IMPLEMENTING CONTEXTUAL DESIGN FOR THE AGING
DESIGNING TECHNOLOGIES FOR AND WITH OLDER ADULTS

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1. INTRODUCTION

The average life expectancy in the United States has increased significantly. Between 1900 and 2003, life expectancy has increased by 30 years (Quadagno, 2013), impacting the need for older adult products and services. Within Asia, North America, and Europe, the population of people over age 65 in 2009 ranged from 6%-16%. By 2030, these percentages are predicted to range from 17%-29%. As the older adult population increases, there is a need to design products that can aid older adults in the aging process. Incorporating technologies in product design can bring promising opportunities to better assist older adults. However, designing technologies easily adopted by older adults can be challenging. Traditional design approaches may not be sufficient for designing technologies considering the decline of physical, perceptual, and cognitive abilities that humans experience with age (Fisk et al., 2009). Contextual Design is an effective method for designing implementable technology for and with older adults because it employs a variety of research methods that enable the designer with an understanding of the user in his or her context. This paper presents the structure and steps of the Contextual Design process and its application with a case study, KeepSeek, an interactive shelving system designed to bolster social connectedness for older adults.

2. BACKGROUND

Universal design is the design of accessible products and environments to be usable by all people, including older adults, to the greatest extent possible without the need for adaptation or specialized design. Universal Design is a proactive, problem-solving approach that reduces environmental demands on all users (with or without functional limitations). The seven principles Equitable Use, Flexibility in Use, Simple and Intuitive Use, Perceptible Information, Tolerance for Error, Low Physical Effort, and Size and Space for Approach and Use differentiate Universal Design from Accessible Design. These principles can be used as guidelines as well as evaluation tools to address issues of accessibility in the design of a product from a perspective of multiple users with varied abilities. As such, it can be said that universal design is a reactive, code-compliant approach that reduce environmental demands on people with functional limitations (Sanford, 2012).

The Universal Design principles are well suited for designing for older adults but they may not be a sufficient model for designing technologies for older adults. Sympathetic design is an approach for designing technology for older adults, specifically the design of communication technologies (Rébola & Jones, 2013). The aim of this approach is to design technologies that aid older adults with aging. But more importantly, it aims to make technology more approachable and accepted by older adults. The Sympathetic Design approach utilizes components from various research projects to form an organized framework that has been developed for designing with older adults in mind. This framework provides an overview of design approaches and methods for engaging practitioners in specific activities of designing technologies for older adults. The framework is based on six dimensions: product functionality, product interface, co-design activities, universal design, product experience, and technology use. Rebola (2013) states that the functionality of the technology must be simple to use and address a basic need of an older adult, celebrating the physicality of product when operating a technology. Of importance, the author emphasizes the necessity for older adults to be actively involved in the product design process.

Contextual Design is a user centered design process developed by Hugh Beyer and Karen Holtzblatt (Martin and Hannington, 2012). It is composed of a variety of research methods that enable the designer to understand the user and his/her context. It provides a rich and qualitative understanding of who the user is and how he or she engages in activities or tasks on a daily basis. Contextual Design is a versatile process in which other tools and techniques can be easily added. It can be customized and adapted for different purposes (Beyer & Holtzblatt, 1997). Traditional design processes often do not allow the designers to fully understand the user from an ethnographic point of view. This is typically an issue when designing for underrepresented populations, such as older adults. Older adults typically are “relevant but absent” social groups in the design and development of new technologies. Even though technology plays a role in their everyday lives, older adults rarely have active involvement in the development process. Many designers of today’s new technologies tend to be young adults who may have a very different perspective of the world than older adults. They may be unaware of the age-related differences and how those differences can affect the adoption and use of technology. Therefore, it is important to fully involve conventionally “relevant but absent” social groups such as older adults in the design and development process of technologies (Xie et al., 2012).

3. METHODOLOGY

This specific case study employed the contextual design methodology (see figure 1). The methodology can be divided into 5 major phases: research, analyze, development, solution, and refine. The next sections describe in detail the following stages for designing technologies for older adults: research (literature search, market search, simulations), analyze (data collection, data analysis), development (brainstorming, 2D ideation, 3D ideation), solution (prototyping, storyboarding), and refine (refining the prototype and usability testing.)

3.1 LITERATURE SEARCH

Literature on the topic should be reviewed in order to understand what questions experts in the field have already answered, what questions remain unanswered, and what areas could be built upon. Becoming knowledgeable of significant statistics on the topic is often an important platform in the beginning of the design process that will leverage and validate future design decisions.

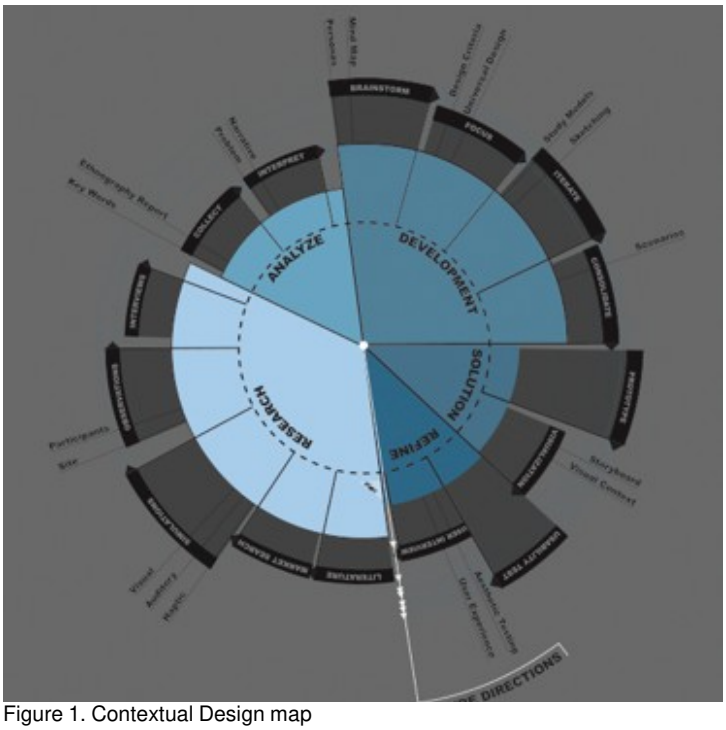

Figure 1. Contextual Design map

Existing literature on older adults showed that older adults often need to adopt new housing options. In addition, older adults may need assistance with daily activities through transportation services and other amenities, and many wish to be around other people their age. The transition of moving from a familiar place to a new and unknown setting is often a stressful experience for older adults that leads them to feel unsafe or dependent (Shippee, 2011). They often lose social connections, have difficulty maintaining their daily routines, and consequentially lose their feeling of independence (Schumacher, Jones & Meleis, 1999).

For older adults to feel safe, three prerequisites must be fulfilled: feeling healthy, having someone to rely on, and feeling at home. Fulfillment of these prerequisites is required for older adults to adopt technology such as home modifications and assistive devices that facilitate the feeling of safety (Petersson, Lilja, & Borell, 2011). Feeling at home is further broken down into two subcategories: feeling in control and having supportive surroundings. Older adults feel in control when they have a conscious knowledge of the placement of their belongings, and the home is regarded as a place where older adults want to have control. Supportive surroundings are characterized by familiarity and routine. Familiarity is accomplished by being surrounded with familiar people and service providers. By being in a stress and violence free environment, older adults feel empowered to independently perform activities inside and outside the home. Based on a time budget analysis study, older adults spent a significant amount of time in the living room on activities such as watching TV, eating, reading, and napping (Krantz-Kent & Stewart, 2007). The sense of feeling at home enables older adults to complete their daily routine and activities with a feeling of satisfaction (Petersson, Lilja, & Borell, 2011).

3.2 MARKET SEARCH

Once relevant literature has been reviewed, the next step is to conduct a market review of products and systems that have been designed for older adults, especially related to the identified focus area from the literature review. It is important to analyze why certain designs succeeded or failed. The KeepSeek designers found a gap in products designed to aid older adults with staying both physically and socially active in a form that was easily adopted and integrated into their surroundings.

Products and systems already on the market intended for older adults to feel safe, socially connected, and independent were reviewed. Products included portable devices that alerted close friends and family, as well as a nearly emergency center if the older adult had fallen, such as LifeAlert, VitalLink, and MedAlert. For social connectedness, the designers looked at products that created a sense of community by letting friends and family know that the older adult was home such a Good Night Lamp. For the independent and technologically savvy older adult, there are beacon devices that send alerts to the older adult's phone when they are located near a service that would appeal to them, with data gathered through machine-learning.

The opportunity to design a device that provides social connectedness for all older adults, not just technologically savvy ones, was discovered by the design team through this research. The design team would focus on creating a technology that could be used with or without a smartphone and would be adopted easily by older adults with varying levels of perceptual and technological ability.

3.3 SIMULATIONS

Understanding first-hand how underrepresented populations like older adults are is an important step in the design process that may often be skipped. As humans age, a variety of changes are experienced that impact their thoughts toward and interactions with products and systems. These declines can be categorized into three categories: cognitive, perceptual, and physical. Dementia is an example of cognitive decline that many older adults experience and greatly affects an older adult's ability to use products at an ever-depreciating rate. For example, when designing for older adults who may be experiencing dementia, it is necessary to provide sensory cues that allow them to recognize memories rather than having to recall them independently. Perceptual decline consists loss of strength and acuity of the visual, auditory, haptic, olfactory, and gustatory senses. The most significant of these are the impairment of vision, hearing, and touch. It is important to incorporate cues and feedback for more than one of these senses with indicators such as lights, colors, sounds, vibration, etc. Physical impairments such as arthritis and wheelchair use must also be considered in design. The design must be easily accessible and used by people of all ages, with or without disabilities (Fisk et al., 2009). Designers can understand the perspective of

users by doing disability simulations and taking notes on the experience.

The KeepSeek designers each used disability simulation materials to experience first-hand the effects of auditory, visual, and tactile impairments. They used ear plugs, vision impairment glasses, and arthritis simulation gloves for four hours each and kept a log of their experiences. The designers learned that having an impairment requires patience from both the individual and others around him or her. It also provided the designers with a unique bank of experiential data to call upon when designing their product. Instead of assuming to know what an impairment is like (or assuming it to be of less-importance than other design directives), they had personal short-term experience to inform their design decisions with contextual data.

3.4 DATA COLLECTION: ON-SITE OBSERVATIONS & INTERVIEWS

On-site observations can be valuable and informative methods to understand how a user lives and interacts with his or her environment. On-site observations enable designers to envision the space they are working with and to see how people behave in environments. In addition to observations, interviewing the population results in useful quantitative and qualitative data. Asking questions that elicit insightful answers is key to a successful interview. With older adults, it is important to be clear when asking questions and to use language that does not prime them for one answer over another.

This project engaged in conducting observations and interviews at a local retirement community on two separate occasions. The interview was semi structured and a guide was used to ask older adults questions pertaining to transition, independence, living room usage, socialization, and technology use. The interview questions allowed the designers to open a dialogue with potential users of their design and gave insight into misconceptions and inconsistencies the team may have otherwise misunderstood. This data provided guidelines for further contextual requirements that would inform a better-received and more easily used design solution. This method allowed the collection of both qualitative and quantitative data for analysis.

3.5 DATA ANALYSIS

In Contextual Design, data analysis is performed at different levels, from coding visual observations, to descriptive statistics and affinity diagrams with the goal of informing the design premises for the project. These methods aid finding correlations between age, gender, and interview answers to identify trends. If necessary, further investigation via follow up interviews may be needed to fully interpret and understand the data.

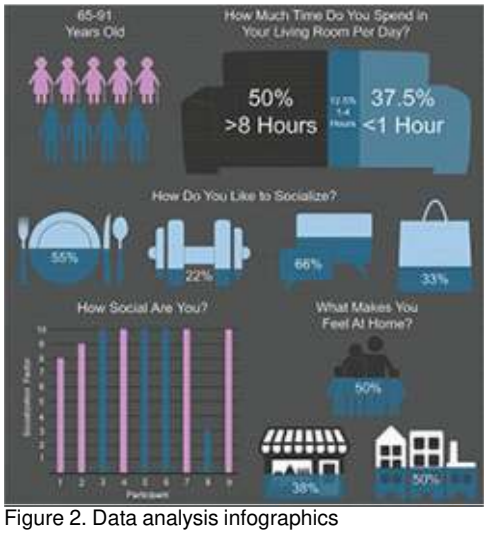

Figure 2. Data analysis infographics

Based on the collected data, infographics were created (see Figure 2).

The designers created infographics and an affinity diagram to organize their data. The results show a positive correlation between older adults who have strong social connections and those who feel independent and safe.

With these results, problems the users face when interacting with a product or system were identified. An affinity diagram was developed in order to place in hierarchical order critical issues for the design development (see Figure 3). With all the aforementioned methods, the design premises for the project were identified as follows:

Older adults are empowered through the ability to control their support system by maintaining connections and memories, preserving routines, and engaging in new endeavors. This is further broken down by the following three statements: 1. The more social support one has, the more independent they feel. 2. Environment can't be one size fits all. 3. A sense of fulfillment is achieved when having a familiar routine and a feeling of independence.

3.6 BRAINSTORMING

Once a problem or need is identified from analyzing the data, the brainstorming phase can begin. Creating mind maps is an effective way of organizing thoughts.

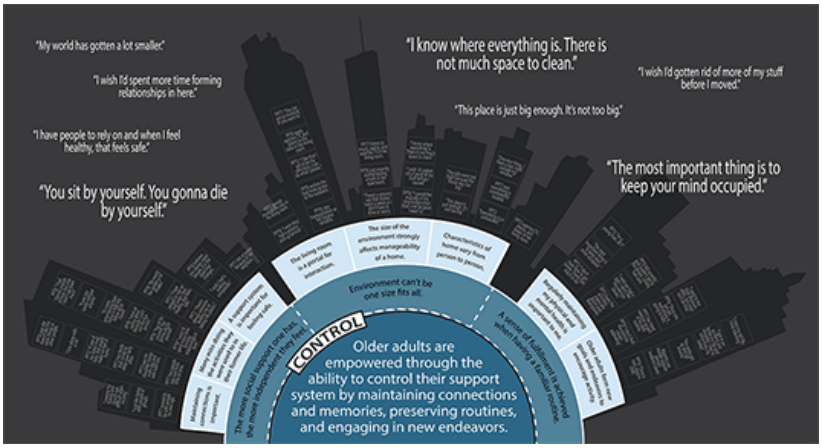

Figure 3. Affinity diagram graphic

The designers utilized a mindmap to breakdown the vague classification of activities into four distinct categories: eating, exercise, events, and errands. From there, personas were created with specifications drawn from varying demographics. Especially with older adults, creating personas serve as a reminder to consider all various personalities, attitudes, demographics, and disabilities.

3.7 2D IDEATION & 3D IDEATION

The next step is to start sketching ideas and creating study models. It is also important to consider scale with the study models. Some designers find it may be beneficial to create a dollhouse of the environment in which the product or system is intended to be used.

In this case study, the designers created sketches, study models, and a small living room out of cardboard to envision the space that they were working with. They also created typical furniture found in living rooms to be aware of objects that may facilitate or obstruct a concept. Small-scale versions of the team's early design ideas were also created and placed within the dollhouse to help illustrate varying ways each design could be placed in the home and the limitations and additional requirements of those placements.

3.8 PROTOTYPING

Once familiar with the environment and scale of the product and its intended environment, prototypes of varying levels of fidelity can be made. Each iteration is developed with higher quality than the last and includes additional details of the form and function.

The designers chose the best concept out of the 2D and 3D ideations and created a series of prototypes. The prototype was a modular and interactive shelving system that served as a way for older adults to send each other invitations to engage in an activity together. The shelving system (see Figure 4) is comprised of five shelving units representing four categories of activities that were identified based on data found in the interviews. The units also come with a set of RFID tokens that users can customize with their contact information. The users can exchange these tokens with people with whom they share an interest with (errands, eating, events, and exercise). The users can then place their friend's token on one side of the respective shelving unit and then press the "send" button to send them an invitation to engage in that activity together. The receiver's unit will light up on the side with the sender's token and makes an invitation received

noise. The receiver is then able to respond “yes” or “no” to the invitation. There is also a community monitor module which lights up when others nearby are sending invitations via their units. This serves as a motivator for all users to get out of their living room and make new connections. The shelving system is intended to be pre-installed in the living rooms of senior retirement centers. The details of the material, color, and form choices as well as the functionality of the technology were improved with each iteration.

3.9 STORYBOARDING

Storyboarding is an efficient way imagining different scenarios in which a product or system can be used and misused. These scenarios are then enacted and photo documented to show a sequence of events or actions. A storyboard is essentially a potential scenario that is developed based on the data. Storyboarding a sequence of events enables the designer to see how a user interacts with a product or system from beginning to end in a variety of situations and contexts. Of particular importance this helps identify potential confusions, misuse, and challenges that could arise in real-life use.

Figure 4. 3D rendering of prototype

The prototype was tested in various scenarios, bringing light to issues that had been missed or uncovered in the initial phase of ideating. These scenarios played into social issues as well as physical issues. For example, to design a device or system to bolster social connectedness, the designers had to consider adding a function to the product in the instance of rejected social connectedness or a connection that must be deleted or removed. Various ways in which the product could be confusing or misunderstood were also identified and noted. Physical limitations like wheelchair use, visual impairment and auditory impairment were also played out with the design and documented. These scenarios were all documented in storyboard form with a low fidelity prototype, allowing the designers to visually understand and explain the physical and elemental limitations that needed to be considered.

3.10 REFINING

After imagining different contexts in which the product can be used, improvements can be made. Every detail is carefully considered and informed by the data.

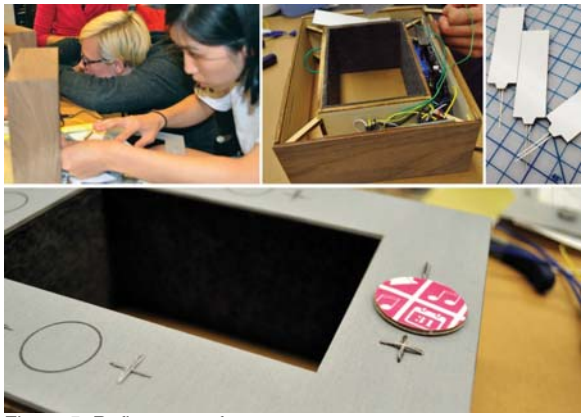
Figure 5. Refinement of prototype

The designers refined the design (see Figure 5) based on uncertainties discovered in different contexts of the storyboards. The interactive shelving unit details were refined. The buttons were stitched out of conductive thread that allowed users with visual impairments to receive textural feedback while sending invites and responses. This also provided a usage action that requires no pressure, so that physical impairments don’t limit usage. The system was made modular and wireless to provide the ability for users to place the units on a wall or table based on their physical mobility. Modularity also allowed the units to be placed in different rooms next to cues as assistance to user with memory impairments. Walnut

veneer and felt were used to cover the basswood frames to provide a familiar, textural and aesthetically pleasing look that could be incorporated into most older adults current living environments.

3.11 USABILITY TESTING

Usability testing is perhaps the most valuable phase of the design process. It consists of asking the user what they think of the product along with asking them to perform tasks and evaluate its ease/difficulty, appearance, functionality, etc. Often, users point out aspects of the design that the designers have overlooked. The success of a product is largely dependent on what the user thinks of it and how he or she interacts with it.

In the case study, the users gave the designers valuable positive and negative feedback (see Figure 6). This experience allowed the designers were able to come up with ideas to improve the overall aesthetics and function of the product.

Figure 6. The users offered constructive feedback on the usability of the prototype.

4. RESULTS

KeepSeek received both positive and negative reviews from the users (see Figure 7). The usability testing allowed the designers to see how the users interact with the product and also get insight into their thoughts on it. Some of the users thought the product was innovative and would motivate them to go out and make new connections. One user thought the design was completely unnecessary and did not go beyond what is already available. She would have preferred to use her phone to make plans with friends rather than using KeepSeek to do so. Many of the users mentioned that there is a learning curve with KeepSeek. They wanted a more simple and intuitive way to learn how to use the system. Four out of the four users struggled with locating the buttons. They all attempted to push or touch the ID token instead of the conductive thread button. The designers realized that the big, round, and colorful ID token resembled a button much more than a small, gray. stitch of thread did. The designers had not predicted that pushing the ID token would be a common mistake when trying to send an invitation. However, all users thought the tasks of sending and rejecting invitations was neutral to very easy, and many liked the visual look of the system. Users commented that they liked the Community Monitor

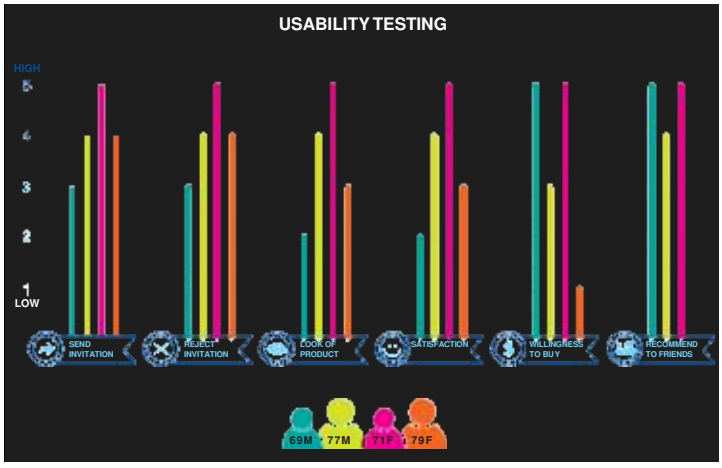

Figure 7. Usability testing results from four users.

specifically and said that unit would motivate them to go out and make new connections. The users' feedback will significantly affect the future directions of the project.

5. DISCUSSION

The contextual design method is an effective way of designing technology for older adults. The designers learned that they cannot force technology into older adults' lives. The technology and design must be unobtrusive and be embedded in the environment. In many cases, the most effective solution with the most impact involves incorporating the least amount of technology as possible. Most importantly, the Contextual Design method allowed the designers to understand the user in his or her context.

6. CONCLUSION

The Contextual Design method is especially useful when designing for older adults. By incorporating all of the Contextual Design steps, the designers were capable of understanding the conditions that older adults face when using technology. This case study demonstrates that the method can be applied to other projects pertaining to older adults or other underrepresented demographics. The method is adaptable to different users or contexts. The Contextual Design method provides a structural backbone of effective research-based design strategies, to which additional tools can be added.

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