Exploration of Communication
Methods for Family Connection
Mechanical Engineering 310 Fall Design Document

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1 Executive Summary

Today, there is a significant and growing divide between members of a family, especially between generations, and we attribute it to three main reasons. The first is **physical separation** - Quick and easy transport and communication technology today has allowed convenient travel, and work and study have pulled family members to different locations. Today, families live further apart than they have at any point in human history. Another issue is the **lack of time for communication** - Technology and modern life have brought with them distractions and longer working hours. We spend less time talking to people and more time working, or watching television or reading or playing computer games. Not only has the amount of time spent at home decreased, but also the proportion of that time spent on communication and family recreation rather than on housework. The third reason is the **generation gap** - the differences between generations in interests whether they like gardening or cooking or watching sports or the news on TV, or playing Call of Duty and also the differences in the platforms they use for communication and for keeping in touch with the world around them. All this has left a wide disconnect between generations that needs to be urgently addressed. Microsoft Research Asia has tasked our ME310 team of three students from Stanford University and four from USTC, China with tackling this problem.

We started our project by defining our target users. At one end of the spectrum is the younger generation, the digital natives. They grew up with the internet and are frequent, and perhaps obsessive, users of social networking services and instant messaging. They are very comfortable with computers and smartphones. The middle aged people, the digital immigrants, use computers more for work, than for fun. Communication on the computer is mostly by email. They do not use social networking services, and networking is done more over the phone or in person rather than over the internet. At the other end of the spectrum are the elderly users, who keep to older technology like the television, radio, and the phone. Communication mostly involves the phone or even snail mail. They are almost completely insulated from the digital world. This is an important target segment as they are a growing proportion of the population, especially in the developed world and in China.

Team Microsoft aims to reconnect families by building a device that allows generations of a family to maintain communication despite being physically separated. The product will encourage families to stay in touch by improving accessibility to technology and by efficient utilization of the users time. To understand the problem space, we talked to people about their families, paying special attention to the most technologically challenged segment, the elderly. We referred to experts in the field, and talked to elders at a senior center to learn about their problems. We also benchmarked existing technology, and searched for new technology that could be applied to our problem. We then brainstormed on possible areas we could produce an impact in, and narrowed the list down, before settling on critical functions and experiences we wanted to test.

Our **Touch Cube** prototype tests the importance of communicating the sensation of touch via temperature and vibration in maintaining a feeling of intimacy while connect-
ing remotely. We found that responsiveness - quick transfer of touch and temperature information - was important to the overall experience, as was the shape of the device, and the material used. Other input and output options, like squeezing the cube and deflating/inflating the cube, were also suggested. Many users thought it would work better with audio or video chat, and that it was best suited for use by a romantic couple.

The Social Networking Aggregator creates a printed version of selected news from your feeds in social networking services for the older members of your family. It aims to connect the older generation who are completely insulated from the world of social networking to the data from their younger relatives feeds. It tests the utility, to your parents and grandparents, of the kind of information posted in services such as Facebook and Renren, and the issues people might have with their data being shown to their family. The feedback we received included an appreciation of having information passed along that
could spark a conversation later, but also worries about the lack of personal interaction. That most of the posts on social networks are not of interest to older people was an issue, and most users preferred the data to be presented on a screen.

![Peripheral Vision Goggle](image)

Figure 1.3: *Peripheral Vision Goggle*

The **Peripheral Vision Goggle** aims to use peripheral vision to maintain a visual connection in remote communication, while at the same time allowing the user to be engaged in another activity that requires his central field of vision. Most users felt that the goggle quite realistically simulated the presence of a person next to them, and many instinctually tried to turn to see the person. The goggles did not significantly affect their performance in tasks. However, the inconvenience of having to wear the device, and the inability to see the person face to face was also expressed.

The **3D table** is a platform with blocks that can be raised and lowered to create a 3d object that remote participants can interact with. It tests whether it is possible to realistically interact remotely with a physical model.

We plan to explore further areas in intergenerational communication, and also build on the ideas we have tested. Based on the feedback we received about our prototypes, we have a list of improvements that could be implemented for each of our ideas. We also plan to explore another area of our prompt - collecting and orienting digital media along the lifespan of a person, and passing it on to the next generation.
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Glossary

**Physical User**  also Physical - A Person who does not use modern technology - May be too old, too young, too poor, uneducated or illiterate, or disabled

**Digital Users**  Person in a developed region who is comfortable using modern technology.

**Digital Natives**  Young people who grew up exposed to digital devices and the internet, and are very comfortable with using them.

**Digital Immigrants**  A middle aged person who grew up without exposure to the internet and digital devices. He uses computers and smartphones more for work than for fun.

**Physical User**  An elderly person who does not use modern technology and modern interfaces.

**Physical Interface**  Interface where the interaction involves more than just audio, video and touching a screen.

**Benchmarking**  A process of researching and observing to understand the state of the art for a given field or topic.

**Brainstorming**  A process by which groups of people generate ideas

**Physical World**  Tools and media which are mainly based on physical interaction and came before computers and the Internet.

**Physidigital Interaction**  CA digital device that can be physically interacted with.

**Generation Gap**  Differences between people of younger generations and their elders, in terms of interests and in terms of the platforms used for communication.

**Arduino**  Arduino is an open-source single-board microcontroller, descendant of the open-source Wiring platform, designed to make the process of using electronics in multi-disciplinary projects more accessible.

**Peripheral Vision**  The part of vision that occurs outside the central field of view. There is a broad set of non-central points in the field of view that is included in the notion of peripheral vision.

**Communicator**  Person using a communication device

**Communicant**  The person who the communicator being talked about is using the device to communicate with

**Haptics**  Technology that tries to use the feeling of touch to communicate with the user
2 Context

2.1 Need Statement

Technology has dramatically changed peoples life. With the aid of computers and the Internet, people can work, relax, and communicate with other people at anywhere and anytime. More and more people choose this digital lifestyle thanks to its convenience and high efficiency. At the meantime, there are some people still sticking to physical world. Among this group, some are elderly who are not used to digital device. They prefer reading newspaper, writing letter to watching video on the Internet and sending emails. Some are children in less developed regions who have limited access to the high end technology. Some people may refuse to learn new technology since they are too busy to change their lifestyle.

Technology has separated people into two groups, the one in the digital world and the one in the physical world. The communication between these two groups of people has become an urgent issue to be addressed.

2.2 Problem Statement

The new generations growing up now are exposed to a world full of mobile devices always connected to the Internet. It is common use to share all you are doing on social media sites, sometimes knowing better your virtual world friends than the people you see in real life every day.

Imagine if social media as we know it had existed when you were growing up. How would that have shaped your thinking? Actually our next generation will definitely face this situation.

The two generations could be divided into the digital natives and the digital immigrants. The digital immigrants are all people above 25 for whom Internet showed up when they were at college or having jobs. They participated on many milestones of the technological change that has occurred in the last 25 years. However the digital natives grew up with these technologies just like they have digital lens to see through the world. Moreover, these two generations physically live in the same world but separate digitally to some extent.

With the separation of people in the physical world and digital world, the weak connection between family members has become a serious problem. This can be caused by several reasons:

- **Physical Distance**: Some family members are separated physically because they do not work in the same place, they do not live in the same city or their children are studying in different cities. This greatly weaken the communication between them, especially for people who are not used to using digital device. Being separated by distance can create major obstacles to building strong, resilient families because of
the limitations on the time the family spends together. Family members must understand and accept the reason behind the time shortage. Research has shown that building nourishing relationships can be more difficult to accomplish when families live apart. Intimate relationships between husband and wife can be challenged, and couples need to have strong individual identities, accept their partner’s absence, and devote time to building intimacy upon reunion (Zvonkovic 2000). Despite the geographic spread, families are making efforts to stay connected. A recent Gallup poll indicated that most people enjoy being with extended family members and desire to spend more time with them. [15]

• **Lack of Time**: people who are attending a school or doing a job may have the problem of lacking time. Although they may be quite familiar with digital device, they can not find a separate time to talk to their relatives. The business environment has been globalized with technology emerging into joint enterprise ventures, expanded international markets, and increased competition (Davis and Botkin 1994). In an effort to stay competitive, full-time work weeks in the United States are getting longer. U.S. workers now have the distinction of working longer hours than any other workers in any other industrialized nation (International Labour Organization September 1999). [15]

• **Generation Gap**: family members in different generations may find it hard to find a common topic and common interest. Every generation develops new slang, but with the development of technology, understanding gaps have widened between the older and younger generations. [17] The number of Americans that are 65 or older will rise from 36.8 million in 2005 to about 71.5 million in 2030, according to the Administration on Aging. Similarly, the number of old age dependants will grow to almost 5 times the value today. However, the following research from the Pew Research Centers Internet & American Life Project indicate that the elderly are still a minor group in terms of Internet using.

Various ways to enhance communication have been exploited in terms of video and audio. We are looking for innovative ways for intimate communication between family members.

The goal of this project is to design and build a prototype to bridge the generations’ gap. Some example domains may include but not restricted to:

• How could we create an emotionally engaging, albeit lightweight connection between generations, engendering a sense of connection and familiarity?
• What kinds of tools will help young generation to more creatively engage with materials from their past culture/collective memories or from previous generation?
• How can we design our own lifespan-oriented digital media from the beginning to the end?
• How we might manage the digital artifacts and content were creating now -and how we might pass on or inherit these kinds of items to next generation in the future?
2.3 Corporate Partner: Microsoft Research Asia

Microsoft Research Connections supports those who dream the impossible—inventing a better world one idea at a time.

Microsoft Research collaborates with the world’s top academic and scientific researchers, institutions, and computer scientists to shape the future of computing in fields such as parallel programming, software engineering, natural user interfaces, and data-intensive scientific research.

Microsoft Research develops technologies to help solve some of the most urgent global challenges. Microsoft Research’s fellowships and grants help foster the next generation of world-class scientists who are critical to the future of scientific discovery.

Microsoft Research Asia is founded in Beijing as Microsoft’s fundamental research facility in the Asia Pacific region and expands rapidly. By attracting the best talent from Asia and across the globe, Microsoft Research Asia has grown into a world-class research laboratory with more than 230 researchers and developers and more than 250 visiting scientists and students. Today, the lab conducts basic research in natural user interfaces, next-generation multimedia, data-intensive computing, search and online advertising, and computer science fundamentals.
2.4 The Design Team

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Skills: 3D modeling in Autodesk Inventor and Pro-Engineer; MATLAB; Web design.
Computing: Programming in C, C++, and Java

I'm from Trivandrum, a city in southern India, and I'm here fresh after completing my Bachelor's in Mechanical Engineering from the Indian Institute of Technology (IIT) in Madras. I'm interested in robotics, mechatronics, and design in general. I also enjoy traveling and travel photography, trying out different kinds of food, and thinking about the future of the human race.

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I was born in China, living in the southern part near sea. Graduated from Zhejiang University in major of mechatronics and in minor of ACEE. I am extremely interested in robotics and devoted half of my undergraduate years on related study, projects and research. I love music, playing instruments include piano, guitar and drum. Also like sport such as basketball and pingpong. Sometimes, I seems to be outgoing but sometimes I just feel that I am not that kind of person.

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Skills: design, mechatronics, welding, prototyping
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Born in China, I have always yearned to explore more about the world beyond this mass land. My undergraduate study in the Hong Kong Polytechnic University has provided me with solid theoretical knowledge, practical skills and an international outlook. It has also greatly inspired on making something real that we can see and touch.

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I was born in China and major in Theoretical and Applied Mechanics. I enjoy the process of making my idea come into reality, so attending the ME310 class and the whole designing process is a precious opportunity for me. I also have great interests in music and swimming.

Yikang Liu  
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I was born in Hubei, a province located in middle of China. Although my major is electrical engineering, I am gifted with interests in nearly everything in the world. I desire to understand why the world functions as the way it does and feel satisfied no matter what field I step into and explore. Among the fields I have stepped into except my major, I love music and mechanics most. I am fascinated by playing keyboard, singing and making artificial gadget in leisure time.
June Zhang
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Getting to know radio direction finding in middle school made me get to be interested in electrical engineering. I love my major and enjoy learning more related to it. Fond of radio direction finding, going fishing, cooking and trying delicacy. Love Stitch and Snoopy.

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Computing: Solid Works, Matlab, basic C programming, Forth

I was born in China and major in Theoretical and Applied Mechanics. I enjoy the process of making my idea come into reality, so attending the ME310 class and the whole designing process is a precious opportunity for me. I also have great interests in music and swimming.

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3 Design Requirements

Introduction

With the understanding of the requirements given by Microsoft Research: to develop a physical prototype which can enhance communication between members of different generations, we also discover other aspects and develop our specific requirements for our prototype, such as suitable for users in multiple generations, affordability, efficient use of time, flexible connectivity options. The following table lists the requirements that should be followed in our design.

3.1 Functional Requirements

3.1.1 Touch Cube

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Metrics</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Delay (responsive)</td>
<td>Less than 50ms</td>
<td>Signal transferred between two boxes are subjected to some delay. Meanwhile, the processing within the control loop also causes delay. Both of them make the Box less responsive. This delay of the Touch Box should be controlled within 50ms for people to feel seamless. This is a crucial factor in the design because a fast responded box can make people feel they are interacting with some real people while a less responsive box trend to make people annoying.</td>
</tr>
<tr>
<td>Wireless Connected</td>
<td>Wi-Fi connection</td>
<td>The touch boxes of the two ends should be wirelessly connected. Family members using it are normally in different location. They can use the Touch Box wherever the Internet is accessible. This will greatly enhance the feeling of intimacy if they can reach family members whenever they want.</td>
</tr>
</tbody>
</table>

Table 3.1: Requirement for improved Touch Cube
### 3.1. Functional Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Metrics</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamic Monitoring the Temperature</td>
<td>Temperature difference should be smaller than 0.1°C</td>
<td>The Touch Box has a function of transferring peoples body temperature. This should be accurate enough for people to trust the device and know the real feeling of the people on the other end. By dynamic monitoring the temperature on both ends using feedback loop, we can ensure that the temperatures are the same at all times.</td>
</tr>
<tr>
<td>Easy to Set Up and Operate</td>
<td>Set up by less than 3 steps</td>
<td>Since this device is mainly designed for people who are separated from the digital world, it should be designed as simple as possible. The interface should be concise enough for non-digital users.</td>
</tr>
<tr>
<td>Quick Heat Up and Cool Down</td>
<td>Heat up and cool down within 1 second</td>
<td>When people touch others hands, they can immediately feel the temperature of the others. We want our device to do the same thing. This can make people feel they are like touching a real person rather a device which only duplicates the temperature.</td>
</tr>
<tr>
<td>Portable</td>
<td>Weight should be smaller than 50g; Size should be smaller than $100 \text{cm}^3$</td>
<td>This touch Box should be able to be carried with people. In this way, people can have instant access to their family members and greatly enhance the intimacy.</td>
</tr>
<tr>
<td>Voice Message</td>
<td>More 1,000,000 voice message store in the boxes</td>
<td>In case the family member is not using it at the time being, people can leave message to them so that they can listen to it afterwards. This will make the function more robust since it provides a way that people may feel easier to communicate when they do not know whether there are some people in the other end.</td>
</tr>
<tr>
<td>Reliability</td>
<td>90% of the product should have a lifetime of more than 10 years</td>
<td>Since this design is facing to the people in the digital world, it should be reliable enough and continuously be operated for a long time. It may make the users uneasy if it breaks when people are using it, especially for people who are not familiar with digital device.</td>
</tr>
</tbody>
</table>

Table 3.2: *Requirement for improved Touch Cube*
### 3.1.2 SNS Aggregator

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Metrics</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy to Set Up and Operate</td>
<td>Set up by less than 3 steps</td>
<td>Since this device is mainly designed for people who are separated from the digital world, it should be designed as simple as possible. The interface should be concise enough for non-digital users.</td>
</tr>
<tr>
<td>Information Filter</td>
<td>Manually filter information</td>
<td>Users can choose the information to present to their family members as easy as tick on some websites, for example Facebook, Twitter.</td>
</tr>
<tr>
<td>Protection of Privacy</td>
<td>User set preference setting</td>
<td>User can choose what information to send to their family members. This can protect their privacy and make them more willing to expose to their families.</td>
</tr>
<tr>
<td>Nice Composition</td>
<td>15 font size; high contrast color; concise style</td>
<td>Since the target readers are the elderly. They need the content be clear enough for them to see clearly. The font size should be large enough; Colors should have high contrast.</td>
</tr>
<tr>
<td>Update regularly</td>
<td>Update twice a week</td>
<td>The content should be updated twice a week for the family members to know their children regularly. This can also enhance the intimacy between family members.</td>
</tr>
<tr>
<td>Multiplatform</td>
<td>Support Facebook and Twitter, Renren and other SNS platforms; possibly also get information from photo stream of iPhone, GPS app and etc.</td>
<td>Different people use different social networking software. Some app and device other than SNS website could also provide some details about people’s daily life. Our design should integrate as many platform as possible to gather enough information and attract more users.</td>
</tr>
<tr>
<td>Glossary</td>
<td>A table a glossary at the end of the newspaper</td>
<td>There many words that are mainly used among young people. The elderly may find it hard to understand it. A table a glossary will be appended to the end of the newspaper so that old people can know the meaning of these words.</td>
</tr>
</tbody>
</table>

Table 3.3: Requirement for improved SNS Aggregator
### 3.1.3 Peripheral Vision

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Metrics</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct Position</td>
<td>20 deg between face and the screen; at the same height of eyes</td>
<td>For people to see the screen clearly and comfortably.</td>
</tr>
<tr>
<td>Crop the Image to Suitable Size</td>
<td>Crop the image to 10 times larger than humans head in terms of area</td>
<td>To make people feel comfortable watching the video. According to users feedback, if the peoples head is too large, it may cause uneasy feeling for the users.</td>
</tr>
<tr>
<td>Camera Easy to Setup</td>
<td>Set up by less than 3 steps</td>
<td>Since this device is mainly designed for people who are separated from the digital world, it should be designed as simple as possible. The interface should be concise enough for non-digital users.</td>
</tr>
<tr>
<td>Sharp Contrast</td>
<td>High contrast video and can past the movement test</td>
<td>According to the literature and users feedback, Peripheral Vision is more sensitive to picture with high contrast.</td>
</tr>
<tr>
<td>Not Harmful to Human Eyes</td>
<td>Not harmful to the eyes for at least 5 hours constant usage</td>
<td>Since it is very close to the eyes, it should be designed to be safe for eyes in terms of radiation and brightness. At the same time, users may use this goggle for long time video chatting; it should be safe even after long time of usage.</td>
</tr>
<tr>
<td>Audio Chatting background voice (setting)</td>
<td>Users can set the background volume according to their preference</td>
<td>Some people feel better to be in a quiet environment while others may find it more comfortable to have the same background sound with the people who he is talking to.</td>
</tr>
<tr>
<td>Adjustable Resolution</td>
<td>320<em>480, 480</em>600, 600*800</td>
<td>Since Peripheral Vision is not sensitive to the resolution of the image, the quality of video may not crucially affect the users experience. Users can adjust the resolution to save the bandwidth for better audio chatting.</td>
</tr>
</tbody>
</table>

Table 3.4: Requirement for improved Peripheral Vision device
3.2 Physical Requirements

3.2.1 Touch Cube

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Metrics</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand Size</td>
<td>Volume $\leq cm^3$</td>
<td>Easily hold by hand and easy for people to carry.</td>
</tr>
<tr>
<td>Soft Surface</td>
<td>Using material such as foam</td>
<td>To mimic the feeling of humans hands and to give a warm feeling.</td>
</tr>
<tr>
<td>Warm Color</td>
<td>Color close to red, orange, and yellow</td>
<td>The colors of red, orange, and yellow are considered warm colors because they are the colors of fire. This can give people a warm feeling and enhance the intimacy.</td>
</tr>
</tbody>
</table>

Table 3.5: Physical requirement for improved Touch Cube

3.2.2 SNS Aggregator

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Metrics</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Font</td>
<td>Font size should be larger than 15</td>
<td>Since the target readers are the elderly. They need the content be clear enough for them to see clearly.</td>
</tr>
<tr>
<td>Environmental-friendly</td>
<td>Recyclable</td>
<td>Since this SNS Aggregator will consume large amount of paper.</td>
</tr>
</tbody>
</table>

Table 3.6: Physical requirement for improved SNS Aggregator

3.2.3 Peripheral Vision

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Metrics</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Weight</td>
<td>Weight should be smaller than 50g</td>
<td>Since people have to wear it for extensive long time. People may find it more comfortable to wear a light glass.</td>
</tr>
<tr>
<td>Appearance</td>
<td>In the appearance section of the questionnaires, the overall rating should be higher than 80%</td>
<td>The glasses should be well designed in terms of appearance, which may affect peoples willingness to wear it.</td>
</tr>
</tbody>
</table>

Table 3.7: Physical requirement for improved Peripheral Vision device
3.3 Venture Requirements

The product we develop should fit in with Microsofts strategy and present infrastructure. Also, the product should make business sense. There should be a market for the product, a target group of customer who are willing and able to pay for it.

- **Affordability** - Since our target user group is family members especially the elderly, the product should have a reasonable price. This will enable more people to use it.

- **Accessibility** - Aiming at enhance the connection between family members, we want our product to be accessed as wide as possible. It should be compatible to most wireless system, such as Wi-Fi, 3G.

- **Simplicity** - The goal of product is to enhance the communication and shorten peoples distance. It should bring simplicity to peoples life rather than creating more trouble. It should be simple enough for non-digital users and let them feel the physical connection between them and their family members.

- **Promotion** - Promotion should be made in a reasonable way so that most people can understand its function and decide whether to buy it according to their need.
4 Design Development

Our task is to 'design and prototype an interactive artifact, to connect people living in the digital media realm and people who rely on traditional physical forms of media'.

Our plan is to first figure out what problems and needs exist. We need to list out what we use digital technology for, what 'physical people' use instead of digital technology to perform the same tasks, and why they prefer to use those methods. We need to learn more about the target user for our device, the technology we can use to build the device, and about Microsoft and its infrastructure and plans. We then need to come up with useful ideas, decide on an area to focus on, and design prototypes to test a critical function/experience.

4.1 Brainstorming

4.1.1 User Personas

We started with thinking about who the digital and physical users were - we created user personas, the 'typical' users we are developing the product for. We hope that by having a clear idea of a specific person, we will be able to understand the needs of the user better.

The digital native - A young person in a developed region, he is comfortable using modern technology. He grew up with the internet, and has been using it since childhood for reference, communication and for fun. He has a smartphone and a laptop computer, and is planning to buy a tablet soon. He is a frequent, and perhaps obsessive, user of social networking services, and sends and receives tens of emails daily. He primarily communicates with his friends by chat, either from his computer or from his smartphone. He also spends time on the phone with his girlfriend, and also uses text messaging a lot. He shares his life via status messages and photo uploads on Facebook, and reads the news on his smartphone on his commute to work.
4.1. Brainstorming

The digital immigrant - A middle aged person, father of the digital native, he uses computers and smartphones, but is not very comfortable with them. He uses the computer for work, and sends email. He has an account he once created on a social networking service, but he does not use it all, as he finds it uninteresting and none of his friends use it. He uses a smartphone since all his colleagues use one, but he hardly uses it for anything other than the basic phone call functions and to check his email. He calls his son a few times a week and discusses the sorry state of the team they are supporting. He also talks to his mother once a week on the phone, and tells her about his family and enquires after her health.

The physical user - An elderly person who does not use modern technology and modern
interfaces. She communicates with her family and with her friends using the telephone. She sometimes sends letters or postcards to her grandchildren on their birthdays. She is fine with using a TV set or a radio, as long as the controls are not too complicated. However, she cannot for the life of her figure out how to change the settings on her TV or navigate the menus. She reads her newspaper regularly, and also the occasional magazine. She thinks the things her grandson can do with technology is magical - but finds it too confusing for her own use. She calls her grandson every few weeks and asks him about his health, his education and whether he is getting good food to eat. She has heard of Facebook from some news item, but does not know what it is. She stays with her husband in the house they've lived in for the past 45 years.

4.1.2 Extreme User

We also looked for an extreme user for our device - the limits of the user-space we are designing the device for. If our device can work for the users at the extremes, it can work for all users.

![Extreme User](http://www.jeffpearlman.com/2008/07/page/6/)

The extreme user is an elderly family member who lives in a Senior Center. He does not talk often with his family, who live across the country, and when he does, he does not enjoy the conversation very much. Due to arthritis, his joints are weak, and he cannot stand very often or walk very far. He rarely leaves the senior center. He does not use a phone, as his fingers are not nimble enough to press the numbers, and he thinks its a useless device anyway - if someone wants to talk to him, they could come and meet him. He uses a magnifying glass to read the newspaper every morning, and spends a lot of time in his reclining chair looking out over the garden.
4.1.3 What ails technology adoption?

We then looked at why the physicals continue to rely on older technology despite digital technology being so commonplace. The biggest problems we identified were the cost of buying and maintaining devices, the steep learning curve involved in using most of them, non-intuitive user interfaces and the fact that these devices use a small subset of our senses (audio, video on a screen, no physical feedback) to communicate with us. Most devices are not accessible to many people - the elderly might have issues like weak hearing or eyesight, tremors, fatigue while using a device for longer periods of time, lack of dexterity, memory issues, and lack of previous experience with similar devices; the visually disabled, the hearing impaired and the physically disabled have their own set of problems. Illiteracy is also a major obstacle to using most devices. Many times, it is the embarrassment of not being able to use a device properly on the first use prevents people from attempting to use a new device. Others do not use technology for fear of losing cherished traditions, because of an aversion to change, or even perhaps due to a bias against technology in general. Other worries about technology include the distractions it poses, and security and privacy issues. A recurring phrase we encountered while discussing about communication technology was that using the device for communication was not intimate.

- Digital technology is expensive.
- Steep learning curve, non-intuitive interfaces.
- Problems associated with old age - weak hearing or eyesight, lack of previous experience with devices, tremors, fatigue while using a device for longer periods of time, lack of dexterity, memory issues.
- Fewer senses involved in interaction - Only audio/video for transfer of information from the device to user. There is not enough physical feedback from the device. For example, shopping is better in person because you can see, touch and feel the object you're buying.
- Lack of education.
- Not accessible due to disability - visual, hearing, physical or other.
- Not accessible due to location - rural areas, areas with no telecom infrastructure.
- People are too busy to spend time learning a new system.
- Fear - Will people laugh at me because I'm too slow at learning to use this device, Will I accidentally modify some important setting, or damage my expensive device?
- Health problems - sitting in front of the computer for a long time, headache on staring at the screen.
- Worry about wasting time/getting distracted by technology - games, movies, music, chat with friends.
- Bias against technology - technology is evil, causing global warming, harming nature, causing cancer...
4.1. Brainstorming

- People do not like change, they are accustomed to traditional ways of doing things.
- Traditional alternatives to technology represent a way of life that people don’t want to lose.
- Lack of security - stories about internet fraud, online banking, viruses, security issues, privacy worries.
- Setting up the system, charging, syncing devices, connecting wires etc. is troublesome.
- Bad/boring/irritating people on the internet; inappropriate content on the internet.

4.1.4 Alternatives to Technology

We tried to create a list of what the digitals use technology for, and came up with an (we hope) exhaustive list. We also tried to see what alternatives physicals have for these technologies, and why they might prefer these alternatives. By this exercise we hope to identify potential areas where technology might be able to make an impact in the life of physicals.

We use technology to communicate, share details of our life, keep updated about what is happening in our friend circles, and to maintain contacts and find new contacts. We also use it to get information, as a reference, for education, and to create content and store the information and content we create. Technology is involved in most of our recreational activities today, whether it be serious gaming on the Xbox or PS3, or just whiling away time playing Fruit Ninja on the iPad. Technology also makes our life simple in other areas like shopping, navigation and in organizing our life.

Physical people, on the other hand, keep in touch using the phone, or by sending letters and postcards. They network and exchange business cards at meetings. They write their to-do lists in a notebook and use a library for reference. Indoor recreation usually involves watching TV. The content they create, written on paper, cannot be widely distributed to many consumers. They are comfortable using older technology like the television, the (non-smart) phone or the radio.
### 4.1. Brainstorming

<table>
<thead>
<tr>
<th>What do digital people use tech for</th>
<th>What alternatives do physical people use?</th>
<th>Why would they prefer these alternatives (if not listed in the previous section)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting the news conveniently</td>
<td>Newspapers</td>
<td>Letter - shows that you're willing to take more effort in communicating with the person, personalized with his handwriting etc.</td>
</tr>
</tbody>
</table>
| Communication, collaboration       | face to face talk, phone call, letters    | • more intimate  
• no signal delay, noise  
• physical interaction with a shared environment (I can draw you a chair)  
• video chat resolution not good enough, audio clarity not good enough |
| Networking                         | Face to face meeting, clubs, parties, conferences, visiting cards | 1) 'intimacy'  
2) shows willingness to go somewhere to meet the person  
3) privacy, security |
| Shopping (online)                  | Shopping at stores                        | You can see/touch/smell what you're buying. |
| Keep records: data, photos, videos (memories) | Paper, notes, framed photos | |
| Recreation: games, movies, eBooks  | Movies at the theatre, on TV, board games, playing outside books | 1) Intimacy due to interaction  
2) distractions on the device  
3) email from boss  
4) the device reminds you of work  
5) health issues  
6) 'atmosphere' of watching a movie in the theatre with others |
| Education: video lectures, slides, eBooks, interactive learning tools, online forums, piazza | Teacher in class, blackboards, textbooks | 1) Some things, like interacting with other people, cannot be taught online; 2) practicals/labs flexibility of the blackboard as a display medium; 3) motivation when comparing yourself to classmates |

Table 4.1: Technology use by digitalis; Physical alternatives and their advantages (Part1)
### 4.1. Brainstorming

<table>
<thead>
<tr>
<th>What do digital people use tech for</th>
<th>What alternatives do physical people use?</th>
<th>Why would they prefer these alternatives (if not listed in the previous section)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization, planning: calendar, sharing and inviting to events, to-do list software</td>
<td>personal organizer, notepad, to-do list, address book</td>
<td>No equivalent of post-it notes: we can put lists, notes in diff physical locations, pass on the list to someone</td>
</tr>
<tr>
<td>Reference: the Internet</td>
<td>Dictionary, encyclopedia Britannica, library</td>
<td>Information overload, too many distractions on the internet, sense of accomplishment when you complete a physical book</td>
</tr>
<tr>
<td>Navigation</td>
<td>Maps, asking people for directions</td>
<td>No signal in the location, no maps for the location</td>
</tr>
<tr>
<td>Travel experience (learning about new places, meeting new people)</td>
<td>Actual travel</td>
<td>Virtual visit is 'not really being there', thrill, excitement, risk, exclusivity of having been to a place</td>
</tr>
</tbody>
</table>

Table 4.2: Technology use by digitals; Physical alternatives and their advantages (Part2)

Then, we tried to list the needs of a typical senior citizen. We started with a typical day in the life of an elder (Fig 4.5).

![Elders Daily Life Curve](image)

Figure 4.5: Elders Daily Life Curve
4.1 Brainstorming

According to the elderlys daily life and the results of the needfinding, we developed our vision in the possible needs of the elderly and for each needs in Fig 4.6 we came up with the general solution showed in Fig 4.7.

In the process of brainstorming we realized that, although there are many digital devices available for the elders, they still do not use them. In spite of the needs of communicating with families or other people, the elderly are resistant to the new social communication tool in digital world. The most important reason may not lay in the infeasibility. Instead, the biggest problem that keeps them away from the digital world may be that they feel that connecting with others using digital technology is unnatural. For the elderly, the communication only based on words, pictures and videos still cannot please them. Their most intense needs may lay in the way by which make them that feel they are close to their families, that they can communicate just like they can in traditional physical ways.

Thus, if we look further in the traditional way of connection between the elders and their families, we can find more inspiration for our challenge. For example, many elders in China will enjoy the process of cooking for the families, according to which we came up with the idea of a kitchen manage system.

Figure 4.6: Possible Needs Brainstorm
4.1. Brainstorming

Figure 4.7: Possible Solutions to the Needs
4.2 User Benchmarking and Needfinding

We started our user benchmarking with data from our own families - after all, we were all international students staying away from home, and good examples of the kind of user we were building the device for. We talked to our families, and discussed in depth about our communication methods and practices, what topics we talked about when we called home, our parents and grandparents use of technology and what kind of devices they would be comfortable with using.

We also talked to David L Jaffe from the ME Design Group. He has a lot of experience in designing assistive devices for the elderly, and was kind enough to share his thoughts on our project prompt. Talking with him gave us a quick insight into designing devices for the elderly. He also pointed us to a lot of interesting existing technology we could explore.

4.2.1 Family Communication Survey

We then collected data using an online survey, which was publicized within the ME310 group and friends of our age group from China and India. Some of the more interesting results of the survey are presented here:

Figure 4.8: Differences in communication duration when talking to parents (left) and grandparents (right).

Fig 4.8 shows the differences in communication duration when talking to parents and grandparents. 45% of the respondents report their talking session with their parents last less than 10min while 76% of the respondents report their talking session with their grandparents last the same duration. This indicate most people spend less time talking to their grandparents than their parents.

From Fig 4.9, one surprising result was that most people were fine with the present frequency of communication with their parents. However Most of the respondents report communicating with their parents once and they think this is the ideal frequency. On the other hand, most respondents communicate with their grandparents less than once a month. most wished they could talk to their grandparents more often than they do.

According to Fig 4.10, communication with different generations involved using different tools as expected. The communication with parents involve tools from a wider range. Besides phone call, there are text message, audio chatting and video chatting etc. In contrast, people seldom use these method to communicate with their grandparents. Phone call is still the most important and most outstanding tool.
4.2. User Benchmarking and Needfinding

Figure 4.9: One surprising result was that most people were fine with the present frequency of communication with their parents. However, most wished they could talk to their grandparents more often than they do.

Figure 4.10: As expected, communication with different generations involved using different tools.

Figure 4.11: The conversation topics also depended a lot on who they were talking to.
Fig 4.11 shows that the conversation topics also depended a lot on who they were talking to. The survey indicates most people have less topic to talk with their grandparents than to their parents. The topics with grandparents are generally confined within events from your daily life and events at home. Most people do not communicate with their family while being engaged in another activity at the same time according to Fig 4.12.

4.2.2 Interview in a Nursing House (Shouxing Garden Apartment)

The USTC subteam visited the Shouxing Garden Apartment for the elderly in Hefei to learn more about the elderly user we were designing our device for.

4.2.2.1 Interview Strategy

It is essential for us to know more about the elderlys life before we find ways to connecting them. As people around us are young generations as us, we decided to find a place where we could meet more old people. Luckily, we found a nursing house near our university and did a 2-hour interview there. To build intimacy between the interviewer and the elderly, we made the interview a volunteer work style chat over domestic trivia and help with household chores (Fig 4.13).
4.2. User Benchmarking and Needfinding

We wanted to explore the needs of communication and keeping record of information of the elderly. So we design questions describing specific scenario to induce the elderly to tell a story of their life. Questions we designed for the interview:

For the elderly

- How do you connect with your families? How often? By what tools?
- Do you suffer from amnesia? How do you remember the phone numbers, birthdays, and other things like when or whether to have the medicines? How do you solve these memory problems? Do you use the calendar, notes, or devices?
- Have other problems in vision, audition or body?
- Do you have any electronic devices like laptop, phone, pad, E-books? How do you use them, and what do you use them for?
- Do you read newspapers or watch TV? Does your presbyopia bother you when you read? Do you want a device to help you read? (computer, E-books)
- Do you like to keep the photos and how?

For the nurse

- What are the most suffering problems the elders have? Vision, audition, body, amnesia?
- How often do the elders connect to their families and how?
- Do they often have the amnesia problem? How do you help them?

In order to get knowledge of how old people use digital devices, we brought two iPads and prepared games and album applications for the old people. We intended to watch them using those devices to know what difficulties they might encounter. During the interview, the four students are divided into two subgroups. Each group had one person for recording while the other one did the interview. We had a voice recorder and two smart phones with us to record the sound and video for further reference.

4.2.2.2 Interview Results

We collected all the audio and video records after we came back from our interview and analyzed the contents (see details in Appendix).

In general, we found out that the device we design should ameliorate the inconvenience caused by their health problems, such as poor memory and body inflexibility. And some experience of inconvenience is beyond our imagination, which means that special functions and interactive approaches should be established in our device. Besides, our device could be designed not for a person, but for a group of old people, according to how they use mobile phones, which has been revealed in the interview. As for the test of iPad games (fruit ninja) (Fig 4.15), we had 7 old people tested and found interesting results.

To play the game, most of them used 3-4 fingers to slide on the iPad screen instead of 1-2 fingers as the way we used iPad. And this triggered the function to switch to another application. When this happened, the old players were confused what to do next.

The elderly were not accustomed to gesture controls. They tended to press harshly on the screen as if they were pressing a button. Nearly all of them cut the bomb
game even though we told them not to. Some of the old people wouldn’t try the game. So we first played the game together and taught the rules of the game while we played. (Fig ??) It seemed that they enjoyed more when this interactive teaching process took place.

We discussed the findings above and concluded some useful guidelines or ideas from them:

- The instruction and interface should be as easy as possible. More instructions would only drive the old users away.

- We might think of including buttons on the device for the elderly. They seem to be more comfortable with buttons.

- To smooth the learning curve of new technology for the elderly, we are considering making a device that will simulate their grandsons presence who will teach them in a natural manner.
4.2.3 Interview on People Around

4.2.3.1 Questions for the Elderly

After visiting the Shouxing Garden Apartment for the Aged, we found that old people live there are not a very common group. The elders live there have less education level than the average, which leads to the result that most of them have little connection with digital world. So we decided to do more survey among the elders. We hope to find their needs in everyday life and know more about their connection with digital worlds.

In our needfinding process, we discovered that the children and grand-children may also know much about the elders, their parents or grandparents. During our investigation, the young people who care about their elder families may find it easier to list their problems and needs. Since we dont have much chance to communicate with the elders in our daily life, and it is accessible for us to get the information from the younger generation, we decided to investigate our classmates about their grandparents situation. We prepared some questions and the results are showed in Appendix A.

4.2.3.2 Lessons Learned

During the survey we find that many old people have eye problem like presbyopia, so large screens and large letters may be more comfortable for them. Most old people involved in our survey dont live with their children, and face-to-face communication is the most common communication methods for them. All the old people in our survey dont play computer. Nearly half of them have their own mobile phones but these phones are only used for making phone calls. Cooking, Beijing Opera and hand working are common interests of the elderly.

From the survey we conclude that large screen and letters may be welcomed by the elderly. Though none of the old people in our survey have tried video talk, they prefer face-to-face communication to other ways. So perhaps when they get accustomed to video talk, they would like it. Many old people like listening or singing Beijing Opera, but they dont have chances to try the true opera suits on and play it on the stage. Also, doing
craft work like knitting is popular among old people. We can think about some interesting devices in these directions. What’s more, we realize that most old people are eager to do something for their children and grandchildren. They hope to be useful and important to their family even as they grow older. So devices that can stress the importance of old people are likely to be welcomed.

4.2.3.3 Insights

From the interviews we got insights on different aspects, which are showed as below:

Communication

- In many cases, the desire for communication and interaction is not symmetrical. One side (usually the parents) may desire more frequent and longer communication than the other side does. Opening up easy access to the other side at any time may be undesirable for some people.

- An important problem in communication (like using Skype) is knowing when the other party is available.

- An important element missing in remote communication is a common environment that both sides can interact with at the same time.

- Audio quality and latency is very important for a good conversation.

Cultural Heritage

- Cultural heritage is passed on primarily by verbal interactions between grandparents and children, like storytelling etc.

Designing Devices for the elderly

- Old people cannot be simply put into one category, each person’s needs and disabilities (if any) are different.

- Devices are less confusing to elders if they have only one function associated with them - a Television is just used to see channels, a phone is just to make calls, a switch turns on a light.

- Abstraction is confusing - Why should I click on Start to shut down my computer? - Concept of nested menus is not intuitive. “No dead ends, no logical leaps,” - as soon as users aren’t sure what to do next and hit “a dead end where it’s not obvious where they’re supposed to go, you’ve lost them.” [16]

- Devices can be disguised as familiar ones to make people feel more comfortable - E.g. A Skype device which looks like a TV, with a dial to flip contacts; Social networking feed disguised as a newspaper

- Most elders would prefer to use devices that do not make it obvious to others that they have some difficulties or impairments.
4.3. Business Benchmarking

- A community computing device might make more sense in rural regions, rather than a personal device. This device sits in a common location, and people can come and use it once a week or so. This is safer; we have more leeway in using expensive technology. This might be the best way to reach people in third world countries.

We have spent most of this quarter looking at needs in communication between generations in a family. What we realized was that the gap was partly due to the forms of digital communication that young people use but are not accessible or attractive to older users. This gap is especially large for those who live far away from their family and don’t have the chance to talk face to face daily.

4.3 Business Benchmarking

Microsoft Research Asia is the Asian center of the research wing of Microsoft Corporation, and develops products for Microsoft Corporation. The device we develop must integrate well into Microsoft’s sales and distribution system, infrastructure, and company ethos if it is to be implemented. Microsoft Corporation, incorporated on September 22, 1993, is engaged in developing, licensing, and supporting a range of software products and services. The Company also designs and sells hardware, and delivers online advertising to the customers. The Company operates in five segments: Windows & Windows Live Division (Windows Division), Server and Tools, Online Services Division (OSD), Microsoft Business Division (MBD), and Entertainment and Devices Division (EDD). The Company’s products include operating systems for personal computers (PCs), servers, phones, and other intelligent devices; server applications for distributed computing environments; productivity applications; business solution applications; desktop and server management tools; software development tools; video games, and online advertising. It also designs and sells hardware, including the Xbox 360 gaming and entertainment console, Kinect for Xbox 360, Xbox 360 accessories, and Microsoft PC hardware products. Source: Reuters[10].

![Figure 4.17: Business model canvas](image-url)
Of interest to our project is Microsoft’s acquisition of Skype in 2011. Skype is a major player in video communication, and our product, if it involves communication, will need to fit into the ecosystem of Skype, MSN Messenger and Windows Live Messenger.

In 2012, Microsoft Corporation had revenue of US$73.72 billion, and assets of US$121.2 billion. It employs about 94,000 people around the world. Skype Technologies earns money from paid Skype subscription, which allows you to make calls to phones. The revenue before being acquired by Microsoft was over US$700 million.

In entertainment and devices segment, Microsoft competes with Sony, Apple, Google, Nintendo, and RIM. In the online space, Microsoft competes with Google and several other online service providers.

Microsoft sells its products in multiple platforms operating system sales with hardware vendors, retail sales and in the case of enterprise customers, through sales to IT departments of companies. They also have a retail presence through its gaming devices, games and PC input devices. Online services like Windows Live and Skype are promoted online.

### 4.4 Technology Benchmarking

#### 4.4.1 Benchmarking existing devices that can help connecting families

We also spent a lot of time benchmarking existing technology, and we found a few very interesting ideas:

- **Storybook coach [11]** - software for grandparents to create a storybook for their grandkids about their life, experiences etc. (The project appears to have been merged into [www.heritagemakers.com](http://www.heritagemakers.com))

- **The Microsoft research Sensecam [5]** is a device which is clipped onto a person and takes pictures intermittently. It takes pictures more often when you’re moving. This can be a way for old people to have automatically pictures of their life to select from and show to their families.

- **Prototype that Dave Jaffe once tested** - A book of memories device for an Alzheimer’s patient. Photos from his past were compiled into a slideshow along with a recording of him speaking about the photo, and made into a DVD that he could occasionally watch and show people.

- **The Memory glass foundation** has an iPad app for seniors to look through their photos [4].

- **An old project called community memory in Berkeley [13]** involved a printer which worked with a bulletin board system to spread details about local happenings to the crowd.

#### 4.4.1.1 Devices for elders

Fujitsu RakuRaku phone for the elderly [2] - Fujitsu has modified an Android smartphone to help the elderly use it better. Modifications include ignoring accidental touches, bigger buttons, voice commands, and touch to select and press to activate
The Clarity Pal phone for the elderly has huge buttons and a simple interface, and also an easily accessible emergency button that can be used to call for help.

The Presto email to print machine set up an email address for users who don’t use computers, and emails sent to that address will be printed out by the device.

4.4.1.2 Devices for children

We also researched about building devices for other members of the physical population. The One Laptop Per Child (OLPC) project has a set of interesting devices built for children in developing nations. Some interesting concepts from their research include a ‘narrative’ interface - a device which talks to children (and uses storytelling) to in order to teach them. A spinoff from the same project is the SUGAR on a Stick OS for children, with a user-friendly interface, and mechanisms for collaboration, reflection, and exploration.

Sugar is a platform that enables children to learn and process according to their own pace. It provides a user-friendly and stable interface which is suitable for children. The platform provides mechanisms for collaboration, reflection, and exploration. Sugar is open-source software based on Fedora. In our trial, we used VMware to run Sugar, thanks to its hardware independence and easy switch between VM and physical computer.

As shown in Fig 4.19, Sugar provides hundreds of functions, called Sugar Activities, including: Abacus, Analyze, Colors, Image Viewer, FileShare, Chat, Physics, Speak, etc. Simply by clicking on the icon, users can launch the application, and the system can record users progress in studying.

4.4.1.3 Devices for visually disabled users

Technology that connects visually disabled users was also explored - we looked at smartphone apps like screen reader which read out all the text on screen, and Georgie, a smartphone system which allows you to managing contacts, using speech input to send text messages and tag previous routes or hazards (like potholes or low hanging branches) using navigation apps.’
4.4. Technology Benchmarking

4.4.1.4 Devices for rural populations in third world countries

Voice-based social media for rural developing regions (The Voice4all project) [1] Television and radio are an effective means of information dissemination in rural areas. However, a platform to discuss, debate, and relate personal experience, information is terribly needed. And this product solves this problem to a certain degree: by dialing a phone number and navigating through simple audio prompts, farmers can record, browse, and respond to agricultural questions and answers. Display agricultural information, Q&A forum, announcements board, and radio archive.

4.4.2 Benchmarking new technology

The touch interface in the iPhone was a game changer in intuitive interfaces, before which the touch screen was limited to a few devices meant for tech savvy users. We explored a lot of cutting edge interface technology, looking for potential technologies that could be the next iPhone and transform the user experience for people inexperienced with technology.

We looked at devices that convert between the physical and digital worlds. Products that could scan any document kept on a table, projects like sixth sense which project a digital layer onto physical objects, devices like tablets and digital whiteboards which digitize writing. Microsofts omnitouch project allows you to project a layer onto any surface and convert it into a touch screen.

We interacted with Prof. Scott Klemmer of the Human-Computer Interfaces group in the CS department at Stanford, because we were interested in some of the projects that their lab had worked on - the papertoolkit project which involved digitizing work as it was being written on paper, projecting digital work onto paper, and using that for computer interactions [7]; the gigaprints project [3] which involved displaying data using extremely high quality prints on paper, utilizing the cost-effectiveness and the resolution.
4.4. Technology Benchmarking

Figure 4.20: The survey of existing technology was compiled into a large spreadsheet for later reference.

of paper prints; voice4all, a social networking project run through mobile phones and audio alone; and Papier-Mch, which integrates digital information with physical objects [8]. However, we found that no student who had worked on any of the projects we were interested in were still working in the lab. We wanted to try these projects from the source that was used 5-6 years ago, but Prof Klemmer recommended that we start from scratch to build a prototype, as the technology used in the (5 year old) projects is now outdated, and it would probably not be worth the effort of learning what was happening and customizing it to work on the hardware we have available. Prof Klemmer also pointed out to us some devices/companies/researchers that might be interesting, like the digitizer pens from livescribe, HPs Presto printer without any buttons which prints out and send email. We also talked about how a touch screen was a more intuitive interface than a keyboard and a screen, and about what made interfaces intuitive to different user groups.

We also found to be of interest Telepresence robots used in certain corporate environments, gloves that allow input using hand motions as signals (gesture control) and many applications of Microsofts Kinect system to allow more physical interactions with computers.

4.4.2.1 Sony HMZ-T1 Head Mounted Display

This is Sonys first generation head mounted display and simulates a 150” 3D screen 12 feet away from the wearer. We wanted to test how immersive such a display could be. However, we were disappointed with the device it was heavier than we expected, and it wasnt really very easy to feel like you were in the world that was being shown in the
display, probably because the screen took up just a small part of the eyes field of view. This device was designed for consuming content that was created for display on a large screen, not for immersing the viewer in another world. We shifted our focus to other products like the Oculus Rift.

**4.4.2.2 Luidia eBeam Whiteboard**

This digitizes what we write on a whiteboard, using an IR sensor to detect the position of the pen. It turned out to be quicker and more responsive and accurate than we had expected. It would have been better with some handwriting recognition and conversion of a chart drawn on the board into digital format. We also think that adding a projector with it to allow data to move in the opposite direction (from the computer to the board) would be a great idea.

![Writing and erasing on the whiteboard.](image)

**Figure 4.21: Writing and erasing on the whiteboard.**

**4.4.2.3 Magictouch resistive touchscreen**

This is a transparent touch input device that fits in front of your screen. It has a stylus to be used with it. However, this is rather old technology, and its performance is rather poor compared to the screen of an iPad or an iPhone - it wasn’t very sensitive to soft touches and quick movements, and there was a noticeable lag. We didn’t know if this is true of all touchscreen add-ons available today. The company (Keytec Inc.) still produces similar devices, with the OPTIR Touch coming in sizes up to 140... and their product videos seem to show much better responsiveness.

**4.4.2.4 Wacom Tablet**

This tablet is both a display screen as well as a touch input device. Using this with a laptop is similar to using a tablet PC. Lessons Learnt: The Windows 7 interface is not designed for use with a touchscreen! It would be better if there were larger buttons to press, and some sort of feedback when you touch. Considering we were using a stylus, it would be very easy to incorporate vibration feedback.
4.4.3 Interfaces without text

We also tried visiting websites and using phone apps in a language we didn't understand (??), to see whether the device was usable - while Mishel attempted to use the iPad and the iPhone in Mandarin, and to use a few Chinese websites, Shiquan and Tony tried to navigate around sites in Hindi and Malayalam. By this exercise, we hoped to learn how a person who cannot read either due to a visual handicap or due to illiteracy would feel while using a device. For a person unacquainted with tech, the technical meanings of common words like submit, ok, cancel etc. may not be obvious.

Lessons Learnt: We use our knowledge of existing user interfaces significantly when we interact with a device. Even though I didn't know what the text said, I could figure out what I was supposed to do to interact with the text because of my experience with similar devices in languages I understand. Websites too follow certain standard formats across languages, and hence navigation was not as much a problem as we expected. However,
4.5 Idea Exploration / Brainstorming

In this section, we will describe the ideas we considered, and ultimately rejected before settling on our critical function and experience prototypes.

After our extensive benchmarking and exploration of existing technology, we had a lot of high-tech ideas and possible solutions to the problem. Listing these out formed the first part of our idea exploration process. However, we realized that we needed to look at the problem more from the perspective of the needs of the user rather than from a technology perspective. We then had another round of brainstorming, on the premise - if you could make a magic device to meet the users need, what would it be? This was done because we felt that our overemphasis on technology was perhaps constraining our imagination. We came up with a bunch of ideas, and then thought about how close to our magic scenario we could bring technology.

![Figure 4.24: Ideas we explored but did not pursue](image)

4.5.1 Communication Toy

The idea is to build a toy that can interact with the person while also performing the function of a communication device. The toy acts as a proxy for the person being spoken to; perhaps it can convey the emotions of the person through some display or motion. Having an object as a stand-in for a person can improve the feeling that the other person is really present there. It would also be possible for the user to carry the toy around with him and just place it down when it is to be used for communication. An alternative approach would be to have a mobile toy that can move inside the house and follow you around. This would be especially useful if the communicant can control the toy to see what’s happening in different parts of the house.

An interesting critical function to test would be to try to integrate communication technology into an existing toy, like a Pleo robot.
Another interesting question to test would be how much the communicator associates the toy with the communicant. Would the motion of the toy be interpreted as the emotions of the communicant without being explicitly told so? How important is it that the toy should remain at eye level? Do people feel comfortable talking to someone who is on the ground? How important is the device being able to move around the house?

### 4.5.2 Immersive Display

The idea is that if we can build a device that is truly immersive, if it can make the user forget she is using a device, and also give her complete freedom in interaction so she can do anything she would in the real world, then that could work for any age group - there is no new interface to learn to use, nothing that she doesn’t already do in the real world. The problem is, however, that complete immersion is not possible using today’s technology. Our best shots at an immersive display would be a head mounted display or a dome that you sit in. A suit worn by the user could potentially transmit touch information, but by then the device has become too cumbersome. In our discussion, we came up with a lot of complexities in building such a device. We benchmarked Sony’s HMZ-T1 head mounted display, and researched other options available, like the Oculus rift [6].

A possible CFP would be to buy a head mounted display, get a 360 degree view image, and show it on the head mounted display - is it realistic? Perform a Wizard of Oz test - when the user moves their head, you move the image so that it seems like they are turning their head to see something. Do they feel dizzy, uncomfortable? Another related idea we discussed was to have a helmet with camera on one side, head mounted display on the other side, so that grandma can see what I’m seeing. It could also be asynchronous - it could track your position, and you can click pictures and add audio comments at each position, and your grandma can browse through the path you took and see pictures and listen to audio clips at each point you recorded - have a virtual tour of the place you visited.
4.5.3 Magic Table

This is a table which converts between digital and physical information display. We can place documents, photos etc. on the table, and they get automatically scanned. Also, someone using the table somewhere else can look at the photos along with you while you're digitizing it, as the photo is now displayed on his table. This idea can be used with multiple use scenarios from having a common surface to write on while communicating, to playing games like tic tac toe or poker, to using the table to digitize an old (physical,
printed out) photo album.

CEP: Create a sample design for the table, implement some functions using Wizard of Oz techniques, test it on people.

CFP: Fix the projector and a camera on a beam above a table, then calculate the position of a hand or pen on the table using an ebeam sensor. Using the combination to scan in and display photos.

### 4.5.4 A DigiPhysical Mailbox

It converts between physical mail and email. Meant for people who are uncomfortable with using email on a computer, the device provides an email id to the user, and all mail sent to the email id gets printed out for the user to read. To reply, he just needs to write his reply on a sheet of paper, with the recipient email address at the top, and drop it into the device. The device then scans and mails the document to the right person. This function could be tested with a printer-cum-scanner device that is set up with a computer. We can write scripts to query a mail server for new email, and take a printout whenever email is received. We can also have a sensor that detects when paper is placed in the scanner, and automatically scans the data. An OCR software then recognizes the email id written at the top of the sheet.

### 4.5.5 Portrait Presence - A device that talks to you like a real person.

The simplest possible interface for a person without any experience with computers would to have a person speak to them and ask them what they want done. If we could have a computer that speaks to them like a person would, and understand perfectly what they are telling it (way better than siri does), that would be very attractive to many users. However, such a product is not within the scope of our abilities and present technology. We also considered introducing personality quirks or character faults in the talking interface to make it more likeable. One idea we had in this regard was something like a moving photo frame from the Harry Potter movie series - photos that move and have a personality. There is a photo of my family at my grandparents place, it moves, talks like it is us, comments on the weather etc., without any action on our part. It also reminds grandma to have her medicines, warns her to wear warm clothes as the weather is going to be cold. Grandmas messages are relayed to us through a similar photo of her that we have at home, and we can leave messages for her. However, the technical implementation of such an idea would involve a combination of chatbot technology, artificial intelligence, realistic voice synthesis, language processing and more.

### 4.5.6 Tele-Manipulator - Actual physical interaction with objects

We realized that an important part of in-person interaction is the ability to interact with a shared environment. Would it be possible for us to introduce this into remote communication? One way to do it would be to create a virtual world and immerse both sides in it, as explored in an earlier idea. Is it possible to actually move physical objects on the other side of the communication, perhaps by using a robot, or some sort of tactile sensor? The ideal scenario is - You have a knife with you, and if you show it to your
4.5. Idea Exploration / Brainstorming

grandma, she can pick it up, feel the edge, and even cut herself if shes not careful. You found a weird shaped tomato at the grocers today, and you can show it to your mother, and she can hold it.

4.5.7 A shared whiteboard or refrigerator front

A wall that both sides can write on, and leave messages on. Other ideas: a large screen with easy interaction with mobile devices (flick to move notes between the screen and the device) and easy interaction with physical artifacts (stick a post-it note to the screen and it gets scanned in) can also be extended to do this. On the grandmas side, it would mostly be physical interaction and on the family side, it is likely to be more complicated and flexible. We could have a kid mode and an elderly mode, along with a normal mode, depending on whom the window is meant for.

4.5.8 Multitasking while communicating

Another issue separating digital and physical users is the lack of time. Presently, we have small slots of concentrated communication with our family, so we have to dedicate all our time in that slot off communication. We might run out of topics during this time, and in general, the quality of interaction is not the same as just being around your parents at home. Most communication at home happens not when you sit down to talk with someone, but over dinner, or over a videogame, or over the newspaper in the morning. Can we introduce this element to daily activities? A more natural communication might be established, if interaction could be maintained over longer durations, but where the interaction is not the primary use of time - for instance, watching a movie or a sports event together, while being separated spatially. If we could integrate interaction into some daily activity - perhaps watch TV together so they could comment on the action, cheer for the team etc or shop online together (allowing the younger side to help the technologically challenged side).

Of course, the activities in question depend on the kind of user. Eg. Grandparents & grandkids - storytelling; adults & adults - TV shows, movies, board games, video games; children & children - video games, education; grandparents & grandparents - gardening, knitting, reminiscing Often, it is not just communication that is a problem which separates physical and digital residents, it is also the lack of access the physicals have to the kind of activities the digitals spend a lot of time on. We can try to address this by allowing the digital side to control a lot of the display - pick up newspaper articles for the other side to read, post on their behalf, and show them pictures from facebook?

This device could be asymmetric - the tech savvy side can have social media integration - recommendation of shows from friends, what they are watching/listening to right now, posting on facebook when youve got a highscore etc.

Question: How do we synchronize activities of these two physically separate users? How do we let them know the other side is available? How do we maintain interaction over a movie, newspaper etc?

CEP: Leave an audio/video connection on between your home and your parents home for a few days. See when interaction occurs, and how well it works.
CEP: Set up Xbox live with a family & grandparent who stay far away from you; watch a movie together. Does it add to/subtract from the experience?

CFP: Set up a camera behind you while you are reading the newspaper, and use it to detect the page you are on and informs the other side so you are reading in sync and commenting on the same articles.

CEP: Set up Teamviewer and skype so you can control your my grandmothers computer for her, open articles for her, show her the shopping website window. Is it too tiresome for the person who is controlling the device? Can your grandmother follow what is happening on the screen?

CEP: Test by leaving a video chat on while both sides are engaged in the same activity, and see if any synergy occurs.

This idea was the seed for the peripheral vision prototype we will describe in the next section.

4.5.9 Video Conference Optimizer - Optimizing bandwidth usage during video conferencing

The bandwidth is the single biggest impediment to good video conferencing. If you can't hear/see the other side properly, there is a barrier; it doesn't let you feel like they're really next to you. Often, a phone call is more intimate than a Skype call because of the lack of a lag in the communication. The requirement of bandwidth is not uniform throughout the duration of the conversation. Certain parts of a conversation are more important than others, it is more important that the other side see and hear what I am doing or what I am showing at certain moments. Question: Is it possible to predict what parts of a conversation need more bandwidth and prioritize data transfer, perhaps in partnership with the ISP? If bandwidth cannot be modified, would introducing asynchronous transfer of higher resolution video/audio be a solution - and can this be made to feel natural?

CEP: How good is the experience of having to wait for high-res video? If you see low res video and the person you are talking to is recording high res video which will come to you in some time, do you get impatient? What methods can be used to make this more comfortable? Test with a Mock-up CFP: Have multiple instances of video conferences running on one computer, one person on each instance, each person sets a priority value changing with time. Distribute bandwidth according to priority, and do not allow anyone to hog the bandwidth.

4.5.10 A reminder bracelet for elders

A watch or bracelet that speaks to the elderly user, reminding them about their medication, warning them about weather conditions, and advising them maybe you should wear a coat, because it's going to get cold soon - in the voice of their children.

CEP: Record some common sentences used while looking after the elderly, then use a micro-speaker and manually play the suitable sentence in corresponding situation and find out how the user feels. Is the voice of a loved one important?
4.5. Idea Exploration / Brainstorming

4.5.11 Video Conference Optimizer - Asynchronous high-quality video transfer in a video conference

Some parts of a video conference are more important than others... for instance, if you are talking, and want to show your parents what your room looks like, you would like better resolution and fps when you're showing than when you're just in front of the computer and listening to what you're being told. We could thus prioritize bandwidth (at the cost of realtime interaction), by having low quality video most of the time and in parallel sending the high quality video (of just the most important moments) to be shown once its completely downloaded.

CEP: How good is the experience of having to wait for high-res video? If you see low res video and the person you are talking to is recording high res video which will come to you in some time, do you get impatient? What methods can be used to make this more comfortable?

4.5.12 Storytelling simulator and recorder - Creating a demand for old peoples stories

People like to listen to stories, even if it doesn't relate to them - it is human nature. Old people like to tell stories. It also helps in controlling memory loss, gives some relief to families of those suffering from alzheimer's. Storytelling can remind seniors of fun times, old friends, and amusing events in their lives. Most importantly it gets them thinking, listening and contributing again. [9] However, more often than not, the elderly do not have an audience for their stories. The internet might be a good source of an audience. How do we connect the two? Will it be useful if old people can tell stories and people can listen to them online, share, comment, post responses etc... a storytelling version of youtube?

Perhaps old people could talk about their life experiences, funny incidences, how did they meet their spouse, their childhood in a world very different from ours, or give advice about cooking, advice about keeping the house organized, advice about family life etc. We could design a device that records stories from old people and uploads it for people to hear. But how do we encourage people to tell stories? How do we make it feel more natural to be talking to a device?

Some ideas we considered includes using soundscapes to revive memories (sounds are often associated with memories, and a soundscape can actually make you feel like you are in a particular environment and can provoke memories), reminding people to tell stories when they visit someplace they have been before, etc.

Another idea would be to allow the user to just make up their own stories, like the "Time Slips Story Telling Project", which inspires seniors and others with dementia to focus on telling stories through imagination rather than relying on memories and facts [12].

We also looked at a bunch of other ideas, from a device that collects photos from people and shows it to their parents, to a device that converts a Television set into a teleconference device. A device that is designed to teach older people how to use modern technology? A device that helps old people with gardening, or tai-chi, or chess? A device that allows asynchronous audio communication, like an audio version of notes put up on the refrigerator.
4.5. Idea Exploration / Brainstorming

<table>
<thead>
<tr>
<th>Idea</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-book mark</td>
<td>Help the reader to take and share the notes.</td>
</tr>
<tr>
<td>Family map</td>
<td>Show the statuses and activities of the family members.</td>
</tr>
<tr>
<td>BOX</td>
<td>Deliver the useful information for the elders. Has a projector.</td>
</tr>
<tr>
<td>Kitchen manage system</td>
<td>Recognize the food materials and find a recipe for the user.</td>
</tr>
<tr>
<td>Aeolian Bells</td>
<td>Transfer the motion, the sounds and the smell in different rooms.</td>
</tr>
<tr>
<td>3D Table</td>
<td>Transfer the 3D information and can be controlled both in physical and digital way.</td>
</tr>
<tr>
<td>Interactive map</td>
<td>Interact with children’s motion and some toys.</td>
</tr>
<tr>
<td>Life recorder</td>
<td>Pop out the status on SNS and record the story about it.</td>
</tr>
</tbody>
</table>

Table 4.3: Even more ideas we looked at

We also asked ourselves whether it was possible to transmit the breath of the person you are talking to, can you feel the air blowing on your face? Is communication really the single most important problem the seniors face? Or are they quite satisfied with just a phone, and have bigger problems with seeing photos and updates from their kids?

We also discussed possible uses of technology - transparent screens to give an overlay on what you see, membranes which convert glass into a transparent screen, possible uses of a kinect + projector + camera combination in allowing interaction of physical and digital objects,

We tried to think what would be the ideal solution if we had MAGIC powers - Here's the scenario: At 6pm in the evening, I want to talk to my grandparents and show them photos etc... I think of that and I am magically transported back to my grandmas house. I am really there, so I can move things, I can help my grandma cook, eat the delicious food she makes, sit with her and watch TV etc. All the photos that were on my smartphone and I wanted to show here have now magically converted into a physical photo album, or become a framed picture on the wall. Some social networking information, like what my cousins are doing etc; news about my life; my health; weather information etc has been morphed into a newspaper that we can read together. And after I spend time with my grandparents, I am magically transported back home, and it is still 6pm, so I have time to work on my homework before sleeping tonight.
4.6 Critical Function and Critical Experience Prototypes (CFP/CEP)

A Critical Function Prototype aims to test/demonstrate one particularly important function in the device we are considering. The Critical Experience Prototype, on the other hand, seeks to produce and test a user experience that is essential to the product. These
exercises are part of exploring the bounds of the problem space and the solution space, and should answer some basic questions we have. They are not prototypes of the final design or a proof of concept, the aim is to help us learn something that merely researching from other sources or benchmarking existing technologies would not help us with.

### 4.6.1 Tactile Messaging CFP

**Background:** A recurring phrase we encountered while discussing about communication technology was that using the device for communication was not intimate. What possible interactions between the users could add more intimacy to the communication? One important aspect of being next to a person is the ability to touch, and crucial to the feeling of touching a person is the warmth and softness of skin. Can we recreate and communicate this tactile experience?

**Question:** Can touch, temperature and motion communication through a tabletop or portable device make remote communication more intimate?

![Prototype schematic](image)

**Description:** The prototype involves a sensor module - an arduino with a temperature sensor, pressure-sensitive resistor and an accelerometer, connected to an actuator module an arduino with a vibrating motor and a Peltier junction. The sensors measure the pressure of touch, the temperature of the hand gripping the device, and the movement of the device. This is then communicated to the actuator module, which warms up the surface and vibrates accordingly.

**Further Questions:**

- Does such interaction work best in synchronous or asynchronous communication?
- What should the device look like if it is to represent the presence of another person?
- What does it take to make the user associate the device with the person they are communicating with?
- How do we attract attention to the device when the other side wants to initiate communication? Will it just be a novelty that will wear off, or will it add value in the long term?

**Findings:** The shape and surface material of the device is very important. However, while some users imagined a smooth and hard surface like a pebble, others preferred softer and more pliable skin-like material. Some users noted that communicating touching is
more useful in certain situations, like in a romantic couple. Most testers agreed that the addition of temperature was useful. Other feedback included advice to use this along with audio or video chat and to use other input and output methods for instance, the pulse of the person can be transmitted to the other side, and the device pulses; the device can be squeezed and the other side also compresses. There were also suggestions that we could modify the shape of the device to indicate the mood of the person on the other side. Portability of the device was critical to many users. In general, different users had very
different ideas about how the device could be used - for instance, one suggestion was that it could be used to communicate by shaking the device in some pattern.

**Whats next:** We plan to test asynchronous communication using the device leaving an audio message along with tactile information. Motions other than vibration what if the device can expand or pulse according to how the other side is squeezed? Can the motion of the device give visual cues (like a deflated object to indicate the other person is tired)?

4.6.2 **Social Networking Aggregator CEP**

4.6.2.1 **Social Networking Aggregator CFP**

**Background:** We share interesting bits of information daily in social networking websites, but this information is not accessible to older members of our family, and it is an added effort to repeat all the same information when talking to family. Modern communication, especially on social networks, can be described as fast food communication, which is quick and easy communication with many people, but without a depth of communication with any single person. However, it does provide a starting point for conversations and other more intimate communication methods. It could be useful to have social networking data aggregated and displayed to older users, of course with appropriate privacy settings and filtered according to what the target users might find most interesting.

**Question:** Does displaying information from your social networks to older family members improve communication and connection in the family?

**Description:** We collect information from our social network feeds that might be of interest to our family, set it on one or two pages and show it to our parents and grandparents as an email to parents, and as printed sheets of paper to our grandparents.

**Further Questions:** What content is of most interest to parents/grandparents? What content are the social media users most comfortable with sharing?

**Findings:**

- The feedback for this prototype has been varied - While some testers felt that they would rather learn about their child/grandchild's life directly from them rather than through an impersonal device, others appreciated the information presented, and thought it would give them more topics to speak about.

- For some of the users, there was a wide difference between the kind of posts they made on social networking services and what their parents/grandparents wanted to know about them. More than one person said that they would prefer to receive this data on a mobile phone or on a screen rather than as a printout.

4.6.3 **Peripheral Vision display CEP**

**Background:** From our studies about our communication with our families back home, we have found that one major issue while using video calls from a computer is that often, the availability of time for communication is an issue. If we have some way to continue our video chat and still be able to engage in some other activity at the time - have some of the benefits of video chat, but still allow you to do something else alongside like a phone call
would it might increase the frequency of interaction. A display utilizing your peripheral vision allows you to see simple movements and shapes while not impairing your ability to perform most tasks.

**Question:** Does peripheral vision give a feeling that the person you are talking to is next to you and still allow you to be engaged in another activity?

**Description:** The CEP setup involves a headset that fixes an iPhone next by the side of the users eye so that the image onscreen replaces their peripheral vision. The iPhone is then connected to a stationary iPhone/iPad via facetime. It is fixed such that the person who is communicating with the user can be seen to be facing the same direction that the user is. The user is then instructed to continue to pursue some activity while wearing the headset.

**Further Questions:**

- What distance from the camera (in effect, what size of the person on the screen) felt the most comfortable?
- How intrusive is the headset do you lose focus on the task youre engaged in?
- How much of the edge of your vision can the display occupy?
- Can the person on the screen grab your attention if he needs to?
- Are there simple movements that can be used to communicate?
Findings: The tests of this device were unexpectedly successful, with most users agreeing that it induced a feeling of the person being next to them and that it was better than just audio communication. Major findings are listed as below:

- Users were able to work on a task without impairment.
- Some users instinctually tried to turn to the side to look at the person they could see out of the corner of their eye, and reported that not being able to transition to face to face communication was a problem. Also, one user reported dizziness after trying to focus on the image on the display.
- Being able to listen to the background sounds of the other person working, and feeling their presence next to you when you’re alone, can make you feel less lonely.
- The correct positioning of the screen is critical for the experience to be successful. Lighting and contrast in the image turned out to be very important in being able to make out the person.

- Staying too close to the camera is bad, as it makes the wearer uncomfortable, going too far away is bad, as it becomes difficult to see the person. The ideal distance was usually when the head was about 1cm on the display right next to the face.

- Some people we interviewed were very enthusiastic about using the device to watch a movie along with someone.

- After some use, many users reported they started getting used to not being able to look into the peripheral display and started forgetting they had it on when they were deeply engaged in an activity.

**Whats next:** Can we be more efficient and transmit just the kind of cues that are most easy to catch on the peripheral display? It can reduce the bandwidth requirement and make certain gestures more noticeable. Will increasing contrast, sharpening edges or increasing saturation improve the visibility?

**Figure 4.36:** *Response test*

**Other areas we need to explore:**

- Designing the transition from peripheral vision chatting to face to face video chatting on a screen.
- Syncing activities using the headset - listening to music, watching TV or a movie together.
- Using stereo audio to add to the effect of the person being next to the wearer.
- Can we influence the mood of the wearer by immersing them in a soundscape and by displaying appropriate (calming/active) scenes on the display?
4.6. Critical Function and Critical Experience Prototypes (CFP/CEP)

• Is it possible to link the displayed image and sound to the activity being pursued? For example, when the user is reading a novel, does adding sounds and video corresponding to the part of the novel he is reading add to the experience?

4.6.4 3D table CFP

After brainstorming and benchmarking, the USTC team decided to make a CFP for the 3D table idea. The 3D table (Fig 4.37) is a game platform providing the experience of playing together for remote players. There are at least three players to fully experience the device: two of them are children who are too young to be able to control digital device, while the other player is a teenager or an adult who is able to control the table with computer, mobile phone or other digital devices.

![Figure 4.37: Brief description of concept of 3D table](image)

The table is made up of array of blocks with 3D scanners (Fig ??). Rising and falling of these blocks can deliver a 3D image, even a 3D cartoon. If a child put a toy, such as building blocks on his table, the scanners around the table will scan the 3D figure of this toy, transmit it to table of the other child and the blocks on the table will be controlled to represent the outline of the toy like pin screen. At the same time, figure of the toy is transmitted to the digital device of teenager/adult and image of toy will be shown in the software. And blocks on both tables can be controlled by the digital device, thus image or cartoon can be downloaded on tables. In this way, two physical worlds and one digital world are synchronous and everyone in the game is able to change the common world: children by toys and adults by computer.

The reason why we chose 3D table are as follows:

• We think that the 3D physical transmission can deliver a better interface and communication experience for the users. While providing a device which can achieve
physical entity information exchange, our users can be connected with each other by working on a physical object together.

- From the benchmarking results, we found that many products can exchange information in words, pictures or video forms, but we did not find any existent device which can achieve 3D physical transmission. We wonder if we can realize this function in CFP process.

Since some classmates of our university have already done the 3D scanning stuff, the critical function of 3D table that will be prototyped and tested should be how to control the array of array of blocks. Apparently, for the large number of blocks, it is unrealistic to use a motor to control only one block. So, the challenge would be to use a motor to control several blocks quickly and precisely.

We considered two ways to control the blocks, the first one is air-powered and the second one is driven by motors and gears. (Although both solutions are feasible under modern technology, we do not have resources to accomplish the first solution so we focused on the second one. But it could be efficient if it were made in a factory.) The essential part of the first solution is that we ”re-array” the matrix of blocks by controlling them with soft pipes, which are arrayed in circles. And by transforming circular motion to plug-in and plug-out motion, pipes can be quickly aerated and de-aerated theoretically. In the second solution, four motors are used to control a row of blocks. Springs and splines are used in a gadget to fix blocks. (See more details in Design Description.)

The following questions are expected to be answered by our CFP:

- What is the possible refresh rate? Is it fast enough to show a cartoon?
- Are the blocks strong enough to support a toy?
• How precisely can we control the blocks and how precisely should we control the blocks to represent a 3D figure?
• What’s the possible size of the block to not only deliver a physical entity experience but also be feasibly controlled?
• How customers feel about the physical entity information transition?
5 Design Description

5.1 Vision

We aim to reconnect families by building a device that allows generations of a family to maintain communication despite being physically separated. The product will encourage families to stay in touch by improving accessibility to technology and efficient utilization of time.

5.2 Tactile Messaging CFP

The CFP uses two Arduino Uno boards with Atmega328 microcontrollers to interface with all the sensors and actuators. The circuit was first implemented on breadboards, and later ported to permanent soldered boards after testing. The first version of the device used a resistive heater, as the heating element, but the response was too slow, and the element did not have the ability to cool itself down, so we could not effectively communicate the feeling of the hand being taken off. So, we moved to a thermoelectric (Peltier) heater/cooler, which responds quite rapidly.

Figure 5.1: Prototype schematic

The boards communicate with each other using serial communication at 9600 baud. Each byte of data sent contains information about one of the following, based on the first two bits of the data:
00 - temperature
01 - pressure
10 - accelerometer
11 - gyroscope
The remaining six bits then have a scaled value of the value being measured. For instance, $0 = 15$ Celsius or lower input from the IR sensor, and $64 = 45$ Celsius or higher.

Pin configurations:

Master (Input module)
- Pin 9 (heater)
- Pin 10 (motor)
  - Pin A4, A5 (I2C pins) - (Accelerometer and IR temperature sensor)

Slave (Output module)
- Pin A4, A5 (I2C pins) - (IR temperature sensor)
  - A0: pressure sensor

![Figure 5.2: Earlier version of the prototype, using a resistive heating element](image)

The pressure sensor is a pad whose resistance falls with pressure. The sensor is connected between power and ground in series with a standard resistor, and the voltage at the junction measured using the analogue to digital converter in the Arduino.

The accelerometer-gyroscope combo, the MPU 6050, uses the I2C protocol to send the data to the Arduino. Standard libraries exist to read the data sent by the accelerometer. The IR temperature sensor also uses I2C to send temperature data to the Arduino. The I2C protocol allows multiple devices to be daisy-chained and thus communicate through the same port.

The vibration motor is a 3V motor with an off-axis mass. It is controlled with the Motor Driver shield for Arduino built by Adafruit Industries. The Thermoelectric heater can take 12V and 58W max, but we supply it a max power of 5V, from the Motor Driver Shield. The voltage supply can be inverted to cool the device down.
5.3 Social Networking Aggregator CEP

The CEP involves selecting two pages worth of information from social networking feeds of the user, collecting and organizing it before printing it out and showing it to their family members who do not use social networking sites.

All kinds of posts, including status messages, shared links, events, maps, friends added, photos uploaded and photos tagged in were part of the aggregated print, so that we could have feedback on what content was appreciated the most.

While the CEP had the user manually select the posts to be shown to their grandparents, the idea is that the final product can use the privacy settings within Facebook to decide what posts the user is willing to show to his family. There will also have to be a grandparent filter, which removes posts that will not be of interest to elders, and also adds a layer to make things simpler. For instance, when there is an event that the user attended, it can give a short description of what the event is. It could also clarify for the seniors terms that younger people use but are not common among older people.
5.4 Peripheral Vision CEP

The CEP setup involves a headset that fixes an iPhone next by the side of the users eye so that the image onscreen replaces their peripheral vision. The iPhone is then connected to a stationary iPhone/iPad via FaceTime. It is fixed such that the person who is communicating with the user can be seen to be facing the same direction that the user is.

The first design for our headset involved fixing the iPhone in a holder which can slide on a Sony headset. This had the advantage of being light, however, it was unbalanced and had a tendency to fall off or feel precarious.

Another issue was that the display could be adjusted up or down, but had to stay in the plane of the ear. This turned out to a problem, and we discovered that peoples heads are shaped very differently.

We then redesigned the device by integrating into a helmet and adding a counterweight that stabilized it. We fixed the phone using an adjustable wire so that the user could place the display exactly where they wanted it.

The prototype used an iPhone 5 as the display. The display specifications are:

- 4-inch (diagonal) widescreen Multi-Touch display
- 1136-by-640-pixel resolution at 326 ppi
- 800:1 contrast ratio (typical)
- 500 cd/m2 max brightness (typical)
Apple claims that the iPhone will last for up to 10 hours with Wi-Fi on. Apple facetime needs a Wi-Fi network to work. Apple has not released technical specifications for the service yet. The camera used is an iPhone camera - Video recording, HD (1080p) up to 30 frames per second with audio.

We also use the iPhone FaceTime camera occasionally - FaceTime HD camera with 1.2MP photos and HD video (720p) up to 30 frames per second.

The iPhone has inbuilt video stabilization. Total weight of the device (including the phone)  0.5kg

5.5 3D Table

As was mentioned in design development, we came up with two ways to control several blocks with one air cylinder or motor. The first one is not realized for limits of resource.

5.5.1 Air-powered Way

![Figure 5.6: The structure of air-powered 3D table(left) and the structure of block-pipe-valve-gear system (right)](image)

Fig 5.6 (left) shows the whole structure of the device and (right) show details of essential parts of the device. Each block is actually a plunger connected to a pipe. When aerating and de-aerating through pipes, blocks can go up and go down. A valve is used at the other end of each pipe, which is re-arrayed in a circle placing upon a plan with teeth in a circle.

A gear with airway is fitted between teeth and valve Fig 5.7. When the plate rotates, the gear will be forced to roll on the plane and at the same time, tip of teeth on gears will be pushed into or pulled out of valves (Figure 5.1.1-3). By controlling the air cylinder to work at the proper time, the movement of blocks will be precisely controlled.

5.5.2 Gear-and-spline-driven way

In this CFP design, four motors are used to control a row of blocks (Fig 5.8 left). Motor A makes the platform where motor C is placed move in the row direction. When motor
C faces the spline, motor B and B’ move and push the spline that is connected to blocks. Thus, the spline separates from the spline fixed on the table and can be moved by motor C, pushing or pulling the block (as is shown in Fig 5.8 right).

After it is moved to the right place, motor B and B’ move again, but in an opposite direction. And springs stretch and push spline to make it fixed on the other spline, which is fixed on the table. Thus, the blocks are fixed and steady on table.

Materials used in the prototype are listed in Appendix B, where figures shows several essential parts of the prototype.
6 Planning

We plan to explore further areas in intergenerational communication, and also build on the ideas we have tested. Based on the feedback we received about our prototypes, we have a list of improvements that could be implemented for each of our ideas. We also plan to explore another area of our prompt - collecting and orienting digital media along the lifespan of a person, and passing it on to the next generation.

6.1 Deliverables

Fall Deliverables:

- Benchmarking Document and Presentation
- Critical Function Prototypes
- Critical Experience Prototype
- CFP/CEP Presentation and Document
- Fall presentation and Brochure
- Fall Documentation

Winter Deliverables:

- Paper Robot - a mechatronic warm-up for winter
- Dark Horse prototype - a 2nd CFP that probes the edge of the design space
- Travel Docs
- Funky Prototype Functional System Review
- Winter Design Documents
- Travel to USTC in March 2013
6.2 Milestones

Figure 6.1: Milestones

6.3 Project Budget

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Table 6.1: Budget (Part 1)
### Table 6.2: Budge (Part 1)

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### 6.4 Distributed Team Management

We plan and manage our project in a systematic way. Before each stage, schedules were made as a guide. During the implementation of the project, various documentations were made to record the progress, including meeting log, budget log and idea log etc. Time manage tools were used to set up target and milestones. With the aid of video conference, we can communicate with USTC team twice a week for cooperation.

#### 6.4.1 Communication

Video Conference twice a week with global Team, during which we report progress to each team and plan for further work. We give feedback and suggestion to each other and improved our work accordingly.

We use Tencent QQ as our communication Tool. QQ provides a convenient way to do meet with the global team. It can provide better quality free video chatting than most of the product in the market especially inside China. Features such as Intuitive Groups Management and Creation, Easy to Use, Improved Translator, Customize Your User Interface greatly enhance its function.

#### 6.4.2 File Management

Google Drive provides an easy way to manage and share file. It also offers collaborative editing on documents, spreadsheets, presentations. Our documents are divided into several groups for easy management:
6.4.3 Team website

http://me310microsoft.weebly.com/

We build our team website based on a free web service provider, Weebly. Weebly is a free web-hosting service featuring a proprietary drag-and-drop website builder. We divide our website into several sections, namely: Home, Timeline, Blog, Prototype, Calendar, Feedback and People. The timeline will show what we have done and up-to-date new about our project in time sequence. The blog will provide more details about those events. Prototype records all of the prototypes we have made.

6.5 Timeline
6.6 Reflection

6.6.1 Mishel Johns

I have enjoyed working on the Microsoft project with my team, and I very firmly believe that we have the best project prompt this year! I love the fact that our prompt is so open ended, and that we have been let free to explore the problem space and find what we would like to work on, and think of a lot of crazy ideas.

ME310 has been a lot of work, but it has been great fun too. I’m guessing it’s true for most of us in the course that our social life now revolves around the course.

I am happy with the prototypes we built and tested... however, I’m slightly disappointed that the *HUGELY INNOVATIVE IDEA* that we were waiting for has not struck us yet. By now, all of us are very familiar with our problem statement, the needs, the existing technology were mini-experts on the topic by now. I wish, however, that we had done more benchmarking on the elderly early on, rather than just relying on secondhand accounts from experts and from the USTC team which visited the elder center. We plan to rectify that mistake as soon as all of us are done with our finals. We were also late benchmarking our peers families with surveys and pulling enough data to rationalize our decisions.

Now, I think I have a better sense of effort vs. returns for ideas than I did a month ago. While the tactile messaging CFP took a lot more time to build than the other two prototypes, its importance to our project is not similarly larger. The smart choice is to probably estimate early on whether the work involved in pursuing the idea is worth the knowledge we will gain.

As a team, we spent most of this quarter exploring different areas and looking at very different ideas. That is also illustrated by our choice of very diverse, and probably unconnected, critical functions and experiences. We were afraid that by not exploring an area or by selecting a topic to focus on too early, we might miss a great idea that was just around the corner. Perhaps, however, it is now time to just select one area and push ahead with it and go in depth.

I am happy that the collaboration with the USTC team is working well. We anticipated a lot of problems due to the Great firewall, but they have not been realized. We share files on Google drive, and have a common meeting log and idea log. However, I think we need tighter integration with the USTC team - we need to plan out our biweekly meeting better, set up an agenda before every meeting so that each meeting is not just letting each other know what we have been doing in the past few days, but actually carries forward the teams work.

I’m very excited about what can do with the project in the next two quarters. I’m also very happy to be finally done with the documentation so I can go get some badly needed sleep.
6.6.2 Shiquan Wang

Our team is quite special: all of us are from engineering department and are fond of mechatronics, which are great, because we share the common interest and easy to go in the direction all of us will like. But as time went, I started to realize the down point of this monotone diversity: lack of person good at keeping the entire project being well organized and also lack of ways of presenting what we have done in a nice way. Actually we did notice that beforehand, which was why we spent quite much time discussing about our collaboration methods. At first, everything was good but then with the curriculum burden sharply increased, the team became less organized and our Google drive was in mass. It is a good time to resort our documents and optimize our team collaboration protocols. During this fall, my orientation has shifted a little bit. I like our team because we have common interest of designing and implementing some fancy devices. But after the thanksgiving break when I spent lots of time in technical things, I started to notice low efficiency of our team sometimes. If all of us were fond of playing with technical things and no one keeps a mind of the broad picture of our project and other things which are not quite technical such as logo and brochure, handout design, it would be a bad thing for a team especially in class like ME310. Then I compelled myself to change my role. It was not that easy, but it is valuable for me also, to learn and pay attention to things that I once didn’t care much about. Our team in this quarter spent most of the time doing divergence things without clear purpose. Though we tried a lot interesting ideas, and it might be good if a team can explore as much as possible in the first stage of project, I still worried about what we tried could really give us valuable insights for our future direction. We experienced tough time of deciding which way even until the day before making CFP. The reason might be: 1) we are too eager to find ideas that are extremely awesome and perfect, which made it difficult to feel satisfied about whatever ideas and reluctant to make the decision of which way to go, which we thought might exclude some potential excellent ideas. But what if there is no idea that exactly good or bad? Or best ideas exist in most of the direction and can only be discovered by delving into and exploring deeply? Then the way we used, tried to figure out the best idea at the very beginning doesn’t make any sense; 2) We might have a wrong understanding of what basing on need means. We thought it means whatever decision we make should base on typical need-finding methods. For example, if we hope to determine our direction as building something useful for family connection. But just as what John Tang told us, there are also many needs that are common senses. Even in Microsoft research center, it is possible to start a research project without doing any need-finding things to prove the necessity. What more important is, there is no criterion to judge which need is better than the other. Even if you do a lot of survey and do a lot of interview, which makes
your project looks nice, it is still possible that those people you meet cannot represent the overall need at all. Probably for every direction, there always exist good needs, which can be discovered only if you can delve into the details. So it is unreasonable to delay making decision of which way just because the needfinding is not enough. A better way might be after some time of brainstorming and needfinding, just pick a way even without enough reasons, then can we needfinding with more purpose and in more detailed scenario.

6.6.3 Xuesen Li, Tony

The first quarter of our Microsoft Team project has left us with an unforgettable experience. We really enjoy the process of making prototype and the time spent with our teammates. We have also learnt a lot of knowledge and skills beyond our major study. Systematic management of the project is crucially important. In the first stage, we cannot find the right direction and thought about ideas randomly. Without insight on them, we abandoned a lot of valuable ideas which can be developed further. Sometimes, we trend to see the problems rather than the opportunities, which made me frustrated at some point. After introspective and investigating of good examples, we discover that one thing which we should always do is to check what have done, what is the problem and what is the opportunity. This will give us a good picture of the whole project as well as much more hidden information which can be discovered. Engineers always think how to make the product functioning, but not beautiful. However, the appearance is of great important to the customers. Design should always start from the users interface. Product design should be based on need. A product only showing off fantastic technology may not be useful. Thinking carefully what people need can never be neglected in the designing stage. Users feedback is valuable information for designer to make improvement. Designer may be confined within their own scope and cannot discover the shortcoming or new opportunities. For example, we did not expect peripheral vision can have such a real and unique experience to users until we tried it. This allowed us further seek for solution to improve users experience.

6.6.4 Yingwei Li

It is an exciting experience for me to work in a global program and to have fun during the process. The most striking thing I’ve learnt in the past quarter is that I started trying to think in a design mind. I had been concentrated too much on techniques
and skills before I took ME310. During the past quarter, I understood how to do get to know a new field by benchmarking and interviewing. I've also learnt how to generate great ideas in a group and how to cooperating with team members—how to share the responsibilities, how to motivate myself and my teammates and how to use the internet to cooperate with teammates.

We've been through various interesting experiences last quarter. There was happy time when we were out for interviews, unpleasant time when we were frustrated by an existing idea and exciting moment when we see our idea worked. Those wonderful moments are memorable to me and I'll keep on learning from our past experience.

The Microsoft project is interesting with lots of possible directions. For next quarter, I think we need to continue finding needs of our potential users and choose one big idea to work on. Additionally, by improving communication with the Stanford team, we can be more efficient and generate more thoughts. I appreciate the help from my Stanford teammates when we got stuck on how to understand the design methodologies. And I was so impressed by the painting techniques of Yunjun and Yikang. They helped a lot when we wanted to demonstrate our ideas in group meetings. I'll treasure the friendship with my teammates. It's quite lucky for me to have you all around to work in this project. I'll keep on working and keep on enjoying.

6.6.5 Yikang Liu

I have been looking forward to getting involved in an international exchange project during my undergraduate years, since I believe that it is in this period time that my opinion of the world gradually generates and it is quite essential to learn more about the world. So, it is really lucky for me to get involved in ME310 and just as I expected, I have learned a lot.

Since I entered USTC, my endeavor in my major has focused on academic study and research. Although I have always been interested in how to transform technology into a device or a product and made a robot in a competition called Robogame, I have never known it systematically, but inspiration and intuition during manufacture. It is in ME310 that I firstly get to know about systematical theory about design thinking and the process of design, brainstorming, need-finding, benchmarking, prototype and dark horse. ME310 has opened a door for me and helped me to really think what I can make by technology I learned, which almost remained as formula, reasoning and figures on books before it. Actually, design seems to have entered my subconscious and interesting ideas sometimes jumps out of my mind and I know what to do next to improve and test my thoughts.

Looking back at what the whole team has done in the last two months, I believe the ability of every team member has improved in many perspectives, such as cooperating,
thinking innovatively, investigating and writing documents. However, several problems showed up and impeded our progress.

The first problem is the lack of collaboration between two teams. Although we communicated by Google Drive and emailed and had two meetings a week, we did many works separately, especially prototype. Though it seems to be more efficient to work separately sometimes due to the distance and different time zone, its disadvantage is quite clear. We would have done better on a prototype if we had done it together, for the reason that two teams have different advantages. The advantage of Stanford team is technology, since the team is made up of three graduates and Stanford provides an excellent technology circumstance. USTC team do well in interview, since there are much more people and much more different kind of people, especially including those not highly-educated and poor, living around USTC.

The second problem would be the lack of coherence of our work. Actually, USTC team found need on the elderly but finally made a prototype for a toy for children. And we made our CPF without knowing what to test and what to learn. The reason is that we were not able to come up with an innovative solution to the elderly’s inconvenience in using digital devices. Every problem we came across settled on solution to a technical problem. When we changed to another direction, which is children, there was no time left for us to need-finding and benchmarking. So, we made our CPF in a hurry, kind of aimless and dizzily. This failure, in my opinion, is partly due to deficiency of communication with MSRA. If we had discussed with MSRA and learned about what kind of problems we were going to face in our challenge and whether it was any room left for us to do something innovative by technology we were able to obtain, such as Kinect as a developing platform, we may had avoided the technical problems and turned to innovative thinking instead.

6.6.6 June Zhang

Joining ME310 is a wonderful experience and has made this semester quite different for me. I was not clear about what we were going to do until the Kickoff course, when teachers in Stanford and other global universities gave those expressive presentations. During the stay in Stanford I gradually understood that this project needs not only mechanical and programming skills but also novel ideas and wide and careful investigations. The project Microsoft gave us is a wide one, but its a really attractive subject. Since its wide, our imaginations were not constricted and many fantastic ideas were thought out. We tried many directions, did lots of need-finding and benchmarking and brainstormed a lot. I learned the importance of need-finding and benchmarking during this process. Through need-finding we can find out what people need and what they care. And benchmarking provides us with available technology and novel ideas. At the beginning of December we USTC team made a CFP of 3D Table. Though its not a very successful one, we
learned a lot about prototype and practiced our mechanical skills. We are glad to see Stanford team made three excellent CEP and CFPs. The next quarter we will make a prototype together. Its really nice working with the three excellent Stanford students. We communicated a lot and they gave us much help. They can always come up with novel ideas and encouraged us a lot. And my USTC partners are also wonderful and excellent. We came across many difficulties together and shared each others pain and happiness. I believe that next quarter will be a challenging but fantastic one with these nice guys.

6.6.7 Yunjun Wu

It’s a really amazing experience in the last 3 months with the USTC teammates and Stanford guys. Though we’ve being through a tough process in our projects, I still have a lot of fun and learn many things about design here in ME310. About our project topic, I think it’s quite large for us to focus, but we have a lot of specific thoughts and ideas about it. During the process of brainstorming, need-finding, I learned more about how to diverge and how to focus my mind. I think that the designing process can be quite annoying when I get everything complicate; and quite fun when I find out the interesting connection of different ideas. So I tried to control my mind and to organize my thinking process to make it more efficient. And the most important thing is that, though this semester, I see more about the world and the advanced technology. The more I see, the more I think. So I guess, I will keep doing this in the nest semester and in the future study. Also, the experience of working in the team is incredible for me. I enjoyed every moments we discussing our ideas, especially when we share the creative thoughts about the projects. It just feels like that an excellent idea can light up the whole day. And even if we are in tough days, like we did with our CFP, we still push on together to make things work. Im looking forward to our cooperation in the following semester and our final prototype for class.
7 Resources

We would like to thank the ME310 Teaching Team, including Prof Mark Cutkosky, Prof. Larry Leifer, George Toye, Tyler Bushnell, Scott Steber and Annika Matta for their valuable feedback and advice at all stages in the project. We would like to thank all of them, especially Tyler, for taking the time to analyze our project progress and suggest corrections. We are also grateful to our coaches Adrit Lath and Rafat Mehdi, who have been very supportive of our project and have helped us out multiple times with advice and ideas.

We would also like to express our gratitude to the following people who have been of invaluable help to us. We would specially like to thank Dave Jaffe from the Mechanical Engineering Design Group for his advice and support, and for the brainstorming session he had with our team.

Scott Klemmer

- srk@cs.stanford.edu
- 650-723-3692
- Gates Computer Science #384 Stanford CA 94305-9035

Scott is an Associate Professor of Computer Science at Stanford University. He co-directs the Human-Computer Interaction Group and holds the Bredt Faculty Scholar development chair. Organizations around the world use his lab’s open-source design tools and curricula; several books and popular press articles have covered his research and teaching.

David L. Jaffe

- dljaffe@stanford.edu
- 650-723-3692
- Gates Computer Science #384 Stanford CA 94305-9035

David is a Class Lecturer and Student Project Coach of Mechanical Engineering at Stanford University. His research includes Using a Simulator to Improve Driving Ability after Brain Injury, Pressure/Motion Feedback to Protect Skin of Sensorimotor Impaired Elders, Improving Stepping-Over Responses in the Elderly using Simulated Objects

We would also like to thank the following organizations which agreed to let us visit them and talk to seniors.
City of Mountain View Senior Center

- Senior.Center@mountainview.gov
- 650-903-6448
- City of Mountain View Senior Center 266 Escuela Avenue

La Comida Dining Room

- manager@LaComida.org
- 450 Bryant Street
- Palo Alto, CA 94301
- (650) 322-3742
Bibliography


Appendix A - Need-finding

Table A-1: Results and Insights of needfinding in the nursing house

<table>
<thead>
<tr>
<th>Results</th>
<th>Insights</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. “I’ll use the public phone in the nursing house and the nurse will help me dial.” “I have a phone but the nurse helps me keep it. When I need to dial or text my family, she’ll help.”</td>
<td>We’ve always thought about devices for personal use. However this phenomenon pointed out a new direction--we can also considering building a device that works for a group of people.</td>
</tr>
<tr>
<td>2. “I’ll record all the numbers on a piece of paper and refer to it when I need to dial.” (actually there were only a few numbers needed to be recorded)</td>
<td>There’s an obvious need that the elderly need a convenient way to record phone numbers, time to take pills and other information.</td>
</tr>
<tr>
<td>3. Most people suffer from disabilities related to hands or eyesight. These disabilities block their way to digital world to some extent. Some people mentioned that they can’t travel places they’ve always dreamt of because of the disabilities.</td>
<td>We may think of ideas about building devices that make up for the inconvenience caused by their disabilities. A “virtual travel” machine might be a solution which will simulate the scenario of the sight spot.</td>
</tr>
<tr>
<td>4. Some old people kept photos in an album and they thought the idea of e-album was good. Meanwhile, most of the elders love magnification function. However, some of them had problems in manipulating the device because of the disabilities in their hands.</td>
<td>While it seems easy and intuitive for the young generation to magnify the photos using finger control, for the elderly it becomes obscure. It seems that they’re more receptive to buttons.</td>
</tr>
</tbody>
</table>

Table A-2: Situation of the Elderly
<table>
<thead>
<tr>
<th></th>
<th>Got a Mobile Phone?</th>
<th>Play Computer?</th>
<th>How to Keep in Touch with Relatives</th>
<th>Have Tried Video Talk?</th>
<th>Like It or Not?</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Y</td>
<td>N</td>
<td>mobile phone, face to face</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>N</td>
<td>N</td>
<td>telephone, face to face</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Y</td>
<td>N</td>
<td>mobile phone</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>N</td>
<td>N</td>
<td>telephone, face to face</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Y</td>
<td>N</td>
<td>mobile phone, telephone, f to f</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>N</td>
<td>N</td>
<td>face to face</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Y</td>
<td>N</td>
<td>telephone, face to face</td>
<td>N</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>What Stuff You Always Record</th>
<th>Use What Materials to record important things</th>
<th>Daily Entertainment</th>
<th>How Often do You Travel?</th>
<th>Want to Travel?</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td></td>
<td></td>
<td>majiang</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>watching TV, cooking</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td>listening to radio, peking opera</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td>doing handwork, opera, chatting</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>time of appointments</td>
<td>notebook or cardboard</td>
<td>cooking, ping-pong, watching TV</td>
<td>Y, three times a year</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td>reading, handwork,</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Birthday of family members</td>
<td>cardboard</td>
<td>opem, reading, shopping</td>
<td>Y, twice a year</td>
<td></td>
</tr>
</tbody>
</table>
## Appendix B: Design Description

### 3D table

<table>
<thead>
<tr>
<th>Component</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stepping motor*3</td>
<td>20mm<em>20mm</em>34mm 1.8Ncm 4V 0.6A step angle: 1.8</td>
</tr>
<tr>
<td>Sliding platform disassembled from a printer</td>
<td>length: 310mm</td>
</tr>
<tr>
<td>Stepping motor</td>
<td>42mm<em>42mm</em>35mm 0.1Nm 4V 0.95A step angle: 1.8</td>
</tr>
<tr>
<td>Nylon spline</td>
<td>tooth module: 1 length: 1m</td>
</tr>
<tr>
<td>Gears*4</td>
<td>tooth module: 1 inner diameter: 4mm outer diameter: 12mm</td>
</tr>
<tr>
<td>PMMA board</td>
<td></td>
</tr>
<tr>
<td>Screw</td>
<td></td>
</tr>
<tr>
<td>Foam</td>
<td></td>
</tr>
<tr>
<td>MCU</td>
<td>ATMEGA328P-AU</td>
</tr>
<tr>
<td>Stepping motor driver</td>
<td>L298N</td>
</tr>
<tr>
<td>Battery</td>
<td>12V &lt;6A</td>
</tr>
<tr>
<td>Voltage transformer</td>
<td>8-45V -&gt; 5V</td>
</tr>
<tr>
<td>Wire</td>
<td></td>
</tr>
</tbody>
</table>
Appendix C - Tactile Messaging CFP Component
Specifications

Arduino:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microcontroller ATmega328</td>
<td></td>
</tr>
<tr>
<td>Operating Voltage</td>
<td>5V</td>
</tr>
<tr>
<td>Input Voltage (recommended)</td>
<td>7-12V</td>
</tr>
<tr>
<td>Input Voltage (limits)</td>
<td>6-20V</td>
</tr>
<tr>
<td>Digital I/O Pins</td>
<td>14 (of which 6 provide PWM output)</td>
</tr>
<tr>
<td>Analog Input Pins</td>
<td>6</td>
</tr>
<tr>
<td>DC Current per I/O Pin</td>
<td>40 mA</td>
</tr>
<tr>
<td>DC Current for 3.3V Pin</td>
<td>50 mA</td>
</tr>
<tr>
<td>Flash Memory 32 KB (ATmega328)</td>
<td>of which 0.5 KB is used by the bootloader</td>
</tr>
<tr>
<td>SRAM 2 KB (ATmega328)</td>
<td></td>
</tr>
<tr>
<td>EEPROM 1 KB (ATmega328)</td>
<td></td>
</tr>
<tr>
<td>Clock Speed</td>
<td>16 MHz</td>
</tr>
</tbody>
</table>

Atmega328:

- 131 Powerful Instructions – Most Single Clock Cycle Execution
- Internal Calibrated Oscillator
- External and Internal Interrupt Sources
- I/O and Packages
  - 23 Programmable I/O Lines
  - 28-pin PDIP, 32-lead TQFP, 28-pad QFN/MLF and 32-pad QFN/MLF
- Operating Voltage: 1.8 - 5.5V
- Temperature Range: -40C to 85C
- Speed Grade: 0 - 20 MHz @ 1.8 – 5V

IR sensor:

- Factory calibrated in wide temperature range:
  - +40 . . . +125 [2DA?][C for sensor temperature and
  - -70 . . . +380 [2DA?][C for object temperature.
- Simple adaptation for 8 . . . 16V applications
- Measurement resolution of 0.02C
- Power saving mode

Accelerometer: MPU 6050

- Digital-output X-, Y-, and Z-Axis angular rate sensors (gyroscopes) with a user-programmable full-scale range of ±250, ±500, ±1000, and ±2000/sec
- Gyroscope operating current: 3.6mA
- Digital-output triple-axis accelerometer with a programmable full scale range of ±2g, ±4g, ±8g and ±16g
- Accelerometer normal operating current: 500μA
- Orientation detection and signaling
- User-programmable interrupts
Appendix D - Tactile Messaging CFP Code

Output Part

#include <i2cmaster.h>
define MOTOR_PIN 9
// define HEAT_PIN 9
#define TURNOFF 0
#include <AFMotor.h>
AF_DCMotor motor(2, MOTOR12_64KHZ); // create motor #2, 64KHz pwm

int heatValue=0;
byte inByte=0B00000000; //for serial read

// valuables defined for the heat sensor
int dev = 0x5A<<1;
int data_low = 0;
int data_high = 0;
int pec = 0;
double tempFactor = 0.02; // 0.02 degrees per LSB (measurement resolution of the MLX90614)
double tempData = 0x0000; // zero out the data
int frac; // data past the decimal point
byte infTemp;
float realTempC;
float goalTempC;
byte motorValue;
// define control coeffeciencts PID control
float P=4; //P should be equal or smaller than 4
float I=1;
float D=1;

void setup() {
  // initialize serial communication at 9600 bits per second:
  Serial.begin(9600);
  pinMode(13, OUTPUT); //port 13 is connected wicth LED
digitalWrite(13, LOW);
  //for the heat sensor
  i2c_init(); //Initialise the i2c bus
  PORTC = (1 << PORTC4) | (1 << PORTC5); //enable pullups
digitalWrite(MOTOR_PIN,LOW);
}

void loop() {
  digitalWrite(13, LOW);
  if (Serial.available() > 0) {
    digitalWrite(13,HIGH);
  }
}
/ get incoming byte:
inByte = Serial.read();
delay(10);

// channel 00: OPTION 0: IF WE USE THE MOTOR TO TRANSMIT TOUCH:
if ((inByte&0B11000000)==0B00000000) { //the priority of == is higher than &
motorValue = (inByte&0B00111111)*255/63;
analogWrite(MOTOR_PIN, motorValue);
delay(10);
}

// channel 01: OPTION 1: TRANSMITE TEMPERATURE
else if((inByte&0B11000000)==0B01000000) {
    // use temperature values sent from the input_part - control system code here
    // temperature coming means touch pad activated, output to the heater using
    PWM control
    digitalWrite(13, HIGH);
    //Receive the goal temperature
    infTemp=inByte&0B00111111;
    //range 15°45
goalTempC=((float) infTemp)/64*30+15;
    //sense the temperature
    pec = 0;
i2c_start_wait(dev+I2C_WRITE);
i2c_write(0x07);
i2c_rep_start(dev+I2C_READ);
data_low = i2c_readAck(); //=Read 1 byte and then send ack
data_high = i2c_readAck(); //=Read 1 byte and then send ack
pec = i2c_readNak();
i2c_stop();
    // This masks off the error bit of the high byte, then moves it left 8 bits and
adds the low byte.
tempData = (double)(((data_high & 0x007F) << 8) + data_low);
tempData = (tempData * tempFactor)-0.01;
    //Write the value
realTempC = tempData - 273.15;

    //PWM control and output the heat
if (goalTempC>=realTempC) {
    //transfer the temperature difference to output intensity
    heatValue= (goalTempC-realTempC)*64/30*P;
    if (heatValue>=255) {
        heatValue=255;
    }
    //using the motor shield to drive the heater
    motor.setSpeed(heatValue);
motor.run(FORWARD);
//analogWrite(HEAT_PIN, heatValue);
}
else {
    heatValue= (realTempC-goalTempC)*64/30*P;
    if (heatValue>=255) {
        heatValue=255;
    }

    //using the motor shield to drive the heater
    motor.setSpeed(heatValue);
    //cool down process
    motor.run(BACKWARD);
}

delay(10); }

// channel 10: OPTION 2: IF WE USE THE MOTOR TO TRANSMIT SHAKING:
else if((inByte&0B11000000)==0B10000000) {
    // use accelerometer values
    motorValue = (inByte&0B00111111)*256/64;
    analogWrite(MOTOR_PIN, motorValue);
    delay(10);
}

// channel 11: OPTION 3: gyroscope information:
else if((inByte&0B11000000)==0B11000000) {
    // use gyroscope values
}
}
else {
    //if no signal sent, no one touch the pad, then just cool down
    //sense the temperature
    pec = 0;
i2c_start_wait(dev+I2C_WRITE);
i2c_write(0x07);
i2c_rep_start(dev+I2C_READ);
data_low = i2c_readAck(); //Read 1 byte and then send ack
data_high = i2c_readAck(); //Read 1 byte and then send ack
pec = i2c_readNak();
i2c_stop();
    // This masks off the error bit of the high byte, then moves it left 8 bits and
    adds the low byte.
tempData = (double)(((data_high & 0x007F)<<8) + data_low);
tempData = (tempData * tempFactor)-0.01;
    //Write the value
realTempC = tempData - 273.15;

    //to recover the temperature to rest temperature when no one touch
if (realTempC>=28){
    motor.setSpeed(255);
// cool down
motor.run(BACKWARD); }
else if (realTempC<=16) {
    motor.setSpeed(255);
    // heat up
    motor.run(FORWARD); }
    // if the temperature is fine, stop the heater
else {motor.run(RELEASE); }

// A0 is used for the touch pad

// I2Cdev and MPU6050 must be installed as libraries, or else the .cpp/.h files
// for both classes must be in the include path of your project
#include "I2Cdev.h"
#include "MPU6050.h"

// class default I2C address is 0x68 (0b1101000)
// AD0 low = 0x68 (default) <I have connected the AD0 pin to ground>
// AD0 high = 0x69
MPU6050 accelgyro;

int16_t ax, ay, az;
int16_t gx, gy, gz;
int acc;
#define LED_PIN 13
bool blinkState = false;
int16_t pressure;
byte acc_send;
byte pressure_send;
// p indicates weather this device was touched by user.
int p = 0;

// valuables defined for the heat sensor
int dev = 0x5A<<1;
int data_low = 0;
int data_high = 0;
int pec = 0;
double tempFactor = 0.02; // 0.02 degrees per LSB (measurement resolution of the MLX90614)
double tempData = 0x0000; // zero out the data
int frac; // data past the decimal point
float realTempC;
byte sendTemp=0;

void setup() {
    // join I2C bus (I2Cdev library doesn’t do this automatically)
    Wire.begin();

    // initialize serial communication
    Serial.begin(9600);

    // the serial communication in this part is for testing only, it will be removed in the final version:
    // initialize device
    // Serial.println("Initializing I2C devices...");
    accelgyro.initialize();
    // verify connection
    // Serial.println("Testing device connections...");
    // Serial.println(accelgyro.testConnection() ? "MPU6050 connection successful" : "MPU6050 connection failed");

    // configure Arduino LED for
    pinMode(LED_PIN, OUTPUT);

    i2c_init(); // Initialise the i2c bus
    PORTC = (1 << PORTC4) | (1 << PORTC5); // enable pullups
}

void loop() {
    pressure = 0;
    p = 0;
    pressure = analogRead(A0); // read the input pin
    if(pressure > 800) {
        p = 1;
        digitalWrite(LED_PIN, HIGH);
    } else {
        p = 0;
        digitalWrite(LED_PIN, LOW);
    }

    // when user is using the device
    if(p==1){
        // read raw accel/gyro measurements from device
        // accelgyro.getMotion6(&ax, &ay, &az, &gx, &gy, &gz);
// read only accelerometer values
accelgyro.getAcceleration(&ax, &ay, &az);

acc = sqrt((long)ax*(long)ax + (long)ay*(long)ay + (long)az*(long)az);
//Serial.print(az);Serial.print("t");

//Serial.print(acc);Serial.print("t");
//sort of eliminate the effect of gravity
//acc = acc - 15850;
acc = acc - 23000;

//if no big acceleration, don't send this information.
if (acc>=500){
  // for serial:
  //channel 10 for shaking
  acc_send = 0b10000000 + (((byte)acc) >> 2);
  Serial.write(acc_send);//Serial.print("t");
  delay(20);
}

//---

// these methods (and a few others) are also available
//accelgyro.getAcceleration(&ax, &ay, &az);
//accelgyro.getRotation(&gx, &gy, &gz);

// display tab-separated accel/gyro x/y/z values for testing
// Serial.print("a/g:");
// Serial.print(ax); Serial.print("t");
// Serial.print(ay); Serial.print("t");
// Serial.print(az); Serial.print("t");
// Serial.print(gx); Serial.print("t");
// Serial.print(gy); Serial.print("t");
// Serial.println(gz);

// blink LED to indicate activity
// blinkState = !blinkState;
// digitalWrite(LED_PIN, blinkState);

//analogReference(type) - calibrate and use this function so we get a nice range of values from the pressure sensor
pressure_send = 0b00000000 + ((byte)pressure >> 2);
Serial.write(pressure_send);
delay(20);
// Serial.println(pressure);
// ---temperature part---
// sense the temperature
pec = 0;
i2c_start_wait(dev+I2C_WRITE);
i2c_write(0x07);
i2c_rep_start(dev+I2C_READ);
data_low = i2c_readAck(); //Read 1 byte and then send ack
data_high = i2c_readAck(); //Read 1 byte and then send ack
pec = i2c_readNak();
i2c_stop();

// This masks off the error bit of the high byte, then moves it left 8 bits and adds
// the low byte.
tempData = (double)(((data_high & 0x007F) << 8) + data_low);
tempData = (tempData * tempFactor)-0.01;

// Write the value
realTempC = tempData - 273.15;

// if lower than 15, than ignore the temperature thing.
if ((realTempC-15) >= 0) {
  // range: 15-45 Celsius
  realTempC=(realTempC-15)*64/30;
  if (realTempC > 63){
    realTempC = 63;
  }
  // typecast the value from float to byte
  sendTemp = realTempC;
  // channel 01 for temperature information
  sendTemp = 0b01000000 + sendTemp;
  Serial.write(sendTemp);
  delay(20);
}

else if (p == 0) {
}

}

Appendix E - CFP CEP Handout

Appendix F - Fall Final Brochure
Motivation
We are exploring methods of remote companionship and communication to strengthen connections between family members and intimate friends which have been impaired by:
- Disparity in communication tool preference
- Lack of time
- Geographical separation

Function 1
Conveying the exact temperature of your hand when you are holding it so the other end can feel your temperature or warm up your hand by holding his device.

Function 2
Conveying your hand’s movements when holding the device to the other end.

CFP System Setup

CFP Finding from Testing
- Most users thought that the temperature communication is interesting especially when:
  - Temperature output is quick and responsive
  - Able to heat the other’s hand up by both holding on the devices.
- Shape and material for touch and feeling temperature are very important.
  - Small enough to be put into a pocket and taken with one anywhere
  - Able to squeeze it to convey nervousness and anxiousness
  - Soft and can press on the face to feel the warmth
- Functions preferred depend on who to use with.
  - More likely to use the temperature conveying function with spouse/lover.
  - Use the movement conveying function to express emotion or emphasize words when audio/video chatting with parents.
- Hope to have other input and output movement.
  - Complex input movement such as drawing smiling face in the air; squeeze
  - Respiring movement; Deflation/inflation; Simple project.
  - It might work better along with audio or video chat
Function 1
Feel family’s or friends’ presence and keep the interaction alive while working or entertaining alone.

Function 2
Create a comfortable peripheral vision and sound background to improve working/entertainment environment.

User Experience
• Among 9 users, 5 felt the device can provide a feeling of that someone was next to them.
• 4 users found the experience more engaging than expected.
• 5 users think the device lets them be engaged in work but still have connection with the other side.

• 4 users felt uncomfortable about unable to see clearly the screen when they want.

Other Useful Findings
• Waving and approaching can easily be realized even when deeply engaged in something. Other movement such as stretch and leaving depends on users attention.
• Background sounds, function of sharing music, stereo audio could

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• 4 users felt uncomfortable about unable to see clearly the screen when they want.

Other Useful Findings
• Waving and approaching can easily be realized even when deeply engaged in something. Other movement such as stretch and leaving depends on users attention.
• Background sounds, function of sharing music, stereo audio could

Testing for Device Optimization

Optimization

<table>
<thead>
<tr>
<th>Distance to Camera</th>
<th>~30in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displayer Angle</td>
<td>~15deg</td>
</tr>
</tbody>
</table>

Other Factors

<table>
<thead>
<tr>
<th>Position of user in Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen Brightness</td>
</tr>
<tr>
<td>Screen Light Reflection</td>
</tr>
<tr>
<td>Image Contrast</td>
</tr>
</tbody>
</table>
Our team, consisting of three students from Stanford University and four from USTC, has been tasked by Microsoft Research Asia to ‘Design and build a device that can bridge the divide between people ‘living’ in the digital world and people only living in the physical world’.

**BACKGROUND**

Today, there is a significant and growing divide between younger members of a family that communicate most often using the internet and digital technology, and older members that are either uncomfortable with or incapable of utilizing the same technology.

**VISION**

We aim to reconnect families by building a device that allows generations of a family to maintain communication despite being physically separated. The product will encourage families to stay in touch by improving accessibility to technology and by efficient utilization of time.

**REQUIREMENTS**

- Enhance communication between members of different generations in family.
- Be suitable for users belonging to multiple generations.
- Affordable to a middle class family in China, including initial and recurring cost.
- Efficient use of time, requires less time to be dedicated to communication.
- Flexible connectivity options, can utilize multiple options for connectivity.
- Portable device requirements, should comfortably fit into a pocket, and should carry enough charge to last a day.
The Peripheral Vision Goggle aims to use peripheral vision to maintain a visual connection in remote communication, while at the same time allowing the user to be engaged in another activity that requires his central field of vision.

Most users felt that the goggle quite realistically simulated the presence of a person next to them, and many instinctually tried to turn to see the person.

The feedback we received included an appreciation of having information passed along that could spark a conversation later, but also worries about the lack of personal interaction. That most of the posts on social networks are not of interest to older people was an issue, and most users preferred the data to be presented on a screen.

The Peripheral Vision Goggle did not significantly affect their performance in tasks. However, the inconvenience of having to wear the device, and the inability to see the person face to face was expressed.

Other input and output options, like squeezing the cube and deflating/inflating the cube, were also suggested. Some users thought it would work better with audio messages or video chat.

The Touch Cube tests the importance of communicating the sensation of touch via temperature and vibration in maintaining a feeling of intimacy while connecting.

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The Social Networking Aggregator creates a printed version of your social networking feeds for older members of your family. It aims to test the utility of the kind of information posted in social networking services.