

Article

Promoting Older Residents' Social Interaction and Wellbeing: A Design Perspective

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Abstract: The aging society has arrived, and more and more older adults are living in a nursing home. However, institutional care settings are often described as places where residents suffer from social isolation. Under this context, we describe the process of translating into fieldwork into interactive systems facilitating elderly residents' social interaction and wellbeing. Comprehensive semi-structured interviews with older residents and caregivers were first conducted in a Dutch nursing home, aiming at understanding the status of their social interaction. The context of a typical elderly resident's social interaction was then generated, and based on which three interactive systems focusing on different aspects of their social interaction were designed and deployed. The paper finally concludes with design considerations for promoting social interaction and wellbeing of older adults living in the nursing home.

Keywords: social interaction; older adults; nursing home; prototype; user-centered design; interactive design

1. Introduction

An aging society has arrived, the worldwide population over age 65 is expected to more than double from 357 million in 1990 to 761 million in 2025 [1]. In this context, with up to 50% of those over the age of 85 likely to be placed in a nursing home at some point in their lives [2]. Social interaction is an essential factor affecting the physical and mental health of the elderly. However, growing old makes people more vulnerable to factors, such as diminished social networks, bereavement, and health problems [3]. Moving to the nursing home is also a significant disruption of a person's social world, considerably altering relationships with family and friends [4]. Social isolation is widespread among older adults in a nursing home [5]. Even if in the nursing home that has a high standard of care and a creative activities department, residents still spent a considerable portion of their days inactive, immobile, and alone [6]. Despite the flourish of social media technologies, the individual needs of older adults have always been neglected in the design of technology tools, such as mobile applications and social media [7]. Technologies tend not to capitalize on an older population that is connected through the Internet and mobile telephony, nor are the technologies being created to address social isolation specifically [3]. Internet and social media use drop off significantly for people age 75 and older [8]—even for the Netherlands is a country with high levels of general Internet diffusion, only around 30% of over-75-year-old had a tablet or smartphones [9,10]. As a result, older adults are missing opportunities to strengthen their social ties through social media, but more importantly, they have a higher risk of becoming isolated from their younger relatives who increasingly rely on social media to socialize [11].

In response to this situation, this paper shows how we could translate into our fieldwork into interactive systems, bridged by the context of a typical resident's social interaction. The context of a typical resident's social interaction is informed by interviews with senior residents and caregivers

in Dutch nursing homes, and it classifies their social interaction into four types. We then introduce three example design cases focusing on different aspects of their social interaction. We finally conclude with insights regarding designing for older adults' social interaction and wellbeing. In the following section, our literature review allows us to identify the stated research and design focus.

2. Related Work

2.1. Theoretical Knowledge of Social Interaction and Wellbeing

Social interaction is defined as “a state of having minimal contact and integration with others and a generally low level of involvement in community life” [12]. Studies have proven and elaborated that an individual's social relationships, directly and indirectly, affect not only mental health, but also to both morbidity and mortality [13,14]. Specifically, the steady social connection could promote older adults' life qualities [15], improve mental health [16], reduce their chances of developing cognitive decline [17]. In a word, the elderly's wellbeing is significantly associated with social interaction.

2.2. Research of Social Interaction for the Older Adults

For clarity, a chart (Figure 1) was presented. From the theoretical level, the most relevant research stems from anthropological studies, providing fundamental, but abstract research. From the practical level, they are from HCI and traditional group activities, which are technology-mediated applications and practical services and activities.

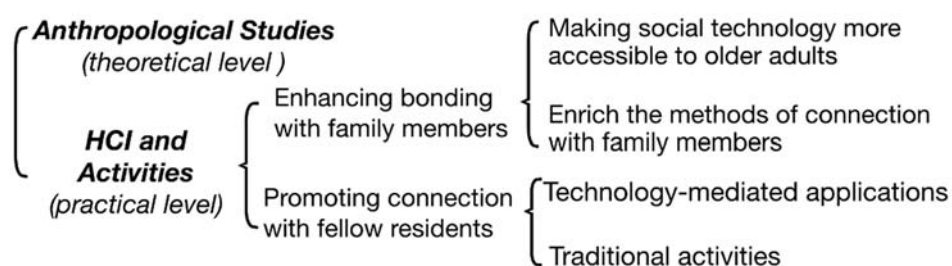


Figure 1. Research of social interaction for older adults.

Within the anthropological studies, broad factors causing social isolation are identified as the absence of quality relationships, physical barriers, psychological barriers, socio-economic, and environmental factors [18]. While nursing home residents currently spend their day has been examined: They spent the majority of their time in their rooms, sitting, and alone [6]. Since social interaction involves widespread domain, some studies focus on particular aspects. For example, older adults' communication preferences for social media [19]; Grandparent–grandchild relationship with a focus on intergenerational the play [20]; Socioemotional Selectivity Theory and the regulation of emotion for the elderly, claiming that older adults' social and emotional goals towards strengthening existing emotionally fulfilling relationships rather than pursuing novel social partners [21], some applications embark on enhancing their bonding with family members.

Within the area of HCI and activities, as shown in Figure 1, two directions could be summarized: Enhancing bonding with family members, and promoting connection with fellow residents. For the former, related applications focus on two areas: (1) Making social technology more accessible to older adults. Since TUI (Tangible user interface) has been identified as having the potential to improve older adults' acceptance of technology acceptance [22], applications supporting social interaction for non-tech-savvy older adults mostly adopt a tangible interface. (2) Enrich the methods of connection with family members. Adopting co-located games between two generations to promote intergenerational relationships [23]. Combining older adult's everyday objects with a display screen to enhance communication with family members [24]. Specifically, for older adults' families living abroad, there is an electronic family newspaper, through which elders and their families share information

and occasionally interact with each other [25]. For the latter, related studies include two areas: (1) Technology-mediated applications and persuasive design strategies. The social robot, aiming to encourage social interaction among the elderly residents [26]. A model of persuasion to be employed by a virtual agent for encouraging social interaction and lowering the risk of social isolation among older adults was proposed [27]. (2) Currently, nursing homes still adopt traditional methods, such as organizing entertainments and activities, and recruiting volunteers to hold workshops, et cetera. This type of intervention is effective, but is high-cost (human and financial) and non-sustainable.

3. Summary

Despite the above-related work, the above two directions seem to be disconnected: The in-depth anthropological studies seem to be too abstract to transform to technology-mediated works, and we find little work discussing translating fieldwork into concrete design cases. In this paper, we abstract our fieldwork into the context of a typical resident's social interaction, from which three interactive systems were designed and implemented. Additionally, since both intimate and peripheral relationships in older adults' social circles contribute to their social wellbeing, their social interaction should be studied in a comprehensive view. Therefore, in our field study, to acquire subjective and objective information, we inquired both the elderly residents and caregivers. The interviews with the elderly were also comprehensive, including their existing connections (with family members and old friends), and potential social connections (with fellow residents, caregivers, and even citizens from local communities), and their daily routine and group activities.

4. Field Work

4.1. Research Site

Our target nursing home located near a primary school, and a supermarket was within walking distance. It was a 270~280-bed capacity nursing home, providing different levels of service: Independent living and assisted living, et cetera. The average age of the elderly residents was around 85. There were approximately twenty residents who were at the early stage of dementia, who were not our research population. One reason for choosing this nursing home as a research site was its openness—it welcomed students, researchers, and volunteers to communicate and interact with the elderly residents. The ground floor of the nursing home was public space, including meeting area, library, restaurant/café, et cetera., as shown in Figure 2.

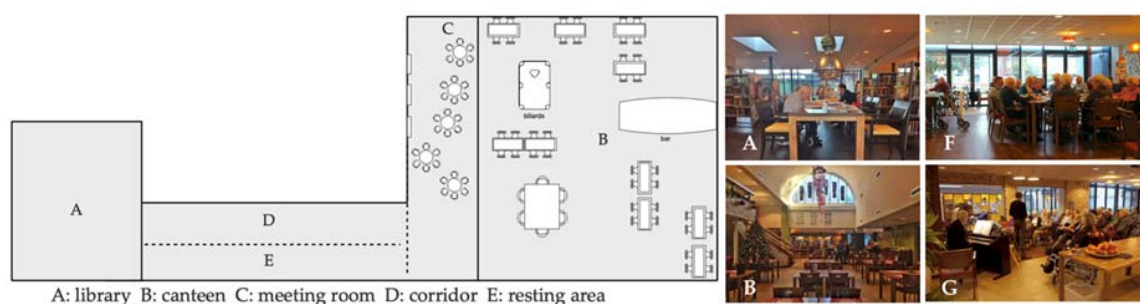


Figure 2. Layout of the ground floor (left), and activities (right).

4.2. Participants and Procedure

Semi-structured interviews were conducted with seventeen older adults (age 81–92; mean age = 83.6, six males and eleven females) and three caregivers in a Dutch nursing home. None of them reported severe illness, and their marital status was: All married, three living with a spouse; fourteen widowed. The interviews were conducted at where they lived, allowing us to understand their living contexts better. They were recruited through putting up posters in the public space of the nursing home,

and recommended by caregivers. We did not have any further requirements for the older participants, as long as they were the residents and had interested in our interviews. Interview durations range from one hour to one and a half, and we paid each participant ten euro as compensation. Since social interaction is usually divided into two distinct concepts: Actual contact or interaction with others, and social ties or resources that are there for support [28], to make our interview as comprehensive as possible, the interview covered the following topics: *Demographic information (age, physical condition, and familiarity with technology). Group activities in the nursing home. Social interaction with family members, old friends, fellow residents, and citizens from the local community.* To understand their social behaviors from a relatively objective perspective, we also interviewed three caregivers, and their work duties and views on the elderly resident's social interaction were discussed. All interviews were audio-recorded with formal consent forms. Interview transcripts and notes recorded during interviews were analyzed. Grounded theory techniques [29] were adopted to analyze the data, to allow themes to emerge from them in a bottom-up manner.

5. Findings

5.1. Basic Information and Their Familiarity with Technology

Most interviewees were suffering from physical declines, such as vision and hearing loss, loss in sensitivity, flexibility, and mobility (ten of them used rolling walkers), which brought massive inconveniences to them. As one said: *"Now two things greatly influence my life: bad mobility and eyesight."* Apart from a few young participants had a tablet to browse webs, videos, and play simple games, the rest did not use computers, tablets, or smartphones. The caregivers also mentioned there were only two men who had computers in their apartments. The following is a typical explanation from the older adults: *"I don't use a computer. I could use TV, radio, and telephone. I watch more TV, and I like football and cowboy movies."* They mainly got news and information through TV, newspapers, and radio, indicating that they still relied heavily on traditional devices and print media. The reasons were twofold: Either they were unfamiliar with digital products and operations, or their physical decline made them difficult to use digital products: Touchscreen-based operation often required precise touch and lacked physical feedback. Since our research context was the nursing home, one thing to note was the bulletin board in the counter of the ground floor, providing internal news and information of the nursing home: *"If I need to know something special, then I look here on the board, or I go to the counter."*

5.2. Daily Life Routine

Public space of the nursing home (canteen, corridor, and meeting area) was where the most social behaviors took place. In general, their daily schedule was monotonous: Moving from the sleeping area to the canteen area. At the weekends, their children visited them, and they met in the meeting area or their own rooms. Sometimes their children took them out for a drive, did grocery, et cetera. According to the caregivers, most elderly residents were mostly idle, and they spent the majority of their time in passive activities, such as doing nothing, sleeping, and waiting, rather than go to public spaces to socialize and attend group activities.

5.3. Behavior Pattern

Older residents tended to form a stable behavior pattern, which was resistant to change. According to the caregivers, every day, the residents sat in the same area and the same chair, and even sat next to the same person. Except on the activity day, the number of people going to public space every day also stayed the same. The existing social circle in the nursing home was so stable that the newcomers often complained about the difficulty in joining them. As one caregiver said: *"Lots of the older residents going to the canteen a lot are very attached to their chairs. They don't want anyone else to take their seats, although the canteen is an open space."* Based on the caregivers' observation, elderly residents tended to copy the majority's behavior. That is, if the majority were doing something, they wanted to follow. This finding

was in line with the theory of social proof, claiming that *an individual may determine what is suitable, appropriate or correct behavior based upon the extent of the behavior demonstrated by others* [27].

5.4. The Psychological States of the Elderly Residents

First, they were easily emotional. Things they came across could easily be memory trigger to evoke their past, making them lost in contemplation, as one said: *"I don't know, but I am sentimental somehow. I often come downstairs and sit here, look outside. When I see a little girl riding outside, I think of my childhood."* They were also liable to be frustrated, caused by physical deterioration: *"Many things that I am able to do before, I couldn't do now. I often need others' help. I feel very depressed."* Second, they liked nostalgia: *"Past things come to my mind somehow. I often look back to my life and feel life is short. Maybe you couldn't understand unless you really grow old."* Another said: *"I don't understand the society of today; I miss the past. Recalling the past is like watching a movie."* Third, they wanted to be self-reliant and independent, rather than be a "burden" to their children and the society, as one said: *"I am not the person like sitting down and consume everything that they give to me. I want to take all on my own hands. I am responsible for my life."*

5.5. Collective Activity in Nursing Home

There were various activities in our targeted nursing home, such as dancing, Billiards, shuffleboard, Keno, cards, Bingo, concert, et cetera. Some residents actively participated in group activities that they were interested in. For instance, there was a group of residents (around fifteen) very active and got together often to play cards, and there was a fixed group of male seniors going downstairs to play billiards every day. They enjoyed being part of a collective. As one said: *"I am glad in the group playing billiards. We always talk to each other."* Another said: *"Residents play Billiards here. We are a group and familiar with each other."* However, notwithstanding the above, the majority of the interviewees mentioned they did not participate in the activities. The first reason was that they had no interest in them, and some even found them annoying and unfair, especially for the activities with properties of competition, like Bingo. As one said: *"It is unfair. When other residents make mistakes in the games, the caretakers don't count those as false because of those people's disabilities. They get it wrong, but they win anyway."* Second, for the activities like dancing that need body movements, some could not participate due to physical decline: *"The dance is nice, but I cannot dance at all. It is a tantalus torment for me when I stand there."* Third, some interviewees never attended group activities, nor did they think it was necessary. *"I always stay in my own room. I go downstairs just to get a cup of coffee."* Some extreme personal reasons like: *"I never attend group activities like billiards or something because I find it a bit silly."* Even if they participate in the activities, they argued the activities could not sufficiently raise communications and conversations: *"Group activities just keep us physically together, but there's no too much communication."* Another said: *"I go to the activities for relaxing, not for socializing. Actually, no one talks."* In brief, despite there was a fixed group of residents, most did not positively participate in the activities, nor did the activities could promote their social interaction.

5.6. Social Interaction with Family Members

Concerning their connections with family members, we discussed the following topics with them: The number of contact family members, the frequency and method of contact (face-to-face or telephone), and talking topics. The results indicated that their connections with siblings were less as they were also aged and even passed away: *"I have one sister and one brother, but they are dying. I am old and couldn't take a train or drive to visit them."* Except for one interviewee, the rest had more than one child. Their children visited them regularly, ranged from once a week to once a month. While for those whose children lived 100km away, they did not visit that often. Visiting time lasted for 3–5 h. They kept in touch by phone at normal times. However, they made phone calls only in special circumstances, such as in disease, festivals, or other emergencies. Other traditional connection methods, such as writing letters and greeting cards, were gradually abandoned: *"We also have the habit and tradition of*

giving gifts to each other at Christmas and other festivals, but usually, I rarely write letters or greeting cards. My hands are getting more and more difficult to write now."

While, objectively speaking, they maintained regular contact with their children, they still wanted to have more opportunities to communicate and meet with their children: *"I am contradictory, I want to talk more with my daughter, but I don't want to disturb her, she is very busy at work."* Except for three interviewees living with a partner, the rest were alone and were extremely dependent on their children, particularly on the psychological side. This could be reflected from that their children were nearly the only people they could share private affairs with, and seek help from when a special situation occurred. As for the activities during family visiting, they mainly chat, did grocery, and had dinner together. Occasionally their children took them out for a ride. Chat topics were diverse, but mainly personal. Older people enjoyed the time they spent with their children: *"Every time my children came to see me, it is my happiest moment."* Similarly, according to the caregivers mentioned, the elderly often shared interesting parts of their family visiting with the caregivers for days. As one caregiver said: *"They would like to talk about the things they experienced, and they will be talkative after a family gathering."*

5.7. Social Interaction with Old Friends

Since friendships emerge from intimacy, mutual understanding, and reciprocity with another person [30], they are irreplaceable components of one's social circle. We mainly wanted to understand their connections with old friends, those whom they had known before moving to a nursing home. The following topics were discussed: The number, the frequency, the method (face to face or telephone), and ages of contacting old friends. The results indicated that since most of their old friends were peers, they became less connected with each other. The first reason was that their peer friends were getting older and even passed away. One said: *"I used to have more than ten good friends before I retired, but now, I have only three. I miss them."* Second, lack of mobility hindered the meetings: *"I used to have a good friend, and now he lives in another caring home, we can't drive or take the train, so we just make phone calls occasionally."*

5.8. Social Interaction with Fellow Residents

Unlike living in a traditional home, living in a nursing home brings the older adults in contact with one another on a regular basis. The relationship with fellow residents has become an important essential relationship that older people need to deal with.

Most interviewees thought their fellows were basically friendly, and they had good relationships with each other: *"I know a couple of familiar fellow residents, and we'll greet each other when we meet."* However, they felt the communication was superficial, and they greeted each other only out of courtesy. For example, when it came to the content of the chat among them, one said: *"It's always Good morning, Good afternoon, Good evening. Do you have a nice meal, and nothing more."* We further wanted to seek the reasons, and the following was concluded: First, some interviewees thought it was unnecessary to connect with other fellow residents: *"Although I have less and less contact with others, I think it is fine because we can do by ourselves."* Second, For those who wanted to chat with their fellows, there was no common topic for them to start a conversation, as they barely knew each other: *"I don't know them, and we rarely have a special opportunity to get to know each other. If, say, we know each other's background and hobbies, maybe we'll have more topics and opportunities to chat with each other."* Third, according to the caregivers, was that some older people found it difficult to join a group, especially for the new residents. They felt nervous when faced with the old residents had been there long. As said by one caregiver: *"When a new member faces a group that has been existing for a long time, they feel difficult and uncomfortable to join in."* Finally, lack of mobility caused by physical decline also lead to older adults to stay in their rooms: *"I need a scooter now, so it's inconvenient to go downstairs, I'd rather stay in my own room."* Another notable finding was regarding the residents' attitudes towards the nursing home: Most interviewees argued that they merely lived in the nursing home, but had no sense of belonging to it. One said: *"I pay for them, and I use the services they offer. That's it."*

5.9. Social Interaction with People from Local Community

There was a certain degree of connection between people in the surrounding community and residents in the nursing home. For example, people from the local community did volunteer work in a nursing home and helped older adults. One older adult said: *“When the snow was heavy this year, many people from the local community came over to help sweep snow in the yard. The strong older people also involved, and I also helped, using the scooter, ha-ha.”* Older residents could also seek help from these volunteers: *“When something goes wrong with my TV and phone, I can ask volunteers for help. When my stuff is heavy, I cannot move, and they are always enthusiastic to help. I have nothing to complain about. They are always immediately available.”* However, except for the above, older people rarely had real communication with other citizens from local communities. The first reason, obviously, was that older residents rarely went outside the nursing home independently: *“I dare not go outside, because my hip hurts often. When the weather is good, I go outside with a walker. But I often worry that I will fall and hurt my hip again.”* The second reason was that some older adults could not find it a reason to connect with them, as one said: *“I don’t want more connection with neighborhood, because I am happy on my own.”* Another one: *“I am not a member of any club or groups, and I don’t think I need more contact with neighborhoods or local communities.”* The third reason was that some older adults preferred to rely on their children when in trouble: *“When we really need help, we ask our children for help.”*

5.10. Social Interaction with Caregivers

Caregivers in the nursing home merely provided physical care (eating, washing, and medicine) for elderly residents, without psychological care. The elderly would like to talk with the caregivers, as said by a caregiver: *“They like to tell us their stories, although in many cases these stories are the same.”* However, this type of communication occurred only when the elderly were taken care of by the caregivers. Each caregiver needed to provide nursing care for ten elderly residents on average. Therefore, they could not spare too much time to chat with the elderly. The caregivers also attached importance to elderly residents’ social interaction, and thus, they encouraged the elderly to socialize more, despite they never forced them to do so.

6. The Social Interaction Context of a Typical Older Resident

Given the above findings, depending on the people that the older adults socialized with, their social interaction could be classified as two types: *Internal Social Interaction*—connections with fellow residents and caregivers, and *External Social Interaction*—connecting with family members, friends and people from the local community. Depending on behaviors, their social interaction could be classified as two types: *Formal Social Activity*—such as a concert, Bingo, Billiards, et cetera., and *Informal Social Activity*—such as chat, greetings, and social encounter, et cetera.

We could further generate the context of a typical elderly resident’s social interaction. As shown in Figure 3, people that the elderly socialized with were arranged based on their level intimacy: Their family members and old friends were whom they could share private content. Fellow residents and caregivers were whom they lived with. While citizens from local communities were people that they had occasional contact with (workshops, projects, activities, et cetera.). There exist differences in their social interaction with different people. Therefore, different design strategies need to be adopted based on different social levels. Based on the framework, we present three example interactive systems focusing on different aspects of the elderly residents’ social interaction. The three projects were not parallel, but successive: Findings of the project one provided insights for project two and three.

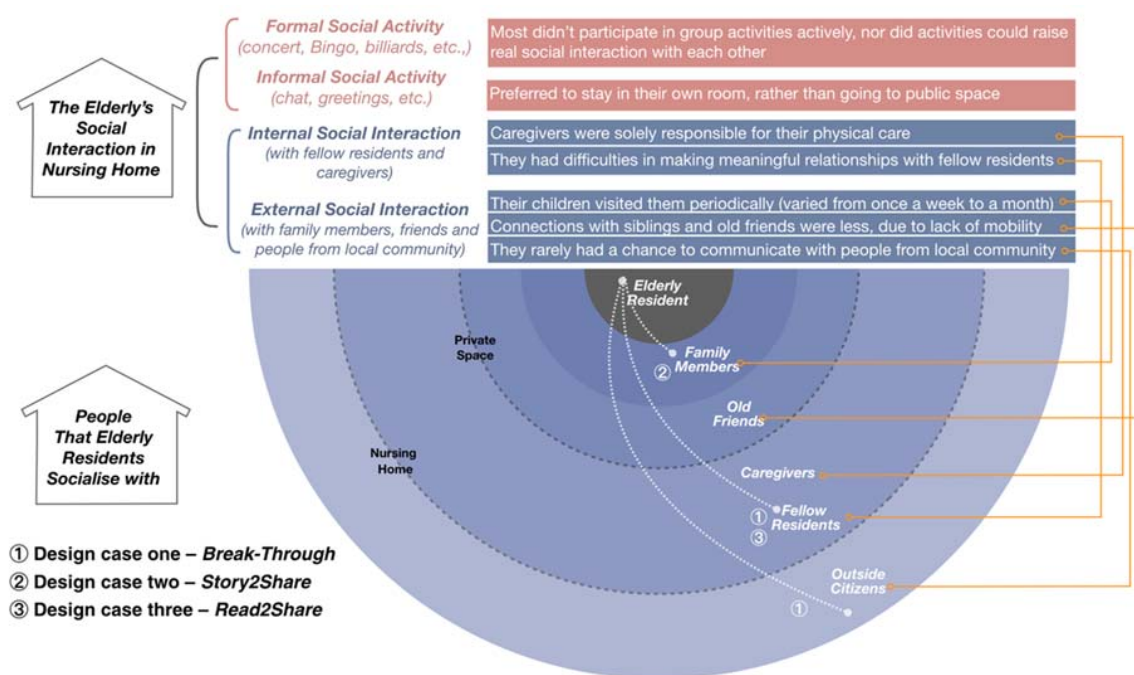


Figure 3. Social interaction context of a typical older resident.

7. Three Example Interactive Systems

The three interactive systems focused on different aspects of elderly residents' social interaction. (1) *Brick-Through*—aiming at building connections between elderly residents and citizens from local communities, as well as promoting social communication among residents within a nursing home. (2) *Story2Share*—aiming at promoting the social bonding between elderly residents and their children through storytelling. (3) *Read2Share*—aiming at facilitating social interaction among residents through augmenting public print media products. The three design cases were all interactive systems belonging to the field of interactive design, which could be more effective when a particular purpose has been defined, since technology supporting multiple types of media types is hard to integrate into interactive products [31]. It will be beyond the scope of this document to describe the detailed design process of each interactive system, and here we take the *Story2Share* as an example. As shown in Figure 4, the design process included interview study (define design requirements), Brainstorm and user consultation (generate and evaluate design concepts), Prototype making, and Preliminary evaluation (usability test).

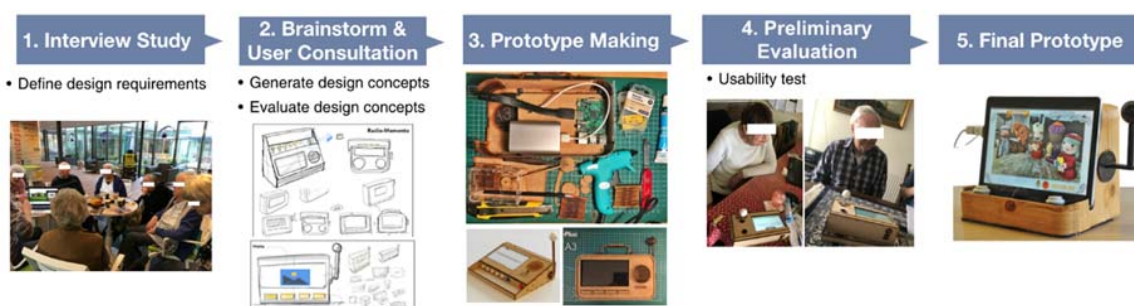


Figure 4. The design process of Story2Share.

7.1. Design Case One: Brick-Through

Few studies investigated the connections between residents in nursing home and citizens from local communities, while our Brick-Through was an attempt. It was a system consisting of gallery-like

installations locating in public space of the nursing home, and view-cameras used by citizens from nearby communities. The former displayed continuous real-time photos of the shared outside sceneries, and the view-cameras kept taking pictures and uploaded them automatically to the server (Figure 5). The elderly residents could watch the scenery photos shared by the citizens and print them into postcards, and further mail them to the citizens. Meanwhile, conversations could be generated when they used it together, and therefore, we hoped the system could also promote the connections among residents within the nursing home. Detailed description could be found in Reference [32]. In the field study, volunteers from local communities were assigned with the view-cameras and encouraged to put them wherever they would like to share. Before and after the implementation, we conducted baseline observation and intervention observation, respectively, to record behaviors of older residents in public space. The baseline observation indicated the normal level of social behavior of the senior participants in the public area. By comparing the percentage of time spent in chatting and meeting areas of baseline and intervention, we could understand how well the installation was working, namely, whether *Brick-through* had a positive effect on social interaction among the senior residents within a nursing home.

The following is a short description of the field study results. We compared two sets of data: The percentage of time spent in chatting during baseline and intervention, and the percentage of time spent in the meeting area of baseline and intervention, both used paired-samples T-test method. For the comparison of the percentage of time spent in chatting with baseline and intervention, there was a significant difference in the scores for baseline observation and intervention observation. The result indicated that the percentage of time spent in chatting of the older residents significantly increased after placing installation. For the comparison of the percentage of time spent in the meeting area of baseline and intervention, there was also a significant difference in the scores for baseline observation and intervention observation conditions. The result indicated that the percentage of time spent in meeting space significantly increased after placing the installation in the meeting space. The above result indicates that during implementation, senior participants spent more time on chatting, and spent more time in the meeting space, where the installation located.

We also conducted interviews with the participants, and the interviews were semi-structured and were based on the following six aspects: *Overall impression, interaction, contents, sharing, usability, comment*. With regards to the overall impression of the installation, almost all the interviewees gave positive comments, and found it fun and interesting. Interviews indicated that their frequency of watching the installation varied. Most interviewees preferred hometown sceneries, especially where they were born or spent their childhood. Regarding the sharing of the installation and postcards, most of them talked about the scenery photos with other fellow residents, caregivers, and family members.

Two significant findings need to be emphasized: (1) The sceneries they were familiar with triggered the residents' memories, and some residents actively printed the sceneries and wrote their memories on the postcards. Yet surprisingly, they preferred to share them with their children, instead of sending to the volunteers. According to the interview, two reasons account for it. First, the residents found sending postcards was a high-cost communication method. Second, the elderly residents explained that it made sense when sharing personal memory with intimates, despite that they were grateful to the citizens' efforts. (2) Percentage of time spent in chatting of the older residents significantly increased after the installation was placed. However, using the frequency of the installation dropped off after a peak, indicating it lost attraction gradually. We think the reason was that elderly residents have never been short of repeated group activities, and therefore, monotonous content could not last long. Additionally, every resident had an individual preference for the content, and therefore, making the content update and diverse were two key factors to sustain the installation in the long term.

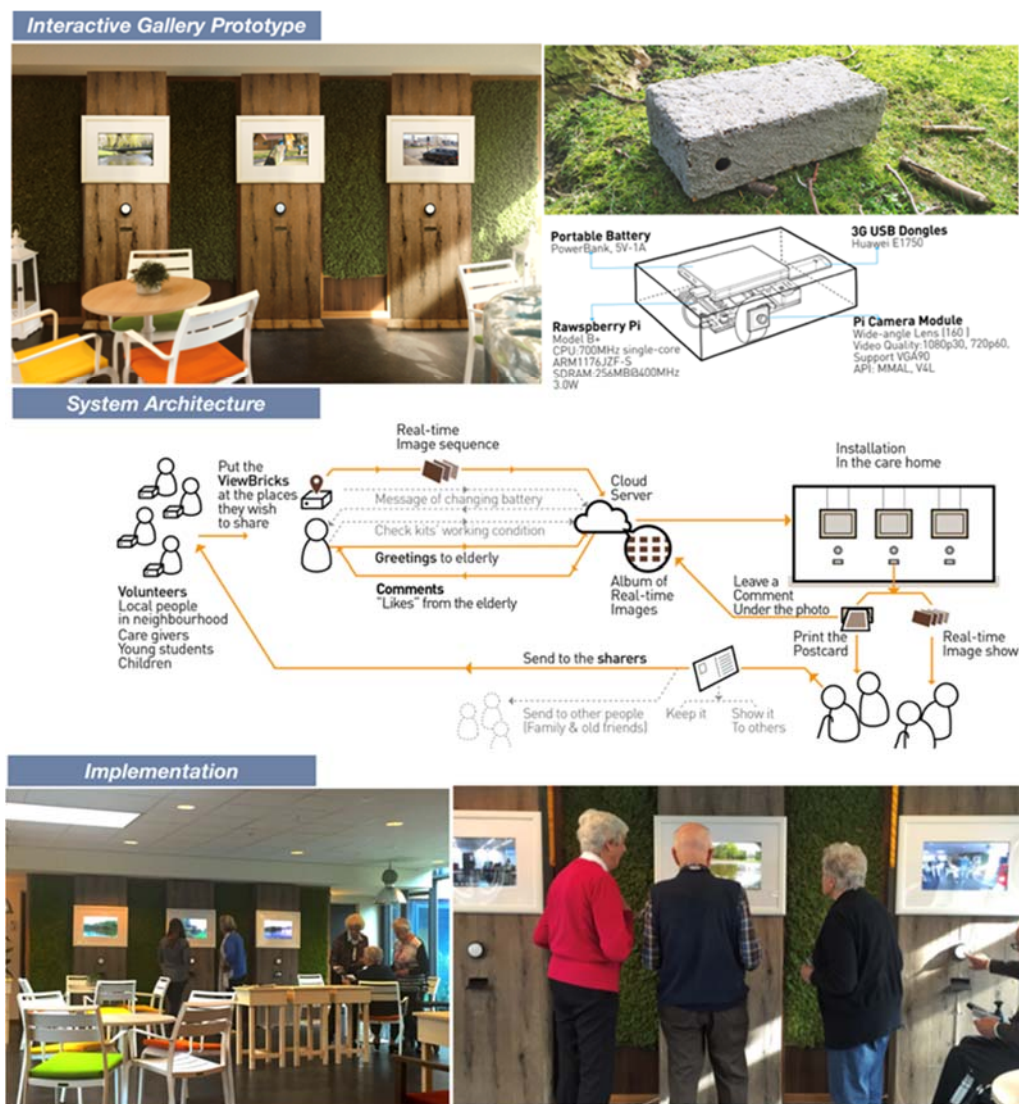


Figure 5. The prototype, system architecture, and implementation of Brick-Through.

7.2. Design Case Two: Story2Share

Based on the first finding of *Brick-Through*, we found that there was a potential that the elderly residents could be story content producers, while their children were the listeners. The system named *Story2Share* was designed and implemented, aiming to promote storytelling between elderly residents and their children. Their children used the cellphone application to provide memory triggers (trigger questions and family memento photos) for the elderly and listen to stories. The elderly used a tangible device to tell and record stories. A detailed description could be seen in Reference [33] (Figure 6).

In the field study, seven pairs of participants (each included an elderly resident and his/her child) were recruited, and used the system for around ten days, with semi-structured interviews at the start and end of this period. We did not set a minimum/maximum number of stories for each pair of participants. Mementos and stories collected were classified and analyzed.



Figure 6. Prototype and system architecture of Story2Share.

The following is a short description of the field study results. The trigger questions were based on The life story interview [34], covering the following aspects: “Birth and family of origin”, “Cultural setting and traditions”, “Social factors”, “Education”, “Love and work”, “Historical events and periods”, “Retirement”, “Inner life and spiritual awareness”, “Major life themes”, “Vision of the future”, and “Closure questions”. Figure 7 unfolds the quantity proportions of trigger questions chosen by the young. For the mementos, the categorization followed our previous research [35], we classified them into three types, and from high to low they were a **photo**, **object**, and **paper document**. The **photo** was divided into *family member, activity, friend, marriage, object, et cetera.*, depending on their themes. The **object** was divided into *from parents, bought, from friends, travelling souvenir, et cetera.*, depending on their sources. The **paper** document was divided into *certificate, letter/postcard, painting, et cetera.*, depending on their forms. By calculating the proportions of trigger questions and mementos, we could have a better understanding of older adults’ preferences for story topics from an objective perspective.

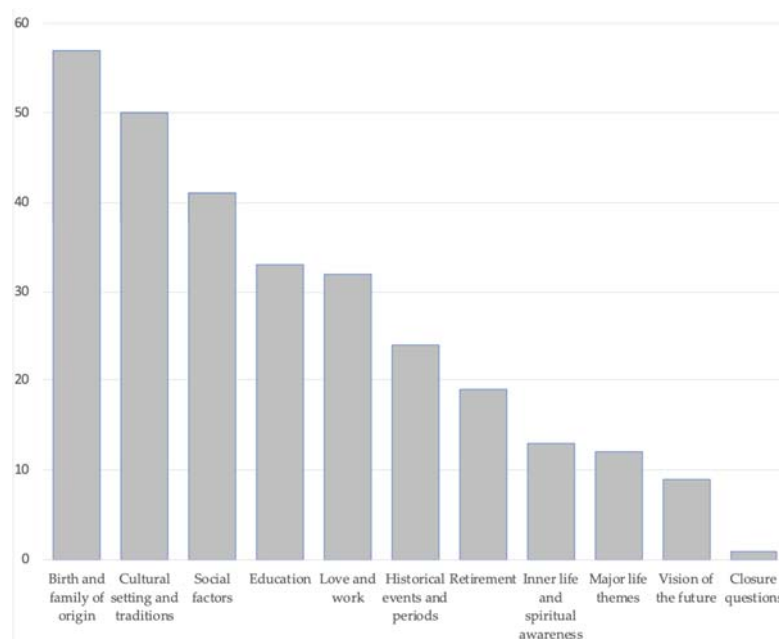


Figure 7. Quantity proportions of trigger questions chosen by the young.

The interview aimed to ask the senior participants to reflect on their use to share stories, and understand their children's feelings. The following findings need to be highlighted. For the elderly, the device helped them to remember what they almost forgot and reflect their life again, and new life insights emerged during reminiscence. It also provided an outlet for their undigestible memories. For their children, they not only learned new things about their parents, but also felt closer to them. Design considerations regarding promoting intergenerational storytelling were also derived: Such as integrating memory triggers (trigger questions and memento photos) into their daily life through a tangible display, adopting audio as the storage medium could reach the balance between retaining information and leaving room for imagination, coordinate interests of different generations to avoid aimless story capture, et cetera.

7.3. Design Case Three: Read2Share System

Based on the second finding in *Brick-Through*, we found that constantly updated contents were necessary to meet the residents' personalized needs, due to their various backgrounds. In this design case, the augmented print media was proposed, combining the traditional print media (newspaper, magazines, et cetera.) with the online digital content. It aimed to enhance their reading experience and further promote their communication and sharing during using. To be specific, it was a tabletop system distributed in the public space of the nursing home, consisting of three parts: A tangible device, multiple specially designed stickers, and a digital display running the application. In this system, the caregivers were also involved, who used the system to update online content (Figure 8).



Figure 8. The prototype, system architecture, and implementation of READ2SHARE.

To initially evaluate the user experience and social impact of the prototype system *Read2Share* (R2S) on care home residents' behaviors and feelings, supervised field trial sessions were conducted in two Dutch care homes. During each session, the system was installed on a table of the popular public area in the care homes. Twenty care home residents in total were invited to participate. They experienced the prototype in pairs or small groups (2–4 people) with the necessary prompts of the experimenters and care workers. Before use, the participants were asked to fill up a modified Inclusion of the Other in the Self (IOS) scale to rate their closeness feelings with their peers at the table. During the experience sessions, the participants' behavior was recorded by a situated camera. After use, AttrakDiff-Short was used to assess the user experience of the system. They were asked to fill up the IOS scale to rate the perceived closeness after use.

The result and findings showed that their perceived user experience was primarily positive. The ratings for the Hedonic Quality and the Attractiveness are located in the above-average region, which indicates the overall impression of the R2S prototype is captivating and attractive. However, the prototype was only rated as average on the Pragmatic Quality dimension, which implies that there is room for improvement in terms of usability, and indeed some usability issues were identified through annotating the experimenters' prompt. Many participants clearly expressed their willingness to use R2S in the future, but there was room for improvement in usability and reducing uncertainty and complexity. R2S was a success by our criteria in keeping the group members engaged and mainly actively engaged in content sharing and viewing. It was found to be effective in catalyzing social interactions between the group members. Furthermore, R2S was found to be able to support various levels of social interactions. We assumed that it might also influence their social feelings. However, neither the questionnaires nor the interviews in this study reported significant differences in their perceived closeness.

8. Discussion

Given the above interview studies and three design cases, the following insights are generated.

8.1. Diverse Technology Mastery of the Elderly

As social media technology advances, the ability to master technology dramatically affects the individual's social behavior. Older adults are diverse regarding cognitive ability, and they comprise a group that is considerably more diverse than people of the general (younger) population. Internet and social media use decrease apparently for people over age 75 [8]. Only 34% of people in the G.I. Generation (born in 1936 or earlier) use the Internet, and 21% have home broadband [36]. Based on the diversity of technical mastery, the elderly could be roughly divided into the non-tech-savvy and tech-savvy group. Our target group was older adults in a nursing home, whose average age was around 85, and according to our interview, most of them were non-tech-savvy.

8.2. Expanding New Social Circle and Strengthening Existing Social Circle

The *Brick-Through* and *Read2Share* were interactive installations in public space, aiming at expanding the elderly residents' social circles (fellow residents and citizens). While *Story2Share* was a portable tangible device meeting the personalized need, aiming at strengthening their existing social circles (family members). The two directions corresponded to their peripheral and intimate relationships, respectively. For these two directions, besides the differences in design forms, the degrees of the elderly's participation was also different. In *Brick-Through* and *Read2Share*, the elderly residents were consumers of content, while in *Story2Share*, the residents had higher degrees participating, as they were the content producers. The difference originated from the different level of social interaction: Compared with citizens and fellow residents, relationship with family members was more in-depth. For these two directions, different strategies need to be adopted.

For the direction of expanding their social circles, we should guide and encourage the elderly residents to stimulate their enthusiasm for socializing, and make use of their group behavior

characteristics. First, in our interview, the elderly residents mentioned they were reluctant, and felt no necessity to connect with fellow residents, and showed little interest in group activities. However, according to the caregivers' feedback, when the elderly residents got involved in group activities, they actually felt happier. It also validated that the peripheral relationship contributes to the wellbeing of older adults [37]. Therefore, they should be motivated to socialize more, rather than "yield to" their subjective will. Second, to do so, we could utilize their group behavior features. For example, as mentioned in the Behavior pattern section, we found the elderly tended to copy the majority. Therefore, the social proof principle could be applied, which is defined as "*the more others perform a certain action, the more likely an individual considering their own behavior will view the others' behavior as appropriate, suitable or correct* [38]". In our *Brick-Through*, some interviewees mentioned the reason for using the installation, was informed by her familiar neighbor residents. As such, a small group of relatively active older adults could be firstly motivated, and their behaviors could exert influences on other fellow residents, and further motivate them to participate.

For the direction of strengthening existing social circles, we should give full play to their enthusiasm and subjective initiative, and enhance their self-confidence. First, according to our interview, the elderly residents already had intense demands for connecting family members. Also, one finding of *Brick-Through* was that they preferred to sending postcards to their children. Combined with another finding—nostalgia was prevalent among them, and they had treasured life stories and physical mementos (albums, artifacts, et cetera.). We then turned them from content consumers to content producers, and we aimed to play their initiative fully by lowering their cost of storytelling. Second, as mentioned, the elderly residents were easily emotional and frustrated. Storytelling could make them feel a sense of achievement and self-confidence, as they valued self-achievement and the development of self-concept more than younger populations [19].

8.3. *The Design Should Conform to the Elderly's Life Habits by Integrating into Their Daily Routines, While the Promotion of Social Behaviors Should Be Unconscious*

First, all our three design cases followed the elderly residents' existing daily routines. The *Brick-Through* originated from a common phenomenon that older residents had the habit of watching outside of the window. The *Story2Share* was based on their nostalgic moods and passion for life storytelling. While the *Read2Share* was based on reading in public areas was a typical daily routine for many residents. All three interactive systems were then integrated into their living environments. That is, before the design, a sufficient survey of the elderly residents' current daily habits was indispensable. Second, instead of "forcing" them to socialize, the promotion of their social interaction behaviors should be natural and unconscious. In all three cases, the social interaction behaviors were integrated or triggered during their using. For example, in *Brick-Through* and *Read2Share*, the scenery photos and media content provided conversation topics for them. In *Story2Share*, social interaction behaviors occurred in two situations: The young contacted the older adults after listening to the stories, and they used prototype face-to-face.

8.4. *Making the System Sustainable by Giving Full Play to the Roles of all Stakeholders*

This includes two aspects. First, for the External Social Interaction (connecting with family members, friends, and people from the local community), the roles of the non-elderly should be emphasized. Take the *Story2Share* as an example. The elderly were the storytellers. To make the system sustainable, the roles of the younger generation were emphasized: They are not only the audiences of the storyteller (the elderly), but also the memory trigger providers. Since there exists a transition of the memento curators when the physical mementos become digital, the young also act as the organizer of the digital collection (stories and digital mementos). Second, for the Internal Social Interaction (connections with fellow residents and caregivers), interactive systems aiming at social interaction were difficult to run independently, since the human factor was indispensable. In this case, the caregivers were important stakeholders that could not be ignored when it came to the social interaction of the

elderly, even they were not direct participants. Take the *Read2Share* as an example. Despite the system aimed at facilitating social communication among the elderly residents, the caregivers were also involved in updating the content. Besides, the caregivers could directly intervene with residents' behaviors, and therefore, their involvement could profoundly reduce the barriers between our design projects and the residents.

9. Conclusions, Challenge, and Limitation

In this paper, we first understood the elderly residents' social interaction in a full-scale view, and we proposed the social interaction context of a typical elderly resident in a nursing home. We then designed and implemented three interactive systems, all of which originated from the elderly residents' current life routines. Design considerations for promoting social interaction and wellbeing of older adults could be summarized as follows. (1) To expand the elderly residents' social circles, we should motivate them to stimulate their enthusiasm for socializing, and make use of their group behavior characteristics. To strengthen their existing social circles, we should give full play to their subjective initiative, and enhance their self-confidence. (2) The design should conform to the elderly's life habits by integrating into their daily routines, while the promotion of social behaviors should be unconscious. (3) Making the system sustainable by giving full play to the roles of all stakeholders. One challenge of our study is that all the interactive systems in this paper are hard to be implemented in a lab setting. Instead, they were deployed in the older residents' living environments, which required higher system stability of the prototypes. While one of our limitations is, although the elderly residents' relations with their old friends and caregivers were investigated in our field study, we did not specifically propose related interactive systems. Regarding future work, other design cases within the framework could be explored, for example, as mentioned, social interaction with friends and caregivers.

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