INTERNATIONAL MinD CONFERENCE 2019

DESIGNING WITH AND FOR PEOPLE WITH DEMENTIA
Wellbeing, Empowerment and Happiness

IoT product design for dementia: HydrationCane (empowerment) & SoundReminiscence (wellbeing)

James Self, Chajoong Kim, Youngwoo Park, Dooyoung Jung

jaself@unist.ac.kr, UNIST (Ulsan National Institute of Science & Technology)
cjkim@unist.ac.kr, UNIST (Ulsan National Institute of Science & Technology)
ywpark@unist.ac.kr, UNIST (Ulsan National Institute of Science & Technology)
dooyoung@unist.ac.kr, UNIST (Ulsan National Institute of Science & Technology)

Abstract: Adopting an internet-of-things product design approach, we present two concepts that respond to practical and emotional needs associated with changes in memory function. HydrationCane, a design to support improved hydration in people with early stage dementia, provides users opportunity to continue to engage in the outdoor pursuits of walking and climbing familiar within the design's Korean use context. SoundReminiscence draws upon research on audio/music therapy and episodic memory to provide people living with dementia opportunity for reminiscent storytelling through technology enabled memory ques as bespoke sound files. Although differing in their focus, scope and aims the two concept designs indicate how an internet-of-things approach represents opportunities for the design of products that empower and enhance the lives of people living with dementia.

***Keywords**: IoT Product Design; Memory; Empowerment; Wellbeing*

1. Introduction

For people living with dementia (PwD) design provides both an alternative to medication and means to empower and support through interventions sensitive to and appropriate for

the practical and emotional needs of users (Howarth, 2017; Schweder, 2017). For example, in the UK, a collaboration between the Design Council and Department of Health, which aimed to improve life through design, provided product and service designs for PwD through the *Living Well with Dementia Challenge* project (Council, 2012).

In line with Mind2019's key terms - *Wellbeing*, *Empowerment*, *Happiness* the current *Design Proposal* describes the interim results of a project entitled: *IoT (Internet of Things) Product Design for Dementia,* conducted at UNIST (Ulsan National Institute of Science & Technology), Korea. Adopting an interdisciplinary approach that includes industrial and interaction designers, medical doctors and human factors engineers, the design concepts describe our endeavours to provide viable and appropriate solutions targeted at changing memory needs through an IoT product design approach. In particular, the project explores opportunities for IoT (internet-of-things) technologies to drive product design solutions suitable to a Korean use context.

In response to the challenges of an aging Korean society (Kim & Suh, 2018) and associated projected increase in the PwD population in line with other developed nations (Patterson, 2018), the current project attempts to identify, explore and validate possibilities towards non-pharmaceutical interventions to address the unmet needs of PwD (Cohen-Mansfield, Dakheel-Ali, Marx, Thein, & Regier, 2015). The current proposal presents two work-in-progress IoT product concepts. Although different in their holistic aims and potential benefit, both address challenges related to memory and dementia, underpinned by the application of IoT technologies.

A first IoT product concept (*Proposal 01, HydrationCane*) focused upon empowerment, responds to changing needs associated with short term memory and hydration in support of continuing active living; in particular mountain hiking and walking within a Korean context. The second design concept (*Proposal 02, SoundReminiscence*) explores the potential of multisensory simulation (Jakob, Manchester, & Treadaway, 2017), including sound, as means to trigger episodic memory recall. This in turn is positioned as means to provide increased opportunity for meaningful communication between PwD, careers and family members, achieved through reminiscent storytelling.

As indicated by Kali et al. (2017), music and sound can provide opportunity for communication through the stimulation of autobiographical, long-term memory recall. *SoundReminiscence* thereby attempts to respond to the emotional needs of PwD through a focus upon memory and emotion akin to Treadaway et al's (2016) provision of playful experiences through sensory (both audio and haptic) simulation.

Thus, the two IoT product design concepts attempt to address both practical and emotional needs. An emotional need for meaningful communication, stimulated through sound cues aimed at supporting recollection of long-term memories. And more practical concerns associated with short-term memory, physical activity and hydration (Timlin & Rysenbry, 2010).

By presenting the two conceptual designs here, we highlight two of the conference's core concerns in designing for dementia. First, a necessity to support existing life habits and behaviours, thereby empowering PwD to continue to live well (Empowerment), and a need to identify possibilities for increasing meaningful communication, thereby supporting wellbeing. Both concepts are provided here to stimulate discussion around how an IoT product design approach may respond to needs associated with memory for the PwD user.

2. Design Proposals

Proposal 01 HydrationCane (*Empowerment*)

Subsequent to a literature review and desk research, user studies in collaboration with community centres for the elderly within the Ulsan and Seoul areas of Korea were conducted. Ethnographic and interview studies were conducted. As a result, insights were gained towards the practical needs of elderly. In particular, hydration was identified as a critical issue for those living with MCI (Mild Cognitive Impairment) and early stage dementia. This also agreed with research exploring challenges around hydration in care home settings (Archibald, 2006). Due to the effects of short-term memory loss, associated with Alzheimer's, PwD often have difficulty remembering when to drink, how much to drink and how often.

Within a specifically Korean context, the national pass-time of mountain climbing and trekking particularly among the elderly, presents unique challenges (Jo, 2018). Our first design proposal, *HydrationCane,* provides a solution to empower elderly users and those living with early-stage dementia to continue to engage in life-long habits and activities through supporting continued engagement in outdoor activities and pursuits (see *6. Appendix, Design Board 01.2*).

Through the application of sensor and IoT technologies, *HydrationCane* monitors the user's hydration during activity. A vibration reminder provides indication of when a drink is desirable. *HydrationCane's* integrated water bottle design removes the necessity to carry or locate a water supply (*6. Appendix, Design Board 01.5*).

The design's sister application allows enhanced monitoring of hydration and fluid intake, providing important information to caregivers (*6. Appendix, Design Board 01.3*). A simple charging/docking station allows simplified feedback on hydration when re-charging. The cane is initiated upon removal from the product's base unit (*6. Appendix, Design Board 01.4*).

Upon gripping the handle, the cane begins to gather information on user hydration through the sensor embedded within the handle design. A rotation axis to the handle design provides two orientations: supportive walking (90° perpendicular to the cane shaft) and climbing (vertical in-line with cane shaft). A vibration feedback provides discrete reminders to drink. It is anticipated that the vibration will become associated with need to drink through classical conditioning between vibration and need to drink over time.

An integrated water bottle is easily detached and re-attached to the cane. Once *HydrationCane* is returned to the base-charger, the user is provided instant feedback on hydration through simple red (negative), blue (positive) feedback by integrated LED light arrays (*6. Appendix, Design Board 01.4*).

For measurement of hydration levels, *HydrationCane* applies *Bioelectric Impedance Analysis* (BIA) technology for a far more accurate measurement of hydration than existing hydration bottles that measure water supply use only. The BIA technology detects the total body water percentage (*TBW%*) through two electrodes placed within the handle grip. A micro-current is introduced from *point A*, safely flows through the user's body, and returns to *point B*. The flow measured between the two points is then employed to accurately indicate the amount of water inside the body. This information is communicated to users through the cane's alert, charger/docking station LED feedback light array and the HydrationCane application.

The HydrationCane concept is thus addresses issues associated with the loss of short-term memory during early-stage dementia. In particular, the design concept focuses upon the need for hydration when active out of doors.

Proposal 02: SoundReminiscence (*Wellbeing*)

Desktop research was undertaken to explore the needs, challenges and opportunities existing to inform living with early to mid-stage dementia. The *SoundReminiscence* concept locates within the alternative, experiential care approach proven to support living well with dementia (Anderiesen, Scherder, Goossens, Visch, & Eggermont, 2015).

Adopting a user-centred research methodology that included interviews at care homes in Ulsan and Seoul, Korea, case-study analysis and observation studies of people living with dementia, *SoundReminiscence* was inspired by the potential for autobiographical storytelling to provide opportunities for meaningful contact between PwD, care workers, peers, and friends and loved-ones.

SoundReminiscence employs recorded audio files to trigger long-term memories and reminiscence. In this way the concept relates to existing studies indicating the benefit of both music/sound therapies in particular (Müller-Rakow & Flechtner, 2017), and reminiscence of long-term episodic memories.

An IoT design approach provides three physical, haptic 'beanbag' interaction points. The three bags correspond to three broad categories of sound: Grey: *People & Places*, Green: *Nature*, Blue: *Musical* (*6. Appendix, Design Board 02.2, Sound Clips Video 02.5*). *SoundReminiscence's* sound clips feature bespoke audio to stimulate remembrance. For example, children playing, *People & Places* (grey bag controller); walking along a mountain trail, *Nature* (green bag controller); the sound of a traditional Korean flute, *Musical (blue bag controller)*, see *6. Appendix, Sound Clips Video 02.5*.

Previous desk and user research indicated the importance of haptic tactility and embodied interactions for emotional stimulation (Fitzsimmons S., 2014). The *SoundReminiscence* concept employs soft materials for each of the three interaction points (three beanbag controllers). A rich interaction approach (Frens, 2007) provides users the ability to increase volume and change sound (*6. Appendix, Design Board 02.2*). The design's accompanying application (*6. Appendix, Design Board 02.3*) gives users, caregivers and family members the opportunity to change and arrange sound files in response to individual requirements (i.e. bespoke sound selection reflecting users autobiographical memories). Through our IoT approach, SoundReminiscence responds to a necessity for individualized solution catering for difference between PwD users (Thomas et al., 2017).

Picking-up a bag controller from the speaker/base-table unit results in activation of SoundReminiscence (*6. Appendix, Design Board 02.2*). The speaker omits cued audio related to the chosen bag. The user may increase or decrease volume by placing the interaction bag in the centre of the table and turning clockwise or anti-clockwise to increase and decrease sound respectively. Gently moving a bag controller between the hands (from one hand to another and/or between users), will result in a change of sound clip. An application provides further ability to tailor sound recordings to the personal, autobiographical experiences of users, thereby responding to idiosyncratic preferences and providing maximum opportunity for episodic memory recall through reminiscence (*6. Appendix, Design Board 02.3*).

SoundReminiscence employs speakers with MCU technology, together with beanbag controllers produced using thermoplastic materials and implemented with gyro sensors. When lifting a bag, the bag's Bluetooth dongle pairs with the MCU speaker. The gyro-sensor implemented within the thermoplastic then provides a signal of movement and acceleration made by the user. This signal is transferred to the MCU speaker located within the side-table component of the *SoundReminiscence* design (*6. Appendix, Design Board 02.1*). The beanbag controllers are charged when returned to the table speaker using wireless charging coils implemented in both speaker and bags.

3. Discussion & Conclusions

The current Design Proposal has described interim results of an interdisciplinary project conducted at UNIST (Ulsan National Institute of Science & Technology), Korea. The project includes contributions from Industrial and interaction design, doctors at UNIST Medical Centre and human factors specialists. An IoT (internet-of-things) approach, together with literature, desk and user-research identified short-term memory support and meaningful communication through recall of long-term, episodic memory as opportunities to add value for PwD (people living with dementia).

Through an IoT product design process, two different design concepts were identified as holding potential to empower PwD. *HydrationCane* provides opportunity to continue to engage in mountain hiking activities associated with a Korean use context. *SoundReminiscence* supports meaningful communication between PwD, caregivers and loved ones through autobiographical reminiscence of long-term episodic memory stimulated by bespoke sound cues.

While different in their scope, aims and potential benefits, both concepts provide indication of two important aspects related to design for dementia. First, the potential for technology to provide innovative solutions for a PwD user group. Second, how product design may support the changing memory needs of PwD.

Specifically, an IoT (internet-of-things) approach to the design and development of product concepts was adopted. IoT product design provides increased opportunity to add value for users in new and innovative ways. However, connected products and their associated opportunities for sharing of information across stakeholders and connect with other products and platforms, requires strategic and systemic thinking that moves beyond traditional product design competencies. This is more so the case when designing for a PwD user group, where understanding towards user needs is still poorly understood.

IoT product design for dementia holds the potential to provide opportunities to gather and share information between stakeholders. *HydrationCane* is one example of how IoT product design may provide improved hydration through monitoring and feedback. The *SoundReminiscence* concept also leveraged the flexibility of IoT product design to provide flexible, bespoke memory cues to stimulate autobiographical reminiscence associated with long-term, episodic memories. Adopting an IoT approach allowed memory cues as sound files to align with the unique past experiences of individual users.

Thus, there remains little existing work related to how IoT product design may best be leveraged to provide for users, let alone the unique challenges and opportunities for the application of the approach for a PwD user group. For example, how might an IoT product design approaches need to consider the changing cognitive and memory abilities of PwD? How can the systemic and connected characteristics of IoT product design solutions be leveraged for the benefit of mutual stakeholders (PwD, caregivers, loved ones)? How can a balance be struck between empowerment, monitoring and independence when gathering data derived from IoT products?

Both design concepts presented here also attempted to support the changing memory abilities associated with stages of dementia. *HydrationCane* targets the loss of short-term memory associated with early-stage dementia and mild cognitive impairment. *SoundReminiscence* employs long-term autobiographical memories as means to provide opportunity for communication through reminiscence between PwD and caregivers, thereby focusing upon long-term memory retrieval abilities in PwD. In both cases, we have attempted to orientate our designs towards the known challenges of PwD at different stages of progression. On the

one hand, *HydrationCane* intervenes in the loss of short-term memory associated with early-stage dementia. *SoundReminiscence*, in contrast, leverages long-term memory in mid-stage dementia to provide opportunities for increased meaningful communication. In both cases, we have attempted to explore design possibilities in relation to the known challenges and opportunities around memory and dementia.

Although the current design proposals presented here provide departure points for exploring both IoT product design as approach in the design for dementia space, and how an IoT approach may support needs associated with changes in memory, more work is required. For example, the two concept designs are yet to be subjected to user tests and validation studies at the date of this publication. User studies with stakeholders (PwD, care providers, love ones) are planned for the project's second year. The designs themselves, while developed, require further iteration through a user-centred-design approach. Only then may we be better placed to provide more generalisable insights into both an IoT product design approach and its application as means to support the changing needs of PwD associated with memory.

Other studies are now required to explore how IoT design interventions may support PwD through understanding how the approach may both support loss of short-term memory and leverage the retained long-term memories of PwD.

Acknowledgements: This work was supported by the Excellent Research Idea Discovery project research fund (1.180052.01) of UNIST (Ulsan National Institute of Science & Technology). We would like to thank the graduate students and undergraduate interns that worked as design and research assistants towards this project.

References

Anderiesen, Hester, Scherder, Erik, Goossens, Richard, Visch, Valentijn, & Eggermont, Laura. (2015). Play Experiences for People with Alzheimer's Disease.

Archibald, Carole. (2006). Promoting hydration in patients with dementia in healthcare settings. Nursing Standard, 20(44), 49-52. doi: 10.7748/ns.20.44.49.s58

Cohen-Mansfield, Jiska, Dakheel-Ali, Maha, Marx, Marcia S., Thein, Khin, & Regier, Natalie G. (2015). Which unmet needs contribute to behavior problems in persons with advanced dementia? Psychiatry Research, 228(1), 59-64. doi: https://doi.org/10.1016/j.psychres.2015.03.043

Council, Design. (2012). Living Well with Dementia. London: Design Council.

Fitzsimmons S., Barba B., Stump M. (2014). Sensory and Nurturing Nonpharmacological Interventions for Behavioral and Psychological Symptoms of Dementia. J Gerontol Nurs., 40(11), 9-15. doi: 10.3928/00989134-20140923-01

Frens, Joep. (2007). Research through Design: a Camera Case Study. In R. Michel (Ed.), Design Research Now: Essays and Selected Projects (pp. 135-154). Basel: Birkhäuser Basel.

Howarth, D. (2017). Pratt Institute students tackle Alzheimer's with Design for the Mind project. Retrieved 02.04.2018, 2018, from https://www.dezeen.com/2017/06/23/pratt-institute-students-tackle-alzheimers-design-for-the-mind-icff/

Jakob, A., Manchester, H, & Treadaway, C. (2017). Design for Dementia Care: Making a Difference. Paper presented at the Nordes 2017: DESIGN+POWER, Oslo.

Jo, H. (2018). Hiking a national pastime with benefits, consequences. Seoul: The Korean Herald.

Kim, J, & Suh, Y. (2018). Korea is now an 'aged' society. Korea JoongAng Daily. http://koreajoongangdaily.joins.com/news/article/article.aspx?aid=3052445

Müller-Rakow, Alexander, & Flechtner, Rahel. (2017). Designing Interactive Music Systems with and for People with Dementia. The Design Journal, 20(sup1), S2207-S2214. doi: 10.1080/14606925.2017.1352736

Patterson, C. (2018). World Alzheimer Report 2018: The state of the art of dementia research: New frontiers. London: Alzhelmer's Disease International (ADI).

Schweder, A. (2017). DESIGN FOR THE MIND: HOW CAN DESIGN ADDRESS THE NEEDS OF THOSE LIVING WITH ALZHEIMER'S DISEASE? Retrieved from Pratt website: https://www.pratt.edu/news/view/design-for-the-mind-how-can-design-address-the-needs-of-those-living-with-a

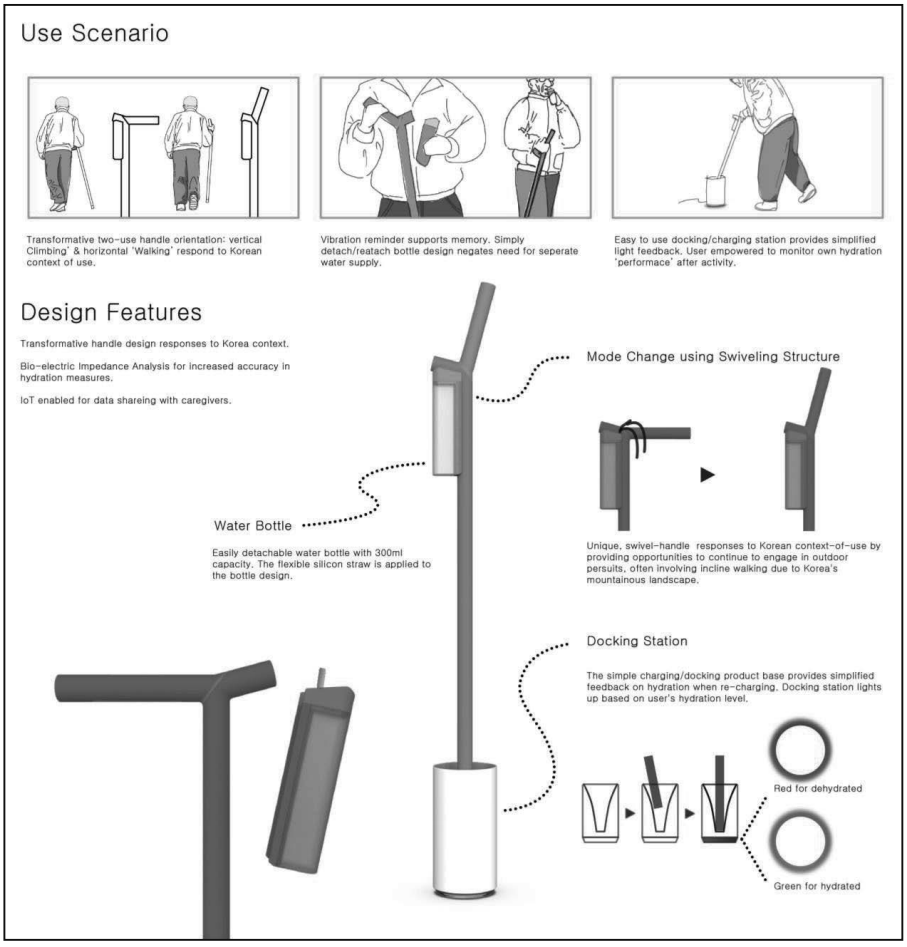
Thomas, Kali S., Baier, Rosa, Kosar, Cyrus, Ogarek, Jessica, Trepman, Alissa, & Mor, Vincent. (2017). Individualized Music Program is Associated with Improved Outcomes for U.S. Nursing Home Residents with Dementia. The American Journal of Geriatric Psychiatry, 25(9), 931-938. doi: https://doi.org/10.1016/j.jagp.2017.04.008

Timlin, G., & Rysenbry, N. (2010). Design for Dementia: Improving dinning and bedroom enviroments in care homes. London: Helen Hamlyn Centre, Royal College of Art.

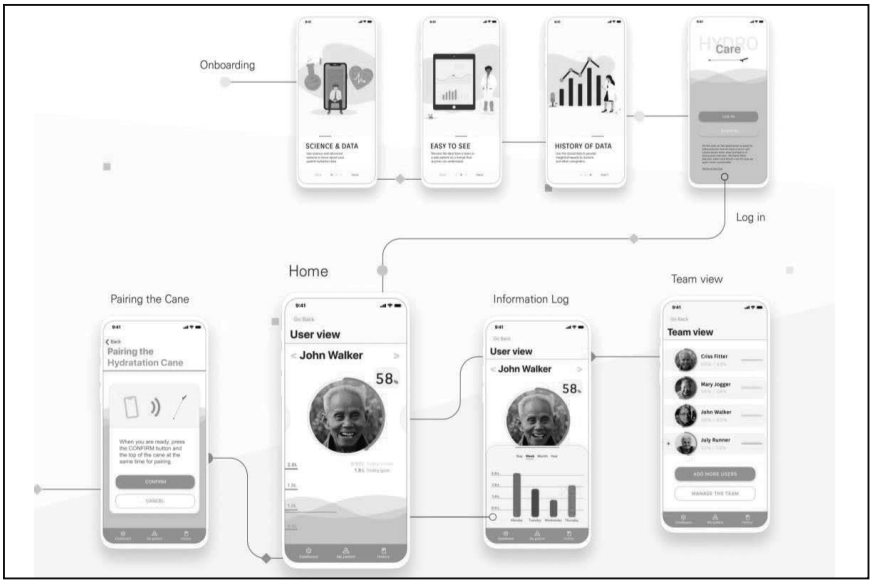
Treadaway, C., Prytherch, D., Kenning, C., & Fennell, J. (2016). In the moment: designing for late stage dementia. Paper presented at the DRS2016 Design + Research + Society, Brighton, UK.

6. Appendix

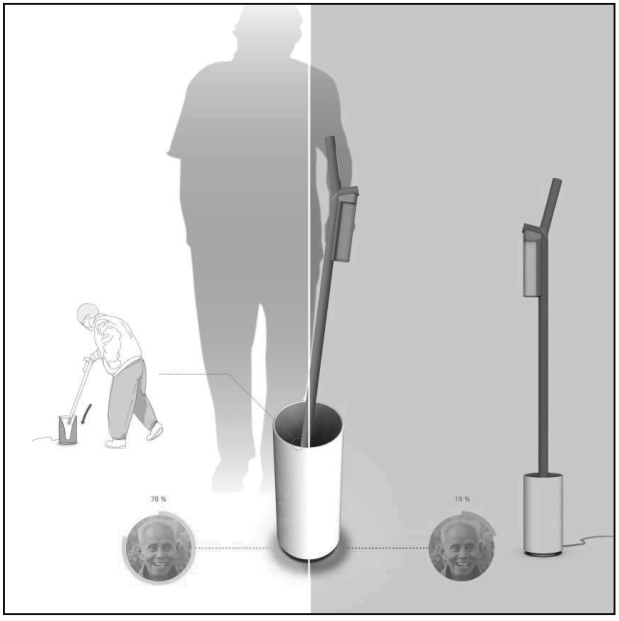
Design Board 01.1: Main Design board and image of prototype



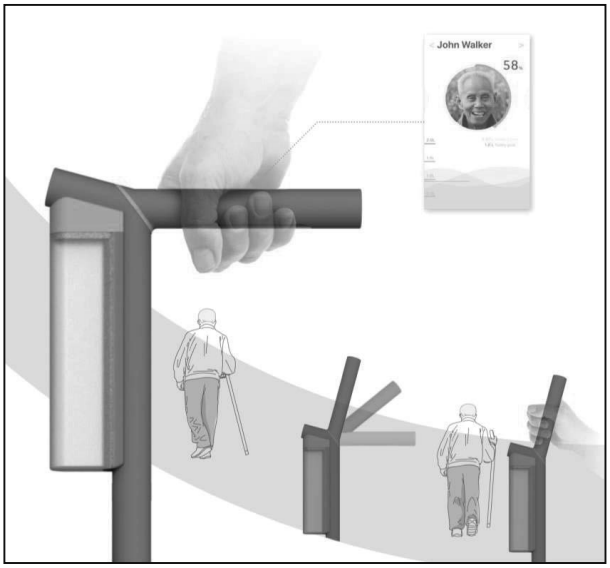
Design Board 01.2b: Scenario-of-Use board. Describing HydrationCane's use context & scenario



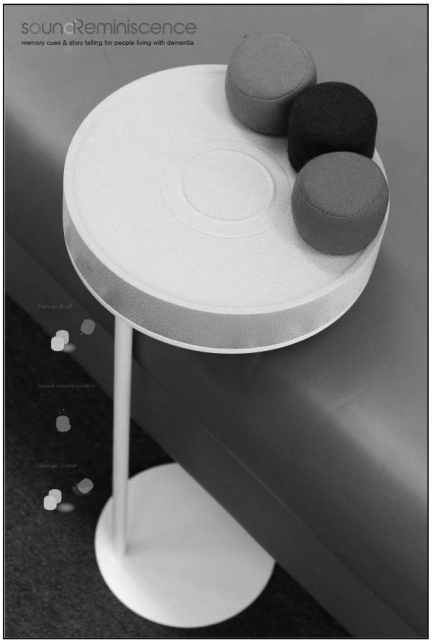
Design Board 01.3: Application design flow. Board to illustrate GUI (Graphical User Interface) design and information architecture towards application design



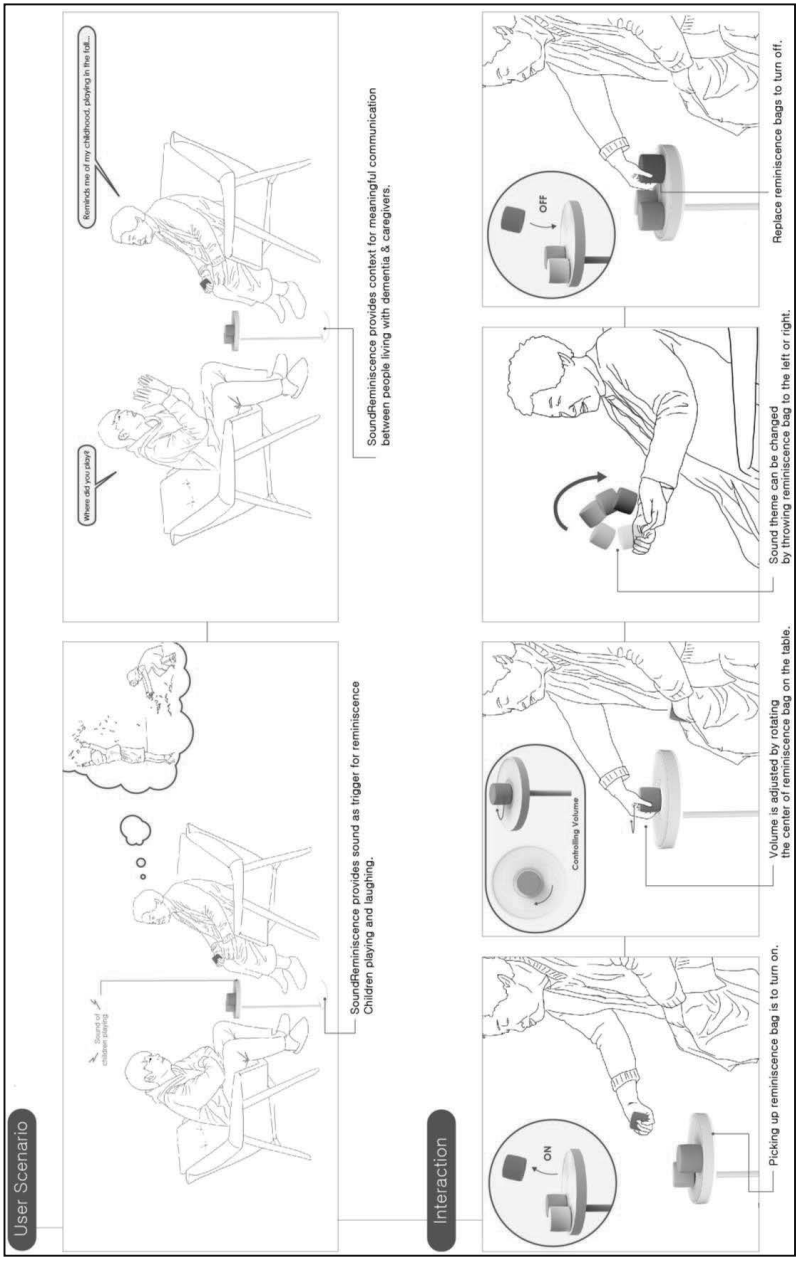
Design Board 01.4: Docking station design



Design Board 01.5: Transformable Handle design

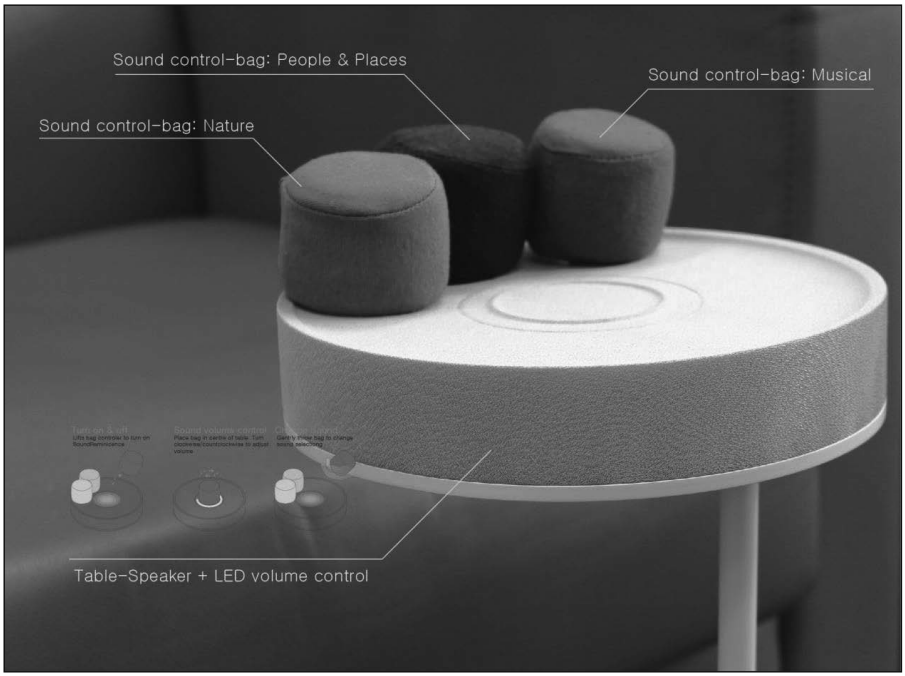


Design Board 02.1: Main Design board and image of prototype



Design Board 02.2: Scenario-of-Use board. Describing use context & scenario

Design Board 02.3: Application design flow. Board to illustrate GUI (Graphical User Interface) design and information architecture towards application design



Design Board 02.4: Interaction Design. Board to illustrate interaction with 'beanbag' controllers

A sound clips video is provided with the digital open access publication.