center of everything he creates. He believes that with well-designed and managed mass production, an innovative product can become beneficial to thousands of people.

Please visit Han Zhao's personal website at https://hanzhao.design or scan the QR code.

Resume

Please download this resume at https://hanzhao.design/about/
Han_Zhao_Resume.pdf or scan the QR code.

HAN ZHAO
赵瀚

UX/UI/Product Designer

Male, 25, Chinese, Beijing
+86-156.1155.7199 (China)
hanzhao.design@outlook.com
https://hanzhao.design

EDUCATION

7/2018-5/2020	**Master of Fine Arts, Design.** Syracuse University, College of Visual and Performing Arts, School of Design *GPA=3.83*
7/2017-5/2018	**Academic English.** Syracuse University, English Language Institute
9/2013-7/2017	**Bachelor's Degree of Engineering, Water Science and Engineering.** Taiyuan University of Technology, College of Environmental Science and Engineering

HONORS/AWARDS

9/2019-5/2020	**GR-Design Award.** Syracuse University, College of Visual and Performing Arts, School of Design
7/2018-5/2020	**Tuition Scholarship.** Syracuse University, College of Visual and Performing Arts, School of Design

WORK EXPERIENCE

10/2019-5/2020	**Advertising Graphics Assistant.** Teaching Photoshop, Adobe XD, and other design software to the students in the Advertising program at S.I. Newhouse School of Public Communications at Syracuse University. Giving them opinions and advice about their designs.

DESIGN EXPERIENCE

8/2019-5/2020	***Portal*, Product Design.** Portal is a teleworking device designed for team collaboration. Including hardware and software. Responsible for all work in research, design, modeling, testing and other stages. (https://hanzhao.design/portal)
8/2019-10/2019	***ResearchGuides*, Design Project (Group Project).** Lead the group to design and hold a promotion event of ResearchGuides at Syracuse University Bird Library to support students when they are searching in an unfamiliar subject.
7/2019-PRESENT	**https://hanzhao.design, Personal Website.** Design, code, and deploy the entire website from sketch.
1/2019-5/2019	***Flowerbility*, Solo Exhibition.** Exhibit one same flower in 36 different styles and formats at Apostrophe's Art Gallery, Syracuse, NY. (https://hanzhao.design/flowerbility)
1/2019-5/2019	***The History of Hendricks Chapel*, Design Project.** Design and hold a light show event in front of Hendricks Chapel at Syracuse University to support students' spiritual and emotional wellbeing. (https://hanzhao.design/hendrickschapel)
1/2019-5/2019	***May*, Game.** Create a game to express my dissatisfaction with Syracuse policemen. (https://hanzhao.design/may)
1/2019-5/2019	***Tiny Home*, Sustainable Design (Group Project).** Design tiny houses for A Tiny Home for Good, Inc. to support people who facing homelessness. Using Life Cycle Analyses to make recommendations for better, more sustainable products.
11/2018-12/2018	***Community+*, Communication Design.** Communication Design for Food Pantry of Central New York. (https://hanzhao.design/communitypluscmd)
9/2018-12/2018	***Community+*, Design Project (Group Project).** Provide an efficient way for the managers of the Food Pantry of Central New York to know the guests' needs and recruiting more volunteers in order to create a community. (https://hanzhao.design/communityplus)
9/2018-11/2018	***You Said*, Video.** Create a video to encourage people to stop finding excuses and make an effort immediately. (https://hanzhao.design/yousaid)

SKILLS

Design Skills: Collaborative Design, Product Design, Service Design, Communication Design, UX Design, Design Research, Concept Development, Design Management, Project Management, English Speaking and Writing

Digital Skills: Photoshop, Illustrator, Adobe XD, Sketch, Figma, Rhinoceros, KeyShot, Final Cut Pro, HTML, CSS, JavaScript