Cook blind: Enhancing cooking experiences for visually-impaired people

Xiaohang Zhang
Purdue University

Follow this and additional works at: https://docs.lib.purdue.edu/open_access_theses
Part of the Art and Design Commons

Recommended Citation
https://docs.lib.purdue.edu/open_access_theses/1023

This document has been made available through Purdue e-Pubs, a service of the Purdue University Libraries. Please contact epubs@purdue.edu for additional information.
This is to certify that the thesis/dissertation prepared

By  Xiaohang Zhang

Entitled

COOK BLIND:  
ENHANCING COOKING EXPERIENCES FOR VISUALLY-IMPAIRED PEOPLE

For the degree of  Master of Fine Arts

Is approved by the final examining committee:

Steve Visser
Chair

Li Zhang

Zhenyu Qian

To the best of my knowledge and as understood by the student in the Thesis/Dissertation Agreement, Publication Delay, and Certification Disclaimer (Graduate School Form 32), this thesis/dissertation adheres to the provisions of Purdue University’s “Policy of Integrity in Research” and the use of copyright material.

Approved by Major Professor(s):  Steve Visser

Approved by:  Harry Bulow  6/14/2016
Head of the Departmental Graduate Program  Date
COOK BLIND:
ENHANCING COOKING EXPERIENCES FOR VISUALLY-IMPAIRED PEOPLE

A Thesis
Submitted to the Faculty
of
Purdue University
by
Xiaohang Zhang

In Partial Fulfillment of the
Requirements for the Degree
of
Master of Fine Arts

August 2016
Purdue University
West Lafayette, Indiana
TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST OF FIGURES</td>
<td>iv</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>vi</td>
</tr>
<tr>
<td>CHAPTER 1 INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>CHAPTER 2 LITERATURE REVIEW</td>
<td>4</td>
</tr>
<tr>
<td>2.1 Visual Impairment</td>
<td>4</td>
</tr>
<tr>
<td>2.2 Five Senses</td>
<td>4</td>
</tr>
<tr>
<td>2.3 Braille</td>
<td>5</td>
</tr>
<tr>
<td>2.4 Assistive Technology</td>
<td>6</td>
</tr>
<tr>
<td>CHAPTER 3 METHODOLOGY</td>
<td>9</td>
</tr>
<tr>
<td>CHAPTER 4 PRELIMINARY STUDIES ON VISUALLY-IMPAIRED COOKING AND EXISTING DESIGNS</td>
<td>11</td>
</tr>
<tr>
<td>4.1 Field Study as a “Visually-Impaired Person”: Cooking without Sight</td>
<td>11</td>
</tr>
<tr>
<td>4.2 Data Collection: Verbal Interviews, Video Interviews, and Web Research</td>
<td>17</td>
</tr>
<tr>
<td>4.3 Data Analysis and Synthesis</td>
<td>24</td>
</tr>
<tr>
<td>4.4 Case Studies of Existing Products to Assist the Visually Impaired Design and Implementation</td>
<td>25</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>4.5 Problem Definition</td>
<td>32</td>
</tr>
<tr>
<td>4.6 Concept Generation</td>
<td>33</td>
</tr>
<tr>
<td>CHAPTER 5 DESIGN AND IMPLEMENTATION</td>
<td>35</td>
</tr>
<tr>
<td>5.1 Design Requirements</td>
<td>35</td>
</tr>
<tr>
<td>5.2 Brainstorming</td>
<td>37</td>
</tr>
<tr>
<td>5.3 Concept Development and Refinement</td>
<td>41</td>
</tr>
<tr>
<td>5.4 Final Design Concept</td>
<td>47</td>
</tr>
<tr>
<td>CHAPTER 5 CONCLUSIONS</td>
<td>55</td>
</tr>
<tr>
<td>NOTES</td>
<td>59</td>
</tr>
<tr>
<td>BIBLIOGRAPHY</td>
<td>63</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Participation as Visually Impaired Person</td>
<td>11</td>
</tr>
<tr>
<td>2. Selected Kitchen for Participation</td>
<td>12</td>
</tr>
<tr>
<td>3. Rice Cooker Console</td>
<td>14</td>
</tr>
<tr>
<td>4. Unorganized Container</td>
<td>14</td>
</tr>
<tr>
<td>5. Stove Console</td>
<td>15</td>
</tr>
<tr>
<td>6. Braille Label Maker</td>
<td>25</td>
</tr>
<tr>
<td>7. Raised Letter Maker</td>
<td>27</td>
</tr>
<tr>
<td>8. Apple VoiceOver</td>
<td>28</td>
</tr>
<tr>
<td>9. JAWS for Windows</td>
<td>29</td>
</tr>
<tr>
<td>10. Be My Eyes</td>
<td>31</td>
</tr>
<tr>
<td>11. Design Concept Ideation</td>
<td>38</td>
</tr>
<tr>
<td>12. Design Concepts Refinements</td>
<td>40</td>
</tr>
<tr>
<td>13. User Behavior Analysis</td>
<td>43</td>
</tr>
<tr>
<td>14. Ergonomic Mock-up Test</td>
<td>45</td>
</tr>
<tr>
<td>15. IPhone 5 Design</td>
<td>46</td>
</tr>
<tr>
<td>16. Final Design Sketches</td>
<td>48</td>
</tr>
<tr>
<td>Figure</td>
<td>Page</td>
</tr>
<tr>
<td>--------</td>
<td>------</td>
</tr>
<tr>
<td>17. Usage Explanation: Voice Label Making</td>
<td>51</td>
</tr>
<tr>
<td>18. Usage Explanation: Voice Label Reading</td>
<td>52</td>
</tr>
<tr>
<td>19. User Experience Explanation</td>
<td>54</td>
</tr>
</tbody>
</table>
This paper introduces a new method to assist visually-impaired people to find what they need in order to complete cooking. Following the design thinking made by me at the beginning of my research, I started to create a new design based on target users’ suggestions and preferences. This study focuses on the demands and user experiences of visually impaired people, the integration of design principles adapted from industrial design, user-centered design, and interaction design. I recorded the daily activities of the visually impaired individuals, and then investigated the most reasonable and effective solutions. My method of recording these individuals’ daily activates was via verbal interview, video recording interview, and online user research. Each method offered particular advantages to identifying the specific demands and needs of the visually impaired. With these methods, I conducted a series of user studies in order to understand the features of each research method including advantages and disadvantages. Then I devised my original design concept through the synthesis of research results. During the
last round of the study, I shared my design with visually impaired persons in order to test
the effectiveness of the new design by comparing visually impaired people’s activities
with and without this new design.
CHAPTER 1 INTRODUCTION

A healthy human has a set of senses. Sight, hearing, taste, smell, and touch are defined as the five traditionally-recognized senses, and a healthy human’s personal behavior is to a great extent based on these five traditional senses. The senses connect and collaborate with each other to perform the necessary behavior patterns. If one of the five traditionally recognized senses is impaired, the human’s behavior will also be affected, and some of the necessary skills may not be completed fluently or may even be found incomplete. For visually-impaired individuals, the factor of impaired sight affects this collaboration of the senses. All of the healthy senses are needed to compensate for the impaired sight in order to normalize each individual’s daily activities. Unfortunately, each sense has its own unique function which cannot be effectively compensated for by the other senses. Therefore, many assistive tools for the visual impairment have been designed as supplementary items to help visually-impaired people. To determine if these are assistive tools are practical, I will evaluate them in order to come up with a new design concept to help the visually-impaired person in the field without effective assistance nowadays, or improve the assistive results in the field with new designs. The
most challenging part of this evaluation is that these existing tools were designed for specific categories, such as mobility, reading, safety, and guidance, not specifically for cooking. My evaluation phase focuses on users’ opinions on current available visually-assistive products. Based on the conclusions from both the preliminary research and user studies, I realized that the process of evaluating only current available visually-assistive tools is insufficient for creating a new assistive device for visually-impaired people, I also need to observe a visually-impaired individual’s daily behaviors in order to identify the difficulties that remain unaddressed. Finally, I composed my original design concept based upon the persisting difficulties for visually-impaired people. This design development process aimed to solve the specific problems defined by both my research and target users’ experience, and my analysis requires a combination of industrial design and interaction.

In a person’s daily life, a great deals of items need to be identified and used. The ability to search for an item is typically relies on functional sight, because sight is the most reliable sense by which to identify different shapes, colors, textures, and other physical features. Without healthy sight, visually-impaired people have to use and combine other functional senses, such as touch, hearing, or even smell to compensate for their damaged sight. For example, touch can be used to understand shape, texture, or other physical features. But which sense can make clear the information contained within 2D media, such as color, graphics, or text? In essence, sight is the only functional sense
by which to identify them. In some cases touch can be used to identify these aspects, but
touch does not offer enough information to allow us to comprehensively identify these
items. As a result, the visually impaired are sometimes limited in what they are able to
find. Typically, assistance from a sighted person can help the visually-impaired
individual, but most of time, visually impaired people do not have sighted people with
them, so they may make mistakes when attempting to find what they need.

In the following chapters, I will explain my design concept creation process,
beginning with a literature review, moving on to the user study, user observation, and
finally to the design phase. The target users, i.e. the visually-impaired individuals, will
proceed with me through the complete design process, and their feedback will guide my
design direction to make sure the final design concept results are both effective and
practical. The objective of this study is to make a final design which can be acceptable to
assist the visually-impaired person in fulfilling their personal cooking and life demands.
2.1 Visual Impairment

“Visual impairment, also known as vision impairment or vision loss, is a decreased ability to see to a degree that causes problems which are not alleviated by usual means, such as glasses. Some also include those who have a decreased ability to see because they do not have access to glasses or contact lenses.” The most severe category of visual impairment is blindness, complete and nearly complete vision loss. Impaired vision may causes dilemmas during visually-impaired person’s daily activities such as walking, driving, and even socializing.

2.2 Five Senses

A generally acceptable definition of sense is: "A system that consists of a group of sensory cell types that responds to a specific physical phenomenon, and that corresponds to a particular group of regions within the brain where the signals are received and interpreted." The traditional five senses are sight, hearing, touch, smell, and taste, touch and hearing are the most important senses for visually-impaired people.

Sound: sound is one of the most significant senses used by visually impaired individuals to locate objects in the surrounding environment. Echolocation describes
Echolocation is when sound waves produced from some formats of noise such as speech, reflect from objects and bounces back to provide a rough idea of the location and status of the objects. The person is not able to specifically describe details of an item based on sound, but rather they can assume the approximate location and status of objects and then make a decision whether to interact with or avoid them.

Touch: touch is another important sense utilized by visually-impaired individuals. It provides diverse tactile information within an individual’s immediate surrounding environment. Tactile information includes shape, size, texture, temperature, and other features which can be felt by touching an item. Touch also helps people with Braille communication, the approach used by visually-impaired individuals. They use touch to feel elevated bumps on a surface in order to understand the meaning interpreted from the arrangement of these bumps. One limiting factor of touch is that not all of objects can be felt by finger such as a hot pot boiling water. Another limitation of identifying objects with touch is that this method requires more time than sight. All of important information for integrating an object can be constructed in the brain immediately by sight; by touch, all details are required to be understood one by one.

2.3 Braille

Braille is a tactile writing and reading system used by visually-impaired individuals. Braille-users are able to read it with embossed paper, computer screens and other electronic Braille displays. Visually-impaired people can write Braille with the
original slate and stylus or type it with a Braille writer. Braille is a language system consisting of two parts: character encoding, which transfers the alphabet into a six-dot system, and the organized representation of these six-dot characters in raised formats.

2.4 Assistive Technology

Assistive technology refers to “any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities.” In other words, assistive technology is any system or object that enhances the capabilities of disabilities. Technology is widely accepted in modern society broadly due to the many benefits it provides.

Assistive technology is also preferred and required by the visually-impaired individuals because many valuable benefits can be received from assistive technologies. With low-vision assistive technology, standard systems and objects can be designed more accessible to visually-impaired users. Accessing traditionally printed materials such as books is also possible with various technologies. One of the most popular low-vision assistive technology is the screen reading software (Screen reader), a program application designed to identify and interpret the information shown on the display. This interpretation transfers displayed information into an understandable output to users, such as text and speech. Making a choice of appropriate screen reader is based on user’s deficits and knowledge, where a vocal translation method or Braille-creating method can
be selected. “Screen reader uses synthetic speech to read aloud the content that appears on a computer screen, in a manner that is compatible with most programs and features for PC operating systems. They are available as an add-on for PCs running Linux or Windows, while Mac computers typically run a built-in screen-reading function.

Examples of screen-reading software include JAWS, WindowEyes”\textsuperscript{13}, and Voice Over.

Depending on the format of the original file source shown on the display, the screen-reading software can be categorized as follows:

1) Command-line (text) screen readers: by inputting information with keyboard, compositions of characters are shown on a display, and are mapped to a screen buffer area in memory simultaneously. All of this inputted information is received from the operating system either by reading the screen buffer or by using an additional standard hardware output, and then speaking out the information to users.\textsuperscript{14}

2) Graphical screen readers: a graphical user interfaces (GUIs) have both characters and graphics located on the display at specific positions. The shown graphical information has no purely textual contents. Therefore, new technologies are employed to collect information from the operating system rather than screen buffer, in order to create an "off-screen model" representing the displayed information with required text contents which was integrally stored in the operating system.\textsuperscript{15}
3) Screen magnifier: the function of the screen magnifier is to operate as a series of program with a graphical output shown on a computer display with enlarged content. This tool is suitable for visually-impaired individuals with some functional vision, because the limitation of the screen magnifier is that users must have a basic reading ability with some vision. Thus, visually-impaired people with little or no functional vision have to rely on hearing ability and use a screen reader rather than a screen magnifier.
CHAPTER 3 METHODOLOGY

The preliminary research for this study began with initiating Participation within my own “visually-impaired” cooking activity with blocked (or covered) eyes in order to generate a research perspective with regards to the elements of cooking by the blind individual and to understand the difficulties which target users may meet while cooking. Also, an objective of this preliminary is to generate a series of questions for later interviews. Participation, also called Participatory Design, is a method to ensure all users involved in the design development process, and the design results are functional and meet their demands. Participatory Design is a design development approach which focuses on design development process rather than a design style in and of itself. Also, it is a method of creating interactive situations that are more answering to users' diverse needs. Also, Participatory Design indicates designers typically arrive at more innovative design concepts while following Participatory Design than by simply creating ideas on their own.

In section 4.1, I will introduce the Participation I experienced, the difficulties I met, and the questions I considered during the Participation, I will then include the limitations of my interview. In section 4.2, I will move on to the interview portion of this research,
including both the verbal interviews and video interviews conducted with visually-impaired individuals in order to better understand their behaviors. After collecting the data from my personal Participation and these interviews, I discovered that it was necessary to bring numerous questions I had uncovered in my web research in order to better refine and complete the data collection. In section 4.3, I discuss my analysis and synthesis of that data I collected as I worked to refine and narrow my design direction. In section 4.4, some current popular visual-impairment assistive products will be analyzed in order to understand the advantages and disadvantages, investigate the design advantages I can acquire and use for my design, and then revise or avoid the disadvantages of the current design with my final design. In sections 4.5 and 4.6, the problem will be defined based on both data collection and the resulting design directions.
CHAPTER 4 PRELIMINARY STUDIES ON VISUALLY IMPAIRED COOKING AND EXISTING DESIGN

4.1 Field Study as a “Visually-Impaired Person”: Cooking Without Sight

An empirical study can help me to find design inspirations and generate a great deal of design options through previous literatures, interviews, and user studies. But what I have discovered at this point is too random, and lacks specific direction. Therefore, in order to better filter these random design ideas, and uncover increasingly targeted user-centered concepts, and understand more about the visually impaired individual’s user behavior and experience, I used the Participation Design method in which I pretended to be a “visually-impaired person” operating with my eyes covered. I was unable to see during my entire Participation activity, and I only had a basic perception of light.
I started by making a plan for my Participation. The kitchen I selected was based on the collected information from my interviews of visually-impaired people. These persons frequently prefer to use electric stoves rather than gas stoves because the physical fire of the latter is too much of a risk for people without functional sight. From the feedback I gathered those with visual impairment infrequently cook raw meat because the act of cooking raw meat is much more difficult than cooking raw vegetables, so they generally cook raw vegetable and use cooked meat. Accordingly, in my Participation, I selected carrots as the food to cook. Since cooking one dish is not common during a meal, steamed rice was the second food I planned to cook. Furthermore, I had to take into account that there are more activities than the actual “cooking”, preparation of the ingredients during the pre-cooking phase, and washing the plates and plate organization.
in the post-cooking steps. Therefore, my entire cooking Participation plan was: prepare the carrots and cooking appliances, slice the carrots, fry the sliced carrots, serve the cooked carrots, and wash/reorganize the used cooking appliances. In order to record the complete Participation process, I employed a camera-man and documented each step.

After covering my eyes, I started my Participation. The first step in this process is searching for the food, and the objective was to find the carrots in the refrigerator and the rice in the cabinet. The difficulty I experienced in finding these needed items would be extreme for people without functional sight. The organization in the refrigerator and cabinets is random, so searching for what I needed without my sight was a challenging task for me. I kept touching a variety of things in the refrigerator in order to find the required carrots; meanwhile, I tried to remember where I had placed the carrots. I assumed I found the carrots and used my sense of smell to make sure that what I found was actually the carrots. Finding the rice was actually a much easier process because the shape and size of rice is more unique than that of the carrot. The second step was accounting for the required amounts of food. Counting carrots was an easy, but measuring rice was quite difficult; I needed to find a measuring cup and gauge the amount contained in each cup, and then count how many spoons of rice I dropped into the rice cooker. I was still unsure of how much rice I had cooked. The third step involved finding the cooking appliances I would need: rice cooker, cooking pot, frying spoon, and the cutting knife. The first risky issue I met in Participation occurred during this step. As
we know, the required tool for slicing is the knife, and a concern which I soon discovered was that I would have to use my sense of touch to find the knife. However, the blade might injure because I would not know the direction and position of the knife. After conquering this danger, I processed to the fourth step: cooking the rice. The only difficulty for me at this point was turning on the rice cooker. There is no letter, icon, or other raised sign that would help me to find the correct button to choose the white rice cooking function. The fifth step involved slicing the carrots. Because I could not see, I found that I was afraid of using the knife to cut without my vision. My attempts at slicing the carrots were poor, and I was unable to slice the carrots evenly. My frustrations continued onward into the sixth step of frying the sliced carrots, which I found to be the hardest step in my Participation. The first challenge I met in this step is finding the required oil and spices. While the shape of the oil bottle is unique, this allows it to be easily found.
I also discovered that I had many similarly shaped bottles in that area of kitchen. I attempted to use my sense of smell to identify the vinegar, but I could not find the soy sauce. I then used my sense of taste to identify the soy sauce. A second challenge arose in this step, the pot had become hot during this process; I was now afraid of using it because I did not want to be burned by coming into contact with said pot.

The third challenge I met in this step was that I did not know the status of the foods in the pot. I could not see the food cooking inside, so I thought that I would have to use my sense of touch in order to determine the food’s status. The inside of the pot was truly hot, so this would not be a safe decision; therefore, I would have to rely on my sense of smell to establish the status of the carrots in the pot. However, when I smelled a burnt odor, I thought that the carrots were ready to be served, and I found that my dish was already over cooked – a factor which affects the flavor of the food. The fourth challenge I met in this step was that I could not easily find the position of the burner. I was not able to figure out where I should place the pot. Because the stove had already been turned on, I could not use my hands to touch it in order to establish the position of the burner. Also, I faced a big challenge while manipulating the electronic stove, I was unable to decide
which button I would need to use because there are no functional signs or alarms for people with impaired sight. The stove buttons are designed with flat text that can be seen by users with functional sight. Visually-impaired users would find these flat, printed signs ineffective. Moreover, there would not be any physical feedback, such as that of a voice, click or other feedback, that could be recognized without sight, when the button was switched from one position to another. My seventh step involved serving the cooked food, a step which was not a challenge for me, as I could use one hand to guide the plate position and the other to handle the food. The last step in my process was the cleaning and reorganization of the used dishes and cooking appliances. Like the previous steps, searching for the items I needed and making sure that what I found was correct remained my biggest problems. Also, as I had to use my hands to touch each washed item in order to best determine whether the item was clean or not, I found that this process increased substantially in length.

During the Participation process, I thought that impaired vision would truly be an immense issue for me. Afterward, I categorized the problems I met into three classifications. The first kind of problem involved situations where the desired items cannot be found. I have trouble to locate the desired items if I do not know the specific location. The second kind of problem is defined by circumstances where the located items cannot be verified. Situations that include confusingly similar shapes and textures, or lack unique odors that cannot be easily identified without functional vision, so I found
that I was unable to verify that I had indeed located identified the necessary item. The third kind of problem consists of the fears which arise when dealing with the unexpected situation. Various issues, such as the sharp knife blade, turning on the oven, or the use of a hot pot, became unexpected and risky situations which scared me and made it virtually impossible for me to continue in the cooking process smoothly. These would similarly present problems for visually-impaired users in their efforts to participate in daily cooking activities.

4.2 Data Collection: Verbal Interviews, Video Interviews, and Web Research

Because of the special needs and abilities of my target users, the visually-impaired person, I believe that it is necessary to conduct interviews in order to receive a more complete comprehension of their thoughts and behaviors. Also, I decided to find multiple visually-impaired people with distinct backgrounds and living habits. I contacted Fizza and David, two visually-impaired individuals on the Purdue University campus. Fizza is a 27-year-old female graduate student; she lives by herself in a university dormitory. David is a married 50-year-old male university employee; he lives off-campus, with his wife who has her own health issues but has functional vision. The reason I chose these two target users as interviewees is because their gender, background, living habits, and even logic methods are different. First, I scheduled an interview with Fizza. The objective of this interview was to obtain a general understanding of visually-impaired people’s behaviors. Important notes I gathered from Fizza’s interview are as follows:
1) Daily habits: she prefers to live alone, but she needs help in her first attempt to do something, such as taking her first walk from her dorm to campus, or making her first cook in the kitchen of her dorm. She does not have roommates because she needs to make sure everything is organized and in a consist order. She attempted to live with a roommate with healthy vision, and although her previous roommate was a nice person, she could not keep everything organized in the same order, and after this experience, Fizza decided it was too difficult to live with a roommate.

2) Five senses: she uses her sense of hearing to a great extent every day, for example, while listening to the traffic and environment surrounding her. She uses her sense of touch (tactile) less than hearing, but it is still the second most important sense in her daily life. She is able to use touch to recognize raised letters and any other tactile information.

3) Language: she knows the regular alphabet (identified by raised letters), but she does not know Braille. She commented that a visually-impaired individual who does not know Braille is quite common.

4) Cooking experience: for Fizza, touching is less safe than hearing, and smell does not provide enough information. She only cooks for family members, and she frequently uses convection oven, because it is much safer. Also she typically eats cooked meat (chicken nuggets, etc.), because cooking meat is too complex. She does cook vegetables by herself, and she finds a deeper pan to be much safer than a regular pan,
because the possibility of spillage is lower. She often uses a microwave to heat food, but with the current design trend, the Touch pad has become an issue, because the screen is flat and cannot be touched to recognize the information. Moreover, a large number of the buttons are not useful for her, so she has labeled the most common buttons (start, stop, 1min, 2mins, 3mins) to help her find the right button. She prefers to bake when she is cooking, because the stovetop is more dangerous than the oven. She uses different forms of jars to identify her different spices. She feels the convection stove is much better than a regular stove, because she avoids catching her sleeves and other objects on fire while cooking. Finally, if she has bought a great deal of frozen food, she often cannot distinguish the variety of foods with similar packaging.

5) Recipe using experience: a recipe may not be really useful for her, if she is asked to use the sense of sight to follow the recipe (such as: turn down the fire when the meat gets brown. Fizza’s related questions are, “What is the time that the meat will take to get brown? What is the temperature at which the meat will get brown?”).

I also contacted David, who is a visually-impaired employee at Purdue University. He was born blind, and he lives with his wife, a woman who has five healthy senses. The reason I planned to conduct an interview with David because his living status is distinct from Fizza. After a brief talk with David, I decided to do a video recording of his cooking process, when he mentioned that his wife assists his visually-impaired cooking
process. The following are some issues I found during the video recording that are important to this study:

Cooking behavior:

1) He has difficulty finding the position of the stove.

2) He hears the gas from stove in order to know whether the stovetop is on or off.

3) It is hard to see the level of fire (no feedback from stove/button).

4) The particular positions of utensils which will be used is important (he places utensils in specific positions).

5) There are disorganized items within the refrigerator (making it hard to know if the items gathered from the refrigerator are correct).

6) Similar shapes of jars lead to confusion with the contents.

7) It is important to reduce (avoid) unnecessary food transfers (leading him to do things within a pot directly, or within a double-layered pot).

8) The position of the trash can is important (will be used frequently).

9) His trash can is not easily reachable (it is not close to his working space).

10) Forgetting to turn off electronic products is a potential danger.

11) It may be hard to for this couple to figure out the position of cooking materials, and there are times when necessary materials are in a dangerous place (i.e. the edge of the table, or partially out of a package).
12) A towel can be used to protect from heat (but the towel needs to be placed close to the stove, in a dangerous position).

13) He has a tool to help him pour ingredients, but he may not realize how much food remains in the can/package/bowl.

14) The sink needs to be well divided, because the couple needs different spaces for different function (disposing of cooking scraps, cleaning of used utensils, etc.).

15) They occasionally use their hands to measure amounts.

16) Without the use of a measuring tool, it is difficult to know how much they have.

17) He uses a talking thermometer to measure the temperature of food (and avoid burning his hands).

Cooking appliances:

1) Double-layered pot, with mesh material is helpful for separating cooked substances.

2) A small glass boiling indicator that alerts users to boiling water with a jiggling sound.

3) Frequently-used towel.

4) Talking thermometer.

5) Stand mixer.

6) Spaghetti serving measurer.

7) Braille timer / iPhone timer.

8) Measuring kits (layered and separate measuring cups, spoons, etc.).
These interviews with David and Fizza guided my sense of the research on-file required before I start ideation for my design. They told me that Braille is one of the most important fields for further research. All other communication methods (such as the alphabet, letters, numbers, symbols) were an area where I needed to research. As we know, there are limitations to visually-impaired people’s perception, so my interviewees suggested that I not only focus on what they lost in perception, but that I also needed to understand what they were able to perceive. Such a reliance on what they could perceive is actually much easier than learning about something new to compensate for their missing perception.

I moved to the web research phase of this study to collect research data from internet. Regarding the actual use of Braille, the truth is: “fewer than 10 percent of the 1.3 million legally blind people in the United States read Braille, and just 10 percent of blind children are learning it, according to a report to be released by the National Federation of the Blind.”17 Many standard systems of Braille have been designed for different languages and objectives. The most basic unit of Braille is dot, and different arrangement methods of dots have multiple meanings depending on the language and surrounding texts. Braille is not a universal language even if many languages were created basing on same alphabet.18 Braille was designed based on a specific alphabet and language composition (word spellings, grammar, etc.). For those languages using the same alphabet but different language compositions, their corresponding Braille is also unique.
A great percentage of visually-impaired people understand the regular alphabet, so raised lettering is a more common language method. The limitation of the raised letter is that this format can only be identified by touch. The sensitivity of an individual’s fingers determines their capacity for raised letters reading.

Blindness features slight level of light perception in several different forms. The level of light perception depends on the condition of eyes and the reason of sight losing. However, blind people may only see light with shadows, but they can detect the location of light source, and determine whether anything is blocking in front of them. In fact, most visually-impaired individuals have a degree of light perception, and the proportion of legally blind people is less than 1% of all of visually-impaired people.19

I found that there was one essential element I missed in my previous research; I failed to consider the very first step in the pre-cooking, i.e. that behavior which occurs during grocery store shopping and transporting the food home for storage. But this is also an important and necessary step within the cooking process. After a brief conversation with Fizza, she said that for the visually-impaired person, especially for the blind, shopping is not a difficult process. This is the case because in her regular shopping ritual, she always has a sighted friend with her, and the typical grocery store, such as Wal-Mart or Payless, will also provide a sighted assistant to help her find the specific items she requires in her shopping activities. I then emailed David, and he similarly said shopping was not a problem for him because he has his wife to assist him in almost all of his
shopping experiences. However, I also learned that these individuals experienced greater issues after bringing food back to their homes. When the visually-impaired purchase items, sighted assistants are able to be their “eyes”, but when these products are brought back to their homes, issues of similar shape, smell, texture, or even similar packaging may confuse them and cause difficulties in the pre-cooking process. Fizza mentioned that she always purchase pre-cooked frozen food that only requires microwave heating, because these foods are more easily cooked. But an issue remains for her: the same brand of frozen food has a very similar packaging shapes and types. The printed name and description on the package cannot be identified by the visually-impairment consumer. So, for Fizza, she has to eat these items randomly, without choosing a preferred vegetable or flavor before cooking it.

4.3 Data Analysis and Synthesis

After the collection of research data, I started to organize this information into three segments: pre-cooking, cooking, and post-cooking. From the feedback of the visually impaired interviewees, I found that the pre-cooking and cooking phase are much more difficult than the post-cooking phase. There are diverse problems met in the pre-cooking and cooking phases, but there is a common problem recurrent in all phases. It is challenging for visually-impaired people to find specific desired items. Visually-impaired people may not be able to find the sugar because the container for the sugar is similar to containers used for other spices; it is also possible that the visually-impaired individual
cannot identify the button to turn on the stove because there are not any assistive touchable or audible signs incorporated.

4.4 Case studies of existing products to assist the visually impaired

In this section, some of the existing products for assisting the visually-impaired with cooking activities will be analyzed in order to identify the advantages and disadvantages of current designs.

Braille label maker: The Braille label maker is an industrially designed product that can provides a Braille label printing function for visually-impaired people. Users can attach the printed Braille label onto any item unidentifiable without sight. The Braille maker is made with a rotatable knob, an English-based alphabet Braille letter indicator, a confirmation button, an attachable sticker printer inside, and a sticker cut button. First, the visually-impaired users should know what information they need to adequately describe the particular item. Then they need to use their fingers to touch the
English-based alphabet Braille letter indicator in order to figure out the target letters required, rotating and stopping the knob at the letters they need, and pressing the confirmation button. The Braille sticker is printed while the Braille letters are typed. After the user finishes typing the information, the sticker cut button is pressed in order to cut the printed sticker off, and the user finally peels off the back side of the sticker, and attaches the front side onto the item. When the visually-impaired people need to identify an item, such as a specific spice, they just need to touch the Braille sticker to verify the contents.

However, the limitation for users is that the language visually-impaired individual uses should be based on the English alphabet. As was found in previous online research, Braille is often not an effective communication method for visually-impaired people. As a result, less than 10 percent of the visually-impaired users know Braille. Therefore few of these users can receive the benefits of this product. What’s more is that the Braille label maker requires that they must also be an English-alphabet based language user.

My personal evaluation of a Braille label maker can neither be substantial nor objective because I am not in the target user group. I spoke with my interviewees, and I found that their feedback is somewhat similar to my conclusions. They agreed with me to an extent, but they also said that this product can be useful for visually-impaired individuals who do not understand Braille. Even if such a person cannot read Braille, that person may find the sticker and raised dots assistive. The visually-impaired may use
stickers with raised dots as a reminder for some unidentified elements within the cooking process, such as the “power button” on a microwave or the “start button” on a remote control. An attachable sticker with raised signs can still be a useful item to help identify something based on their simple ability to touch.

![Figure 7. Raised Letter Maker](www.merrimentdesign.com)

Raised letter label maker: The principle behind the raised letter label maker is quite similar to that of the Braille label maker. Visually-impaired users need to choose the right letter they want typed out and then click the “confirm button”; at this point, this letter will be printed on the sticker. Because most visually-impaired people do understand the regular alphabet and letters, raised regular alphabet letters sticker can be understood by a large percentage of the visually-impaired population. One issue with this product, however, is that there is not an effective feedback method by which to inform the visually-impaired individual of what letter has been chosen. Visually-impaired users are required to rely on memory in order to find the letters they need. When I talked with my visually-impaired interviewees, they mentioned another issue for this product. They
noted that in instances where they could feel the raised letters by their sense of touch, they often found that the letters were not large enough to distinguish. Furthermore, the interviewees emphasized that the distance between each letter should not be too close together, since placement could actually confuse the users’ ability to read. This concern was not one which typically bothered the users of the Braille label maker, for Braille is a tested language system which is able to provide enough information within a limited area.

Figure 8. Apple Voice Over (www.apple.com)

Voice Over & JAWS: This is the description I found on Apple’s official website:

“VoiceOver is a pre-installed mobile application in the IOS system of Apple smart devices (iPhone, iPad, Mac, etc.). VoiceOver is a gesture-based screen reader that lets visual impairment smart device users to enjoy the fun and simplicity of iOS even if they can’t see the screen. With VoiceOver enabled, just triple-click the Home button to access it wherever users are in iOS. Hear a description of everything happening on the screen, from battery level to who’s calling to which app users’ finger’s on. Users can adjust the speaking rate and pitch to suit them.”20 From the interviews I previously conducted, I found that VoiceOver is very important and functional for the visually-impaired people. A
large number of educated visually-impaired people use a smart device nowadays, because they are unable to read the information shown on the screen; in essence, a reliable screen reading program needs to be installed into their smart device in order to assist these users to operate it effectively and efficiently. Apple designed and installed VoiceOver into all of their smart devices. Visually-impaired people, therefore, frequently rely on VoiceOver to send messages, reply to email, surf online, and do other common smart device tasks just like other sighted users.

Figure 9. JAWS for Windows
(http://www.freedomscientific.com)

This is the description I found on the official website for JAWS: “JAWS, full name is Job Access With Speech, is the world's most popular screen reader, developed for computer users whose vision loss prevents them from seeing screen content or navigating with a mouse. JAWS provides speech and Braille output for the most popular computer applications on your PC.”

Technically speaking, JAWS is VoiceOver for the Windows System. For regular use, users just need to select the target and click, but for JAW, visually-impaired users may click the target file and can then hear the vocal transcription
of this file. Users can double click anywhere to access the file they desire to hear rather than clicking the target file.

New technology, especially smart devices, may bring more benefits and convenience to users and as the visually-impaired people also have the right to enjoy these, and this shared societal priority is the primary reason that these screen-speaking programs have been designed. Voiceover and JAWS are the most two popular screen-speaking programs used by visually-impaired people daily. Regardless of the IOS or Windows system being used, the user’s activities will have vocal assistance in order to permit that person to better enjoy the benefits provided by smart devices. In the visually impaired people’s cooking activities, screen-speaking programs will help users to read (hear) online recipes.

However, while VoiceOver and JAWS provide functional and useful programs well-designed for the visually impaired, the issue remains regarding the fact that screen speaking software has a typically slower application rate than regular smart devices processes. This is because when one uses the screen-speaking software, one needs to: 1) click the file, 2) hear the vocal description, and 3) then double click to confirm that the clicked file is correct. Ideally, without mis-clicking files, users have to add clicking and hearing activities into the file-choosing activities rather than double clicking the targeted file to access into it. The possibility of mis-clicking is considerable, so we can see that the actual user experience may be even slower.
Mobile App Be My Eyes – lend your eyes to the blind: basically and logically, Be My Eyes is a network of eyes. “This is an application that connects blind people with volunteer helpers from around the world via live video chat. One may download now and start helping blind people to see. Initially, a blind person requests assistance in the Be My Eyes app. The challenge that he/she needs help with can be anything from discovering the expiration date on the milk bottle to navigating new surroundings. The volunteer helper receives a notification for help and a live video connection is established. From the live video the volunteer can help the blind person by answering the question which that person needs answered”.22 We can imagine how useful this app can be in visually-impaired people’s cooking activities involving a multiplicity of things, such as looking for a spice, identifying a food material, and even checking expiration dates.
After analysis of this app, however, I found that there is an important defect of the Be My Eyes app. Let us re-analyze the user process; the visually-impaired people update their request online, and the sighted volunteers receive a notification and answer the request. We can see that there is a gap between each visually-impaired individual’s request and the sighted volunteer’s response: waiting. If the visually impaired people do not need a real time solution for their question, this app is perfectly functional and practical for them. However, in many cases, the visually impaired individual may require real-time assistance and is not able to rely on Be My Eyes app. My visually-impaired interviewees replied to me regarding this research about the fact that if he needs urgent help, he chooses instead to use a video call app, such as Face Time, to request real-time assistance from his wife or sighted friends, in order to fulfill his demands for an effective feedback to solve his difficulties on time.

4.5 Problem Definition

Based on all of my research, analysis, and the users’ feedback gathered earlier, I tried to organize and evaluate the information in order to find out a target problem. First, I chose to look through my interviews and current product analysis in order to find the common issues and/or features. My interviewees mentioned many times in our interviews that many items cannot be found or that wrong items have been found without sight; furthermore, in the current product analysis phase, the majority had been designed for assisting the visually-impaired people to discover what they want, no matter if it is a
physical item or merely a file in a smart device. Also, without having access to touchable or audible information, the visually-impaired individuals are not even able to identify the manipulating methods of common devices in the kitchen. Second, I planned to divide the complete cooking activities into pre-cooking, cooking, and post-cooking and then find the common problems in all or most phases. We can see that finding wanted items is a common and general problem which arises in all three phases. There are many items which must be found in the complete cooking activities, no matter whether one is discovering a required food material (pre-cooking), finding the demand-functional buttons on microwave (in-cooking), or searching for the dish detergent to wash the used bowls (post-cooking); in all instances, these might cause a challenge for visually-impaired people. As a result, the most urgent problem I found in the visually-impaired people’s cooking activities is that the needed items cannot be located or are misidentified. This difficulty may cause the use of a wrong ingredient, waste time, or the misuse of a cooking device.

4.6 Concept Generation

After taking steps in decision making for the target/objective of my new design, I started to consider the user experience, or the interaction between the product and visually-impaired person. First, I needed to best determine how to let target users understand the item they could not distinguish or recognize without sight. From the analysis of the currently available visual assistive products, I noticed that the attachable
Braille/raised letter label maker is the most popular and functional for the visually impaired. Also, from the feedback provided by my interviewees, I was told that they always make thick stickers signs or alarms by themselves. So, I chose to maintain these visually-impaired users’ natural/daily behavior as a guideline, but I refined the sticker so that it might become a better source of information. Previous research suggests that both Braille and the raised letter are neither practical nor functional enough, in and of themselves, so it is now time to also transfer the advantages of the screen-speaking software to this new design, which will then incorporate voice/audio as the manner by which to provide information to visually-impaired users. I had come to truly appreciate the design concept of the Be My Eyes app, one of “borrowing eyes”. I considered the concept that with my design creation I could make this device into the “eyes” of target users. As a conclusion, then, my generated design concepts are: 1. attachable labels with understandable and friendly information for the visually impaired; 2. voice/audio information which is practical and functional for the target users; and 3. a new design that can be “eyes” for visually-impaired people.
CHAPTER 5 DESIGN & IMPLEMENTATION

5.1 Design Requirement

Benefiting from the generated concepts and the synthesized data gathered in this research, the final objective of my project is to create a new industrial design product for assisting the visually-impaired person in a field which has received minimal assistance. As the conclusion defined in previous phase states, assisting the visually impaired to discover what they need to cook is the principal target of this design. Also, based on the situation of target users, this design should be both user-friendly and easily learnable for those individuals without sight.

First and foremost, the new design is made for fulfilling the visually-impaired person’s demand, they are a group of people without healthy or functional vision. Therefore, the ideas behind this design must be substantiated by the target users, i.e. the visually impaired. So, visually-impaired individuals will be asked to participate in the entire design process in order to ensure that the design direction is correct and that the final design is both functional and acceptable for my target users. Also, in-time suggestions and recommendations from the visually-impaired individuals obtained during the design development will be used to help me to avoid mistakes and to refine the design
details in order to provide a practical user experience for my target users, visually-impaired people.

Second, the interactions and user-experiences regarding the design drawn from the visually-impaired interviewees become essential. The greatest percentage of these individuals’ observed behavior during product use should be both natural and highly mistake tolerant. Equally important, this new design must not upset users’ personal emotions, even if they meet difficulties and make mistakes during product use. Because of their personal disadvantages, visually-impaired people are sometimes found to be more emotionally sensitive than those individuals with five healthy senses. Therefore, if they meet difficulties in the using the product and the problem cannot be solved, the visually impaired may connect such faults or mistakes to their impaired vision. So, as a result, a user-friendly interface is the core target.

Third, the feedback provided from this new design concept to the users themselves is critical. Speaking in terms of the definition of “feedback”, this process happens when the outputs are routed back as inputs of a system as part of a cause-and-effect loop.23 In the design area, the user experience or the interaction between product and user is a loop of input and output. As we know, visually-impaired users cannot rely on sight for their understanding of the complete user process. As a result, I had to make sure that the feedback/ response provided from the product in the user process needs to be understandable via one of the four remaining functional senses, hearing, touching,
smelling or tasting, so that users can adequately understand every step in product usage. This is essential to guarantee that controlling the product will be a smooth and consistent experience for visually-impaired users.

5.2 Brainstorming

After deciding upon the design direction and requirements, I started to work on the brainstorming based on the design target that arose from my research. In this step, I had two main objectives: 1. Assure that the interaction method between user and design is fully operable; and 2. Decipher the final direction of the form design. What will be the interaction method between this product and the users? Let’s lay out all of the possible design elements: attachable sticker, voice/audio media information, and “be my eyes”. I turned back to discuss with my interviewees, and they agreed I should define the user’s behavior with this product initially, then decide upon the form based on functionality and user’s habits.

The core is audio information. We have already discussed the reasons that Braille and raised letters are not functional enough, so audio became my final decision. Similar to the evaluation received in the previous phase of research, I now understand that both the barcode and QR code can be functional and effective containers of information and that scanning is a tested acceptable behavior of the visually-impaired individual; therefore, I chose to keep the scanning behavior for target users to avoid confusing or challenging them. The information/message contained in the barcode/QR code is located
within an audio media file. Furthermore, because the current barcode or QR code is located on 2D media which cannot be distinguished without sight, creating a touchable label is a solution for users. As a summary of the core design concept, this product is able to create a touchable label containing an audio message inside.

Figure 11. Design Concept Ideation

(Illustration by Xiaohang Zhang)

What will be the source of the item information? First, we know that attempting to rely on an online database is impossible because we cannot make a database that contains everything. The barcodes which have already been designed can be a good source of information. But there are three issues regarding these barcodes which make use of the barcode unpractical: 1. there is only basic product information linked into barcode, and some useful information, such as an expiration date, is not included; 2. not every
purchased item has a barcode attached; 3. currently, almost all barcodes are printed on the surface of the package or item, and these cannot be located without sight. If I could design an additional barcode label with an appropriate thickness which could be identified by touch, it could be a useful and functional option for users. Also, if we have a barcode, we must have a scanner to identify the code. And so, at this point, we have discovered the core design concept already: visually impaired people are able to use this product to create an additional barcode label with a touchable thickness, and the information embedded into the barcode is stored in audio media files. Scanning the barcode will be the method for users to understand the information connected with the additional tactile barcode.
Figure 12. Design Concepts Refinements

(Illustration by Xiaohang Zhang)
How can we create a database of everything owned by the visually impaired? The answer appears to be: impossible. However, I tried to go through the complete cooking process, and I found possibilities within the shopping step. Visually-impaired individuals know what they are purchasing because they almost always have a sighted assistant, such as those people assigned by the grocery store or their friends. Users could make an audio recording of the purchased items during the shopping step, because this is the very initial step in their cooking process and they have sighted assistants to help them ensure that the recorded information is correct. Also, the visually impaired people are able to ask their sighted assistants to record the information of purchased items in the language which can be understood by the visually impaired themselves.

After deciding upon the interaction/manipulation process between users and the product, I came up with a number of different design ideation concepts that fulfill the target function. Also, I tested different color and material combinations in the ideation step in order to refine my design ideas. Then, I tried to define some details and re-organize them into some possible lay-outs and organizations.

5.3 Concept Development & Refinement

Ergonomics, or human factors, is a principle of product development system by considering an appropriate interaction between humans and products based on an analysis of human factors. The International Ergonomics Association (IEA) defines ergonomics as: “ergonomics is a scientific discipline concerned with the understanding of
interactions among humans and other elements of a system in a product development process, in order to optimize human well-being and overall system performance.\textsuperscript{25}

Ergonomics has been broadly utilized in the design development process of all kinds of products. Basically, ergonomic is consisted of human anatomy, anthropometric, physiological, and biomechanical characteristics that relate to human’s natural activities.\textsuperscript{26}

Because of the special needs of my target users, I felt it necessary to emphasize the importance of ergonomics, especially the ergonomics of touching and hearing, more than is found in regular consumer products, in order to create a practical and acceptable product for visually-impaired person. User behavior analysis is the first step I took. I tried to research the possible behavior and actions exhibited by users within a comfortable and natural status. As I had analyzed in the previous phases, the user behavior of this new design can be divided into four parts: 1. recording the verbal description of a purchased item; 2. transferring the audio recording into the attachable label; 3. scanning the attachable label to receive the audio recording; and 4. receiving and understanding the audio recording.
Figure 13. User Behavior Analysis

(Illustration by Xiaohang Zhang)
Based on the function of the design, I planned to create a similar smart phone sized device because the new design would also be frequently taken to the store, so the size and weight should be convenient for users. I made a fast foam mock-up similar in size to a smart phone, and then I brought it to my interviewees and asked them to try it out. I recorded their natural and spontaneous behaviors in order to find the most comfortable user method for visually-impaired people employing a wearable smart device. As showed in the image, there is more than one natural and comfortable method for each user behavior.

As was emphasized in earlier phases of this research, touching is found to be quite important for the visually impaired person, so I believe that the device holding experience is also significant and will affect the user experience and interaction perceived from the design. Following the feedback I received from my visually-impaired testers, the shape refinement process was gradual. At beginning, I provided them with a square shaped foam with sharp edges, and then rounded the form in order to provide a better gripping perception. As the visually impaired testers mentioned, the size was initially too big to tightly hold, so I shrank the size and made it thinner; in addition, a sharp edge was added on the front surface to improve its friction. But the result was still not satisfactory, because such a skinny shape could not be held comfortably, and the added edge was conducive for holding. At this point, I kept both of the sides thin, and I added a curve on the profile in order to provide an improved gripping experience.
Figure 14. Ergonomic Mock-up Test

(Illustration by Xiaohang Zhang)
For the lay-out of all details and accessories, such as buttons, scanners, microphones, etc, based on the users’ preferred hand movements, I arranged them into the Figure 14, one which assures that all of buttons and controlling behavior are in a comfortable and reachable zone. As a template and reference for my design, the iPhone is a good resource for detail arrangement. As the most popular smart phone in today’s market, controlling the iPhone is intuitive. I tried to mimic the layout of iPhone by keeping the circle shaped button at the lower portion of the front face. This is the most comfortable position for the thumb which is a good start for the comprehensive controlling behaviors. As a result, this position will be reversed for the very first interaction activity. Another important position is the earphone/front receiver position designed on the iPhone. The second step controlling activity will be designed at the front receiver position. After deciding upon the position of the two most important buttons, I started creating the final design concept.
5.4 Final Design Concept

After deciding to use rounded and protruding cuboids shape to create the basic form, I moved back to finalize the complete interaction activities between the design and users, involving: 1. recording an audio description of a purchased item, 2. printing the label with a code which links to the audio description, 3. scanning the label in order to receive the audio description, and 4. hearing the audio description in order to best understand the scanned item.

Based on an analysis of the users’ natural behavior, I placed the scanner and printer on the top end of the device. I put the microphone holes on top and the speaker holes on the front surface. When visually-impaired users are recording their voice, their hand may block the area surrounding the video recording button, so the microphone cannot be designed for placement in an area which may be blocked. Also, following the same principle, when the scanning activation button is pressed, the recording button surrounding area will not be blocked, so placement of the speaker in this area may provide a better audio recording hearing experience. My visually-impaired interviewees mentioned in previous research that they might prefer to use earphones rather than a speaker because: 1. they do not want to be a hot spot within a crowd, and 2. they do not want to disturb others in public. So I prepared an earphone jack to be placed on the bottom of the device in order to transfer the device into a personal mode; the sound would not be heard by the general public.
Figure 16. Final Design Sketches
(Illustration by Xiaohang Zhang)
The decision of an appropriate material was a difficult process for me.

Visually-impaired individuals cannot see the color of a product, so the material used becomes much more important than for a common product. The feeling of touch will become a primary issue for the visually-impaired consumers when they decide whether to purchase and use a product. An unfriendly feel may cause rejection from the customers.

I talked with some of my target users on the topic of material choice; the following are some of the notes I made during our discussions:

1) They want something “cool”, which means the design should follow the latest design trends and should make them look socially-sophisticated when using the product.

2) A feeling of “trust” is important. Regardless of the weight or the material finish, they should feel that they “trust” this product. With regards to their description, “trust” is a feeling of high priority.

3) The material used should be easily identifiable.

By following the current design trends and my users’ preferences, I used a combination of glossy and matte finishes to provide a contrasting texture on the product. This contrasting glossy and smooth finishes is used on both the front and back elements of the product, with a distinctly different matte finish used for the middle piece. Also, in order to provide understandable guidance for the individual user’s fingers, I emphasized the audio recording button with a matte finish material.
As a result, the final design and manipulation interaction processes are shown in following images. Let me finalize the design of all of the details: A: In the label making step: 1. the visually impaired user holds the video recording button which is designed at the mid-lower part of the front surface. 2. the user makes an audio description of a selected item. 3. The “Voice Label” will be printed automatically after releasing the video recording button. 4. The user attaches the Voice Label onto the selected item. The reason that the Voice Label was designed in a unique shape is that there may be many labels which have already been attached onto the selected item, and most of them are in a rectangular shape; in order to help the visually impaired user to distinguish the Voice Label, it was designed as a rectangular shaped label. B: In the Voice Label reading step: 1. the user finds the position of the Voice Label. 2. the scanner is faced towards the Voice Label and the scanning activate button is held. 3. the audio recorded description of the selected item will be spoken out automatically while the scanning activate button is being held. 4. the user releases the scanning activate button to stop the audio recording.
“VOICE LABEL” MAKING

1. Describe the item which needs “Voice label” attaching.
2. Hold button to start recording; Release button to finish.
3. “Voice label” will be printed automatically after recording.
4. Attach “Voice label” on the item.

Figure 17. Usage Explanation: Voice Label Making

(Illustration by Xiaohang Zhang)
"VOICE LABEL" READING

1. Hold button to start scanning; Release button to finish.
2. Place the "Voice label" in the scanning area.
3. "Voice label" will be read automatically when the label is in the scanning area.

Figure 18. Usage Explanation: Voice Label Reading
(Illustration by Xiaohang Zhang)
Besides these main design details I have introduced, there are also some supplementary details designed to provide an effective and functional user experience to visually-impaired people. Every controlling behavior requires feedback to make sure that the users understand every input is functional and that the feedback will better guide the users in moving on to the next controlling step. Vibration is the most basic feedback element which I designed as part of the interaction; as visual feedback is not practical for the target users, a physical feedback method should be inserted. With this device, no matter whether one is pressing the recording button, or holding down the scanning activate button, the product will provide users with an element of vibration feedback in order to confirm that the interaction is smooth and effective. Most of the visually-impaired people have some light perception, so light feedback can also be a functional features for users. Also, LED light is popular in current design trends, so an LED light that indicates whether the device is on/off has been designed to offer functional feedback for users and to keep the controlling process intuitive.
Figure 19. User Experience Explanation

(Illustration by Xiaohang Zhang)
CHAPTER 6 CONCLUSIONS

The essence of problem solving is discovering a shared problem by a target user group and identifying a method to solve the problem or refining current solutions. The objective of design is generating a better quality of life for target users, or even more specific, to create a simpler interactive relationship between users and designed items. Design should not be solely an independent activity completed by designers, true design is an interactive development process between users and designers; in other words, the design process requires collaboration to be effective. Selected users are required to join the design development process. Designers should have a deep understanding of target users before they jump into the design development process, because an understanding of the general features of a target user group is the foundation of a successful design concept. Designers may select the appropriate methods to collect comprehensive information about selected target users. Based on users’ life experiences and demands, their acceptance of a design concept may influence the designer’s innovative creation. On the other hand, a designer’s creation results may affect the users’ quality of life, which can be a positive or negative influence. Recently, user-centered design has become much more important, and the interaction between users and products, has been emphasized by
current design trends. Depending upon the variety of users’ demands, a wide range of
designs can be created in order to fulfill them. With the development of modern
technology and design theories, designs are becoming ever more diversified and practical
for users.

This thesis was inspired by the problems encountered in the real cooking experiences
of visually-impaired individuals. Problems were defined under a variety of contexts;
between myself and visually impaired individuals, in other words, designer and target
users, all eager to solve the defined design problem via collaboration. The design result of
this thesis could not have been defined or created by my personal definition only, as a
sighted person, I had limited and superficial knowledge of the daily difficulties and
cooking activities of visually-impaired person. The essential dedication of the
visually-impaired individuals who worked through this project was required to inspire
and adjust my design direction. Also, a variety of research methods have been utilized in
the user studies of design process: literature reviews on current scholarly papers,
Participation (e.g. cooking as a visually impaired person), interviewing selected users,
and web research. In order to generate practical design concepts, all of these methods
were necessary. The collection of supportive data assisted me in brainstorming many
possible design ideas. Without these essential research methods, I would have generated
different or even inappropriate design results. To prove the feasibility of selected design
concepts, literature reviews were needed to solidify their theoretical foundation. Through
my personal Participation simulating the experience of cooking activities as a visually-impaired person, the designer’s understanding of the target user’s demands, as well as natural or possible behaviors, were approximated and strengthened. As a user-centered design development process, two visually-impaired users were included throughout the design procedure. This variety of research methods and feedback were necessary to create the design solution. My observation of the visually-impaired person’s behaviors helped me to narrow down various design possibilities, in order to design the best solution to their identified problems. After analyzing the collected data, the final design is a representation of desires and demands from target users. The resultant product was designed to assist visually-impaired individuals to find the items they need without making mistakes or seeking assistances from sighted people. This process of generating the solution began by finding a method to solve cooking problems of visually-impaired individuals. But the final design is able to be used for solving more daily problems beyond cooking difficulties. The interaction between the final design and visually-impaired individuals has been improved by emphasizing the complete product user process, including interactive elements such as effective feedback to guide users’ behaviors with vibration and LED lights; consideration of materials and finishes used on the product with a material combination of plastic and metal, and a texture combination of glossy and matte; a comfortable gripping perception with fine crafted surface and appropriate weight; and a smooth manipulation experience with an intuitive interaction
process that does not rely on sight. All of these are all important and necessary to provide a smooth and effective interaction between the design and visually-impaired users.

In conclusion, this thesis is mainly focused on considering users experience as central design development process. The target user’s natural behavior, emotional expression, way of thinking, and personal preference have been integrated from the very beginning to the end of the design process. Designers need a complete understanding and knowledge of target users’ activities and daily habits. By doing Participation studies with a temporary blindness, I experienced the general difficulties of the user group. A designer’s responsibility is using professional design knowledge to analyze collected data when generating design concepts; a target user’s responsibility is to identify the mistakes made by designers and refine possible design concepts suggested by designers based on previous research and ideation works. The collaboration between designers and selected users contribute greatly to this design development process. The final design concept will provide target users with a practical design and effective user experience, which is the ultimate goal of this design-oriented thesis.
NOTES
NOTES


BIBLIOGRAPHY


Arnott, Stephen R., Lore Thaler, Jennifer L. Milne, Daniel Kish, and Melvyn A. Goodale.
   "Shape-Specific Activation of Occipital Cortex in an Early Blind Echolocation

   ToolsTemplates/EntertainmentEd/Tips/Blindness.html.

DA, Maberley, Hollands H, Chuo J, Tam G, and Konkal J, Roesch M, Veselinovic A,
   Witzigmann, Bassett K. "The Prevalence of Low Vision and Blindness in an Inner
   City in Canada." Eye 21, no. 2 (March 04, 2006): 274-75. doi:10.1038/sj.eye.
   6702522.


