Apply Funnel Model to Design Thinking Process

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The intention of this study is to experiment with the modified design thinking process by leveraging the Funnel Model, a participatory research framework, to increase the opportunity for users to engage and co-create in the product design and development process. The design thinking process is not only about collaborating with trained designers and experts but also working with users and participants to satisfy their needs and to address their pain points. Incorporating the Funnel Model into the modified design thinking process enables designers to distill and integrate research insights into further workflow. The Funnel Model includes the four key steps: (i) Recruit Right Participants; (ii) Select Suitable Participatory Research Tools; (iii) Conduct Qualitative Interpretation; (iv) Distill Research Insights to integrate the voice from the users. In the study, the model was designed and applied to an in-home IoT product design project in the stage of define as an example. Rather than introducing a novel design research methodology, the Funnel Model is a participatory research framework incorporated and built on the design thinking process.

\textbf{Keywords:} Funnel Model; Participatory Design; Design Thinking; Co-creation; Product Design
1. Introduction

This study focuses on applying the Funnel Model, a participatory design framework, by involving the voice, behaviour and action from potential and targeted users. The study refined the existing creative approaches in the field of design (Design Thinking), business (Affinity Diagram), and research (ZMET) methodologies by highlighting the importance of user engagement. The study compared the difference between the typical design thinking process (Figure 1) and modified one with Funnel Model in the context of the users’ participation. ‘The design process today is an immersive, action-oriented experience, usually involving engineers, manufacturing experts, social scientists, marketers, designers, and whoever else relevant to the problem’ said by Prof. Lorrain Justice (Justice, 2019). This greatly resonated with the creation of the Funnel Model in the study.

The study provides a novel view of the design research approach as well as demonstrates how to apply it to product design projects, to create future in-home IoT smart slippers. The application example comprehensively illustrates the benefit and impact of the Funnel Model both from the theoretical and practical aspects.

2. Related Works

2.1 Design Thinking Process

According to Stanford Hasso Plattner Institute of Design (d.school) design thinking bootleg 15/06/2020 19:40:00, the typical design thinking process diagram consists of six key modules: Empathize, Define, Ideate, Prototype, Test and Assess. Six interconnected hexagons represent the iteration of flare and focus, which indicates that the design thinking process is a convergence and divergence process (Design Thinking, 2017). Among all six modules, the main module with the input of the users/interviewee is in the Empathize stage, defined by the design thinking bootleg three key steps: Observe, Engage and Immerse. The intention of this stage is for design team to observe the targeted users and their behaviour in the context of their daily lives, engage with them through both planned interviews and short ‘intercept’ encounters and lastly, the design team should immerse themselves to see from users’ perspectives what they see and experience. Other versions of the design thinking process such as the Interaction Design Foundation (Dam & Teo, 2020) have a similar structure: Inspiration, Ideation, and Implementation; Double Diamond framework created by Design Council in 2004 consists of four steps: Discover, Define, Develop and Deliver; and IDEO design thinking process (IDEO, 2020). The rest of the design thinking process is to translate and synthesize the Empathize mode into ideation and design stage.

‘Design thinking is a problem-solving process that focuses on the end-user needs and their experience to generate better product solutions’ (Crandall, 2019). Some research had been used the design thinking to solve “wicked problems” in the context of organization and society (Buchanan, 1992). Think ahead and extensively, how does the design thinking integrate with other methodologies? (Beckman, 2020) However, in the study, the research process will emphasize on the co-creation phase with the participants/users/interviewees and highlight the importance of the participation. ‘Design thinking encourages deep and critical thinking in a deliberative collective from an emphasis on staying the course to a result that serves an end user’ (Hamington, 2019). Therefore, the Funnel Model reframes the engagement level of the participants/users/interviewees from a static-yet-time-independent input to a dynamic-yet-time-dependent process evolving with the project (Table 3).

![Figure 1](Typical Design Thinking Process (Modified from Standford Hasso Plattner Institute of Design (d.school) design thinking bootleg))
Apply Funnel Model to Design Thinking Process

Figure 1 is the synthesizing and modified design thinking process diagram from IDEO design thinking process (IDEO & Riverdale Country School, 2012), Stanford Hasso Plattner Institute of Design (d.school) design thinking bootleg (Doorley et al., 2018), Interaction Design Foundation (Dam & Teo, 2020) and Design Council Double Diamond framework (Design Council, 2019).

2.2 Participatory Design Tools

The realm of research tools for Participatory Design describe a wide range of rigorous research approaches and methodologies that share a common interest in collaborative engagement with users and aim to understand and investigate their needs (Yamazaki, 2009). Some studies also referred Participatory Design as Co-design (Langley, Wolstenholme, & Cooke, 2018) with great emphasis on its process by integrating viewpoints form varied participants to contribute their in-person experience and knowledge (Björgvinsson, Ehn, & Hillgren, 2010). Its intention is shifting the role of users from passive receiver of the design process to active participant of design development (Smith, Bossen, & Kanstrup, 2017). Therefore, it fosters the typical design process and methodologies to become transparent, open, and sharable approaches without heavily depending on the support from the professional designers (Experienced Based Co-Design Toolkit, 2013).

In the study, the Funnel Model was applied as a tool to facilitate and catalyse the define stage, the process between the research stage and the ideation stage (Figure 2), to become more engaging and approachable for the participants/users/interviewees as well as the design team. The Funnel Model was inspired by some collaboration toolkits related to Participatory Design and product design development such as human-centered design(IDEO, 2015, p. 201), Tile IoT design toolkit (Mora, Gianni, & Divitini, 2017), collective action toolkit (FROG, 2011) and interview techniques for UX Practitioners (Wilson, 2014).

2.3 Analysis Research Methods

Zaltman Metaphor Elicitation Technique (ZMET)

Developed by Dr. Gerald Zaltman in the 1990s, ZMET is designed to tap into the powerful symbolic language of the mind of customers consciously and unconsciously (Hancock & Foster, 2019). ZMET is a technique that can help understand user’s mental model and decision making process through image selection activity (Chiaing, Rau, Shiang, Chiang, & Hsieh, 2017), which gives design team an indication of what really matters to consumers and how they see the world (Zaltman, 1996). In a typical circumstance, the participants are given the task to gather and bring the images and photos that can represent certain topics assigned by the research team. During the interview, the participants are asked to share their thoughts via images and create a digital or physical collage while discussing with the research team. The process will be documented either in the audio or video format to assist the research team to interpret the hidden meaning such as thinking pattern, instant subconsciousness, true behaviour and sensory visuals that words normally cannot convey. In this way, the gap between what participants say and what they really mean can be clarified (Cyr, Lassiter, & Roberts, 2001).

In Chapter 4, the application example presented the modified ZMET and incorporated the interview process with participatory research tools. Instead of assigning participants to bring their own images by cutting pictures from magazine (Leiber, 1997), the design team pre-selected thirty-five images as mood boards and let the participants pick three to five images that they felt matching selected in-home IoT devices in terms of their feelings, aesthetic views, functional aspects and other emotional or rational reasons. By probing the questions to ask why the participants chose or didn’t choose certain photos, the team has a better understanding of their meaning, metaphors and interpretation. The purpose of applying modified ZMET as part of the Funnel Model is to extend the opportunity of collecting the voice of the interviewees beyond textual format and intentionally capturing participants’ abstract thinking through visuals and behaviours (Zaltman, 2003).
**Table 1** The Key Steps of Applying the Modified ZMET Technique

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>The design team pre-selected design thirty-five images as mood boards to allow the participants to express their ideas by picking three to five images.</td>
<td>The design team probed the questions by asking why the participants chose or didn’t choose certain research tools to have a better understanding of their meaning, the metaphors and the interpretation.</td>
<td>The design team recorded the full experiment process and transcribed the video or audio content, which helped interpret the thinking pattern, invisible behaviours and ideas from the participants.</td>
</tr>
</tbody>
</table>

**Affinity Diagram**

The Affinity Diagram, also referred to as KJ Method, coined by Jiro Kawakita in the 1960s, originates from the business realm (Kawakita, 1982). It is a project management tool (Scupin, 1997) commonly applied to organize data and allow large numbers of brainstorming ideas that stem from ideation phase to be clustered into sub-groups depending on their natural relationships and connections, as a preparation for further analysis and studies (Widjaja, Yoshii, Haga, & Takahashi, 2013), which can generate result objectively (Lokman & Kamaruddin, 2010).

In the case study, the example was presented by modifying the typical Affinity Diagram into the three layers (Table 7, 8). The design team started by selecting participants’ quotes (scrubbed statement) from all the interviews, clustered and translated them into the third person narrative under the principle level—Layer 1. The following step was to distill the essence of Layer 1 into the theme level—Layer 2 to describe the potential customer needs and the research observation. Layer 3 was stated in the format of the keywords directly connected to Layer 2 as a takeaway.

The reason for applying the modified Affinity Diagram as part of the Funnel Model is to help clarify the potential user needs by using the video and audio transcript as a way to conduct the qualitative interpretation, referencing from the field of human-centered design (IDEO, 2015), social research method (Bryman, 2016) and qualitative interview data analysis (Kvale & Brinkmann, 2009). The qualitative interpretation is to decompose the raw material including quote, video and audio transcripts and then translate them into useful and meaningful user insights based on some guiding principles and the experience of the design team, which serves as the source of critical inputs for the next stage of the design thinking process – ideate.

**Table 2** The Key Steps of Applying the Modified Affinity Diagram

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>The design team discussed and selected participants’ quotes (scrubbed statement) from all the interviews, clustered and translated them into the third person narrative under the principle level—Layer 1.</td>
<td>The design team distilled the essence of Layer 1 into the theme level—Layer 2 to describe the potential customer needs and the research observation.</td>
<td>The Layer 3 was stated in the format of the keywords directly connected to Layer 2 as a takeaway.</td>
</tr>
</tbody>
</table>
3 Funnel Model

3.1 Modified Design Thinking Process

Design Thinking Process, including a range of activities which enable the design team participants and users play an active and influential part in the decision-making, has been widely in the different phases of the research to enhance the participation of a design project (Spinuzzi, 2005). The aim of utilizing the concept of participation is to involve key stakeholders into the decision-making process. Regarding some user research methodologies, users’ involvement is limited to specific moments and stages across the design process, making it difficult for design team to create solutions that are relevant to users’ input as a critical step. The purpose of using participatory research tool is to enhance the understanding and observation of users as well as distilling insights and learning points from interactions with users.

Unlike the typical module-based design thinking process (Figure 1), the intention of modified design thinking process with the Funnel Model is to establish a collective framework with interwoven stages that seamlessly connect the Design Team (Figure 2—Red Line) including designers, developers, and other key stakeholders with the User Group (Figure 2—Dotted Line) including interviewees, potential customers, and extreme users. The modified design thinking process is a time-dependent dynamic journey that keeps evolving between the Design Team and the User Group. The study visualized two design thinking approaches (Figure 1, 2) and made a comparison of Table 3 as a reference.

Figure 2 presents the main structure of the research approach applied in the study. Modified design thinking process refers to a series of the existing design process, tools, methodologies that can facilitate and engage the User Group as well as the Design Team along the journey. In this study, the Funnel Model was designed and placed in the define stage to integrate the voice of user and translate their needs and expression from the research stage and ideate stage.

[Figure 2] Modified Design Thinking Process with Applied Funnel Model in the Define Stage
Table 3 The Comparison of Design Thinking Process and Modified Design Thinking Process with Funnel Model

<table>
<thead>
<tr>
<th>Brief Definition</th>
<th>Design Thinking Process</th>
<th>Modified Design Thinking Process with Funnel Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Design thinking is a process for creative problem solving (IDEO, 2020). • The design process is what puts design thinking into action (IDEO, &amp;Riverdale Country School, 2012). • “Design thinking is a human-centered approach to innovation that draws from the designer’s toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success” (Tim Brown, Executive Chair of IDEO).</td>
<td>• Modified design thinking process with the Funnel Model is based on the design thinking process and refers to a series of the existing design tools, methodologies that facilitate and engage the groups from both users/customers/interviewees and the design team along the journey. • Funnel Model provides the design team an open framework to embed users’ voice into the design process more efficiently.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Method Structure</th>
<th>Interconnected modules</th>
<th>Interwoven stages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engagement Level</td>
<td>View the voice of users as a static input</td>
<td>View the voice of users as a dynamic evolving process</td>
</tr>
<tr>
<td>Time Relevance</td>
<td>Time-independent</td>
<td>Time-dependent</td>
</tr>
</tbody>
</table>

3.2 Funnel Model

In most user research, the engagement is limited to certain moments and stages in the whole design process, which makes it hard for design team to work with direct results and feedback from users. The Funnel Model is designed to enhance users’ involvement and capture their insights. As a framework conducted in the modified design thinking process, it will help users to express their experience and needs. Meanwhile, it can help design teams to establish a deeper understanding of users.
Four main steps of the Funnel Model are demonstrated in the following and its detailed applications will be explained in the chapter four.

**Step 1 - Recruit Interviewees:** To capture users’ perception of the product, interviews are well-organized and recruited in this process. The potential interviewees are categorized into four main groups, including extreme user, normal customer, opinion leader and industrial expert.

**Step 2 - Select Participatory Research Tools:** Participatory research tools are selected based on the goal of the design team’s purpose and the extent they proposed to engage users’ opinions in the design process. Table 6 shows examples of selected participatory research tools.

**Step 3 - Conduct Qualitative Interpretation:** After conducting the interviews, the design team adds interpretations to quotes and records from the interviews as well as categorizes the interview material for the next step.

**Step 4 - Distil Research Insights:** Through the entire interview and analysis process, insights from interviewees and co-creation procedures will be elicited as the main source of the design journey. With the layer diagram, explicit insights are transferred to more concrete design elements for designers.

### 4. Example Application—Smart Slipper Design Project

#### 4.1 Project Overview

The project iFootPrint—Smart Slipper Design is an in-home IoT device that helps people improve their in-home quality of life, in-home mapping feature and is expected to provide healthcare assistance in the near future, which is defined as an adaptive, portable and communicative product design catering to the needs of the public. The design team has integrated the technology into slipper design for people and used behavioural data as an ancillary tool to understand people’s in-home daily behaviour and real needs. Different from the existing health care IoT product, it incorporates innovation design and research process including applying Funnel Model, conducting in-depth user and expert interviews and establishing a data-driven product feedback system and platform, which have been integrated with the users’ perspectives.

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Purpose and Design Challenge</th>
<th>Target User</th>
<th>Key Milestone</th>
</tr>
</thead>
<tbody>
<tr>
<td>iFootPrint—Smart Slipper Design</td>
<td>The project is to capture and apply the user behavioural data to influence and improve the in-home space and user experience design for people.</td>
<td>People with the age around 25 to 55 year-old.</td>
<td>• Research Phase: 1<del>2 months  • Product Development: 4</del>6 months  • Data Infrastructure Building: 1<del>2 months  • Implementation Stage: 2</del>3 months</td>
</tr>
</tbody>
</table>

*Note: The paper only covers the early stage of product development. The product design is still work-in-progress.*

#### 4.2 Application of the Funnel Model

**Step 1 - Recruit Interviewees**

In order to apply the Funnel Model fully for the design research phase of the smart slipper project, the study recruited five interviewees under the theme of in-home IoT devices including one extreme user, one normal customer, two opinion leaders, and one expert in order to have more diverse opinions. For each user research, the design team conducted sixty-minute in-person interviews, co-creation prototype, card sorting experiment and role-playing exercise to capture the interviewee’s overall perception of in-home IoT devices (Table 5).
### Table 5: The Interviewee Information (Co-contributor: Anahi Vega)

<table>
<thead>
<tr>
<th>Interviewee Type</th>
<th>Interviewee Background</th>
<th>Research Type</th>
<th>Research Time and Location</th>
<th>Interpretation of IoT</th>
</tr>
</thead>
</table>
| Participant 1 Extreme User | Graduate Student                | In-person Interview, Co-creation, Prototype, Card, Sorting Experiment | • 60 mins  
• Shared space at student dorm  | “Probably it has a sensor that is invisible. Actually IoT should be like that, you should not be able to identify when a product is IoT or not.” |
| Participant 2 Normal Customer | Graduate Student                | In-person Interview, Co-creation, Prototype, Card Sorting Experiment | • 60 mins  
• Interviewee’s home  | “I purchase Alexa for aspiration.” |
| Participant 3 Opinion Leader | Administrative Staff at a University Research Center | In-person Interview, Co-creation, Prototype | • 60 mins  
• University lab space  | “The great smart slippers design is to make me feel as if I were walking on the cloud. Very comfortable.” |
| Participant 4 Opinion Leader | Product Manager and Graduate Student | In-person Interview, Co-creation, Prototype, Card Sorting Experiment, Role-playing Exercise | • 60 mins  
• Shared space at student dorm  | “I hope IoT could offer me mental power rather than saving my physical energy.” |
| Participant 5 Expert Interview | Postdoctoral Fellow at a University Research Lab | In-person Interview | • 30 mins  
• University lab space  | “You should start with something very dominant like everyday objects in place and add technology step by step.” |

### Step 2 - Select Participatory Research Tools

Take IoT in-home product design as example, design research is conducted for the design team to better understand users’ need of in-home products. In our implementation with the Funnel Model, ten customized participatory research tools (Table 6) were harnessed to get potential users’ feedbacks.

According to the background information of interviewees, the tools were chosen from the participatory research tools list to conduct the interviews. Among them are Card Sorting (Figure 4), which was selected to understand users’ attitude towards IoT and smart-home products and in which condition users would like to use the product, as well as Product Storytelling, which helps the design team to capture users’ preference of design elements in existing products.
<table>
<thead>
<tr>
<th><strong>Steps</strong></th>
<th><strong>Tool</strong></th>
<th><strong>Purpose</strong></th>
<th><strong>Example</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Prepare the field guide; prepare the product cards based on the product prototype.</td>
<td>Experience Building</td>
<td>Test the prototype and its interaction with interviewees.</td>
<td><img src="Image1" alt="Experience Building Image" /></td>
</tr>
<tr>
<td>2. Provide the product cards based on the product prototype.</td>
<td>Time-line Narrating</td>
<td>Get to know users’ living space well through their narratives.</td>
<td><img src="Image2" alt="Time-line Narrating Image" /></td>
</tr>
<tr>
<td>3. Use in-depth conversation to explore their daily behaviour.</td>
<td>Space Memorizing</td>
<td>Understand users’ user experience and thought concerning the product.</td>
<td><img src="Image3" alt="Space Memorizing Image" /></td>
</tr>
<tr>
<td>1. Prepare the field guide; prepare the product cards based on the product prototype.</td>
<td>Product Storytelling</td>
<td>Get to know users’ living space and interpret their stories in guided tours.</td>
<td><img src="Image4" alt="Product Storytelling Image" /></td>
</tr>
<tr>
<td>2. Provide the card deck of cards with images or words related to products.</td>
<td>Card Sorting</td>
<td>Get to know users’ living space and interpret their stories in guided tours.</td>
<td><img src="Image5" alt="Card Sorting Image" /></td>
</tr>
<tr>
<td>3. Use in-depth conversation to explore their daily behaviour.</td>
<td>Semi-structured Interview</td>
<td>Get to know users’ living space and interpret their stories in guided tours.</td>
<td><img src="Image6" alt="Semi-structured Interview Image" /></td>
</tr>
</tbody>
</table>

**Table 6: Participatory Research Tools (Co-contributor: Anahi Vega) **

- **Purpose:**
  - **Experience Building:** Explore different ends of the product prototype.
  - **Time-line Narrating:** Trading and understanding of product and interviewees’ response.
  - **Space Memorizing:** Enable interpretation of users’ daily life through narratives.
  - **Product Storytelling:** Get to know users’ living space and interpret their stories in guided tours.
  - **Card Sorting:** Understand users’ living space and interpret their stories in guided tours.
  - **Semi-structured Interview:** Get to know users’ living space and interpret their stories in guided tours.
In detail, in order to capture the user’s perspective seamlessly, product storytelling, one of the participatory research tools paired with the slipper drawing template as shown in Figure 5, which effectively facilitated the conversation with the user (participant 3) through quick sketching. Participant 3 shared other relevant product information including the feather materials on the side, the different concepts between the slippers, and flipflops. She also shared her stories and perception about in-home slippers, saying ‘The great smart slippers design is to make me feel as if I were walking on the cloud. Very comfortable’, which served as a reminder to the project research team of considering the future features of the smart slippers. The participatory research tools (Table 6) empowers the design team to conduct deeper conversation with interviewees, which will serve as valuable resources for the next qualitative interpretation stage.
Step 3 - Conduct Qualitative Interpretation

After conducting five user interviews, the team distilled and added interpretations for some of the insightful and interesting quotes. Based on interviews with selected participatory research tools (Card Sorting, Product Storytelling), design team clustered and decomposed the quotes of interviewees into six core themes, as well as interpreted the verbal material from design team’s perspective. Followings show six categorized interpretation of users’ quotes from interviews.

A. Personified In-Home IoT Device for Companionship
   - Another emotional aspect to see the in-home IoT device is to consider it as companionship. People tend to personify the in-home IoT device and want to have further interaction with it.
   - The interviewees tend to personify in-home IoT devices and project emotional attachment on it. The next questions raised by the team were about how the IoT company design left the right impression on the target customers/users.

B. The Purpose of Having In-Home IoT Devices
   - In general, the design of in-home IoT devices needs to arise from people’s core needs that are relevant to their life and behaviour. The company shouldn’t design just for the sake of design or technology.
   - In general, users may use in-home IoT products to assist themselves in conducting some mental or physical activities including curing insomnia. Both healthcare and daily assistant functions could be potential pain points for the future of IoT products.

C. The Security, Privacy, and Safety of In-Home IoT Device
   - Even Though the interviewee said it’s OK to share personal info and data, the design team discovered the data that people are willing to share is the data that does not touch upon security and safety issues such as banking account, personal biological data.

D. In-Home IoT Device Embedded in People’s Life
   - The in-home IoT device should be designed in a way that fits people’s behaviour seamlessly in the context of home settings, which means the product is integrated into people’s lives.
   - From this perspective, we can see that some users address time-saving issues with IoT products. That is to say, in order to satisfy distinctive needs of users, customized function and purposes should be considered.
   - From the view of professionals, we can see that IoT products should function as people expect and fit people’s daily behaviour, thus designers should not only treat the product as IoT, but more importantly, keep the user-friendly function in the mind.

E. Interference of Technology in Personal Life
   - The basic criteria for a well-rounded IoT product is not how fancy or highly technological it is, but how well it functions for people to easily use it.
   - One of our interviewed experts talked about his experience collaborating with users to design IoT products. The interference technology brought to people’s life should be seriously considered when designers integrate novel techniques into their product.
   - From this user-experience designer’s words, we can see that the future of IoT and smart home products has the potential to be designed as invisible or subtle components in people’s daily life. That is to say, redesigning everyday objects could be a big opportunity.

F. User Experience
   - From a professional perspective, utility is a significant element for the success of IoT product. Thus, embedding user research and collecting users’ requirements in every step of design is meaningful.
   - From the designer of IoT design toolkit, which helps people with non-design and technological background to ideate and create their imaginative IoT product, we learned that conducting research on user experience and observing how people use their everyday objects is a good start point for designing in-home IoT products.
Step 4 – Distill Research Insights

According to the six categorized themes, the design team implemented three rounds of cluster forming exercise to unscramble all the interview quotes and reframed the statement into three layers: Layer 1 (Principle Level), Layer 2 (Theme Level) and Layer 3 (Keywords) with modified Affinity Diagram. The outcome of the modified Affinity Diagram generated several keywords which tried to reflect the aspects concluded from the qualitative interpretation and gave the direction to the ideate stage.

[Table 7] Modified Affinity Diagram of Smart Slippers Project—Part 1 (Co-contributor: Anahi Vega)

<table>
<thead>
<tr>
<th>Layer 3 Keywords</th>
<th>Layer 2 Theme Level</th>
<th>Layer 1 Principle Level</th>
<th>Scrubbed Statement Interview Quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Security</td>
<td>• People are always struggling to find a fine line between convenience and privacy when they use in-home IoT/smart devices that need the input of user’s data and information.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Safety</td>
<td>• Users will be concerned with to whom and where their data captured by IoT devices will be even though it is convenient to use the product.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Privacy</td>
<td>• Users will fully rely on in-home IoT devices or people only trust people.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Users want brands to be transparent about the usage of the information they are sharing.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Users need to know the brand and its value to share information.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• People’s Real Needs</td>
<td>• People purchase most in-home IoT devices with a strong purpose. They need to solve a certain type of problem at home.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• People’s Desires</td>
<td>• People clearly know when, where and why they need to use in-home IoT devices.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Users find value in products that are intelligently designed and smoothly integrate technology.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Users want products to be able to adapt to their daily activities and habits.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Users want products to predict their activities and facilitate them.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• “I don’t like sharing much information with certain apps. It depends on what the app is and who its creator is.”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• “If it is something that I believe to be sensitive information and the company may take advantage of it, I will probably pay more attention to what the brand is.”</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

• People’s Real Needs
• People’s Desires

“Because of the screen, it makes me think I could obtain more information from it, but that isn’t necessarily better because sometimes I can look at screens.”

“I define smart as being able to provide shortcuts and feedback on things at the appropriate amount.”
### Modified Affinity Diagram of Smart Slippers Project—Part 2 (Co-contributor: Anahi Vega)

<table>
<thead>
<tr>
<th>Layer 3 Keywords</th>
<th>Layer 2 Theme Level</th>
<th>Layer 1 Principle Level</th>
<th>Scrubbed Statement Interview Quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Efficiency</td>
<td>• People tend to have multiple in-home/smart devices, which indicates that information and documentation exchange is very common and often. The file exchange process needs to be simple, easy, efficient and accessible to the users.</td>
<td>• Users can switch between different IoT devices with ease to share information and document.</td>
<td>• “The most efficient things are like air dropping things, which I can send across my devices and always stay there.”</td>
</tr>
<tr>
<td>• Compatibility</td>
<td></td>
<td>• The IoT device can increase the efficiency of work and life.</td>
<td>• “If you want integration, I would say go with Amazon, because it is faster and easier. But if you tell me it’s just for asking questions, I would say go with Google, because Google owns the search engine.”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Users value products that allow interconnectivity.</td>
<td>• “One thing that annoys me is that you can only connect it to two devices. But always having that connectivity is super convenient for me.”</td>
</tr>
<tr>
<td>• Aesthetic</td>
<td>• People naturally view in-home IoT devices in the context of a home as a whole, which indicates the in-home IoT product design process needs to take consideration of the environment settings.</td>
<td>• The in-home IoT device needs to be designed in a way that can fit people’s home settings easily.</td>
<td>• “Probably it has a sensor that is invisible. Actually IoT should be like that, you should not be able to identify when a product is IoT or not.”</td>
</tr>
<tr>
<td>• Form</td>
<td></td>
<td>• The in-home IoT device needs to be designed with a simple geometry form in order to match different interior design styles.</td>
<td>• “I want something that is more geometric but kind of resembling an AI thing.”</td>
</tr>
<tr>
<td>• Shape</td>
<td></td>
<td></td>
<td>• “Because it reminds me when I used to work on a company and needed to dress formally but my Fitbit didn’t match my outfits, it looked more casual.”</td>
</tr>
<tr>
<td>• User’s Behavior</td>
<td>• People like the interface and the design of the in-home IoT device that is human-centered and user-friendly, which matches people’s behavior.</td>
<td>• The interface of IoT products needs to be intuitive and easy to use.</td>
<td>• “People this age (+60) have a lot of limitations, but this kind of device can help them with many daily activities.”</td>
</tr>
<tr>
<td>• User’s Journey</td>
<td></td>
<td>• Consider the reason to add or get rid of the extra screen of an in-home IoT device.</td>
<td>• “People need to think about the customer journey when they decide whether to include IoT or not.”</td>
</tr>
<tr>
<td>• User-friendly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Human-centered</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Use IoT for the Sake of IoT</td>
<td>• People have an impulse to purchase the latest in-home IoT product, but not in terms of what people want and why. Sometimes people can’t articulate their needs well.</td>
<td>• People don’t know why they need to purchase in-home IoT products.</td>
<td>• “So there are things that may not be important if you connect them or not, like once in Singapore I wanted to buy a microwave that was connected to Alexa, but later I found it wasn’t worth it. It didn’t make a difference, and you still need to go near the object and put the food in and out.”</td>
</tr>
<tr>
<td>• Reasons to Buy</td>
<td></td>
<td>• People purchase in-home IoT products just because others did the same.</td>
<td>• “In the past I bought products not out of necessity but because they could be connected to Alexa.”</td>
</tr>
</tbody>
</table>

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4.3 Preparation for the Next Stage: Ideate

The modified Affinity Diagram helped the design team to decompose the interviews and observations into three levels, from selected interview quotes to the principle and theme level. In this case, it gave the design team holistic-yet-relevant perspectives to ideate the in-home IoT product and its system. In this study, using smart slippers product design (Figure 6,7) as an example, the design team considered efficiency, compatibility, form, shape, purchasing motivation from Layer 3 (Keywords) of the modified Affinity Diagram and implemented them into the early design and development process.

At the first stage of the product design, the focus was on the main part—the sole of the smart slippers. The sole was designed based on ergonomic consideration and its sensor (tracker) and the power source were embedded in the back of the sole for the purpose of maintaining the flexibility of the slippers. The smart slippers were wireless charging that allowed users to recharge the smart slippers in a convenient and intuitive way in order to create for the user a meaningful walking trajectory and walking pattern at home. Summarizing from the distilled insights diagram, the sub-1-meter location precision in-home tracking device was required. Bluetooth 5.1 and UWB technology fulfilled the lower power consumption and higher location precision product requirements, and the small-scale system design was embedded into slippers easily.

[ Figure 6 ] The Sole Concept of iFootPrint—Smart Slipper Design

5.1 Result and Discussion

In the process of developing the Funnel Model, the design team concluded three main learning insights and suggestions for further modification and discussion.

Treat Funnel Model as an Experimental and Open Design Framework

In this study, Funnel Model provides an immersive and engaging approach to help the design team equip itself with the right user engaging tools focusing on the in-between stage of Research and Ideation (Figure 2). Funnel Model is an experimental framework established on ZMET, Affinity Diagram, and other participatory research methods to extract and integrate their essence of user engaging process and analysis method. Unlike other typical research tools, the Funnel Model gives prominence to the point that the tool is designed for inviting the users to have more interaction with the design team in a project.

Evolve Funnel Model into an Inclusive Methodology

The intention of using the Funnel Model is to empower targeted users and invite them as part of the design team to co-design, as well as contribute their voice, ideas, thoughts, and action to the project. Apart from involving users in the core team, how might we apply the Funnel Model to rescope and recruit participants from the user group to the client and investor, and extend the co-creation phase from the research to the whole project? The design team wants to refine and transform the Funnel Model into a more inclusive and universal creative approach. Further development will focus on how to connect design teams, users with clients, and make the design process more transparent, engaging and collaborative.

Diversify Participatory Research Tools

When applying the Funnel Model, the design team considered one question—how could we capture some nonverbal messages such as body language, facial expression, Post-it notes drawing during the interview? Instead of using audio or video recording and translating it into text format, how might we better leverage other senses of the facilitator to have deeper and more comprehensive observation and cultivate more empathy of the interviewees? Meanwhile, further research on the methodology to decode the raw material from users such as quotes can be helpful for researchers and designers to engage more users’ expression in the product development process.

5.2 Further Study

Design and Use Different Funnel Models to Bridge Each Stage of Design Thinking Process

In the study, Funnel Model was specifically designed for the define stage (Figure 2) in order to maximize the opportunities to invite the users/interviewees in the design thinking process. Since the connection and condition between each stage are varied, it affects the design of the Funnel Model. Further study can explore and experiment with different types of Funnel Model in terms of process catering to the requirement of different stages.
Expand the Selected Participatory Research Toolkit

In the study, the example applied Card Sorting and Product Storytelling tools, two of the ten participatory research tools to conduct user interview and co-creation process. The study suggested ten selected participatory research tools at a high-conceptual level in Table 6. There are still many detailed procedures that need to be addressed, prototyped, and validated for the further study.

Apply the Right Technology with High Resolution to Improve User Experience

Regarding technical feasibility to satisfy users’ needs, the design team improved and developed a high-resolution-in-home tracking device embedded in slippers for the next step. In order to get the meaningful user walking trajectory and walking pattern at home, the sub-1-meter location precision in-home tracking device is required. Bluetooth 5.1 and UWB technology can fulfill requirements for lower power consumption and higher location precision on products, and the small-scale system design can be embedded into slippers easily. For further study, more technologies need to be considered in the research stage of design thinking process focusing on the user needs, pain points, and observation. Therefore it can help the design team integrate the right technology into the product design development.

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