

Ambient Information Design to Amplify Connections Between New Empty Nest Parents and Their Children

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Abstract. Empty nest is a global social phenomenon that is constantly increasing during the recent decades. The loneliness and depression faced by parents and children lead to a decrease in life quality and other health problems especially for the families with international students. Remote family communication is crucial to reduce the symptoms and improve mental and physical health. Traditional verbal communication methods require synchronous interaction with a convenient time and a suitable environment. We aim to work on this issue from a perspective of immersive and transparent interaction through the ambient display. Based on a series of user research and iterations of concept development, our design outcome FAMILINK employs existing technologies and methods to offer a novel non-intrusive information communication experience. It constructs a cohesive system that generalizes collected data into ambient hologram display and projection and informs the user other family members' real-time statuses in an ambient approach.

Keywords: Ambient information design · User-centered design · Empty nest syndrome

1 Introduction

This paper introduces the motivation, design process, and evaluation outcomes of an interactive system FAMILINK that supports non-intrusive communications between new empty nest parents and their children. Coming from the analogy of young birds flying away from their parents' nest, *empty nest* refers to a kind of family in which the children have grown up and left home. This global social phenomenon is constantly increasing during the recent decades. The number of older adults who are living alone in rural areas has been sharply increasing as a result of the migration of younger adults to urban areas for employment [1]. Between 1900 and 2000, the percentage of Americans aged 45 to 64 who lived as a solo couple increased from about 10% to about 33% [2]. This phenomenon leads to a particular syndrome, empty nest syndrome, which refers to the grief that many parents feel when their children move out of home [3]. Such syndrome becomes very typical and more severe and in the families with international students. Remote family communication is crucial to reduce the symptoms and improve

family members' mental and physical health. With the rise of globalization and digital media technologies such as social media and mobile phones, new forms of maintaining connections to home are emerging among this present generation of transnational migrants (including international students) [4]. However, traditional methods of verbal communication, such as phone calls, text messages, and video chats require synchronous interaction with convenient time and a suitable environment (private and quiet). Such setting requirements make it inconvenient to communicate, especially given potential time zone differences and individuals' busy schedules.

Bearing these problems in mind, we aim to develop a system solution that can facilitate the connections between new empty nest parents and their children from a perspective of immersive and transparent interaction through the ambient display. Our design process included semi-structured interviewing, observation, iterations of concept development, prototyping, and usability testing in a gallery setting.

2 Background

2.1 Two Perspectives in the Empty Nest Phenomena

The children have grown up and left home to begin their adult lives in other cities or other countries is a typical stage in a family's cycle. It can be challenging emotionally for both the parents and the child. The parents of empty nest families commonly have a lower quality of life after their child's departure [5]. Common experienced loneliness and depression often cause stress and anxiety, which further exacerbates loneliness and depression [6]. These emotions have a synergistic effect in diminishing the well-being of elderly parents [7]. Tollmar & Persson [8] found that the elderly tend to keep meaningful items, which link to specific individuals; they may place a postcard or photo on a refrigerator, table, mirror, or furniture because these objects remind them of absent family members. Meanwhile, empty nest syndrome makes parents more prone to many problems such as drinking, smoking, weight gain, financial difficulties, various disorders, including cardiovascular disease, cancer, and asthma [7]. However, empty nest parents – especially the elderly – seldom communicate with other people in face-to-face interactions. Thus, for empty nest parents, one of the most practical ways is to build a connection to their remote child through communication, a lack of which is largely the initial cause of their feelings of loss and loneliness.

For many college students, especially in their first year, homesickness is a common problem. According to Thurber & Walton [9] and Johnson & Sandhu [10], many university freshmen have their first experience away from home during the first year, and all of the students must face challenges independently, such as making new friends, adjusting to new life routines, and making progress in school and life. For these young adults, the adjustments to these challenges are not easy and can easily cause depression. A change in the type and frequency of contact with primary caregivers makes the adjustment even more challenging [2]. Stress or anxiety disorders caused by separation from home is defined as homesickness, according to the DSM-IV [11]. Thurber also states that self-reports of homesickness typically have included negative emotions, cognitions focused on home, and physical symptoms [11]. Moreover, the frequency of

contact to parents cannot be guaranteed because of the separation, which in turn creates more homesickness. Aside from homesickness, the challenges of adjustment can develop to be more complicated by the cultural differences between home and school [9, 12, 13]. Cultural adaptation problems are significantly common among international students; their lack of social support, overwhelming academic pressure, and even discrimination could be risk factors for depression among international students [14, 15]. In 2007, nearly 44% of international students reported that they had experienced depression problems that affected their well-being or academic performance [16].

To minimize the depression, loneliness, and homesickness experienced by international students, building effective and efficient means of connection with their parents – for the mutual benefit of both sides – is crucial.

2.2 Existing Technologies to Support Distanced Family Communication

Phone calls, texts, and video chats are commonly used communication methods in empty nest families. These methods require verbal talk or messages that are synchronous – real-time communication between users. Accordingly, the mismatch of parents' and child's daily schedules creates a major obstacle for such communication. For families with children who are international students, time zone difference makes the direct communication tougher. Apart from that, the emotional bond and sense of loneliness cannot be solved by verbal communication [17]. Sometimes, the feelings cannot be directly expressed by the language and some Social media, such as Facebook, Twitter, and WeChat, provides a different type of platform for empty nest parents and children to maintain a connection through sharing information online. By following posts and blogs, they can keep each other informed of their statuses and whereabouts. However, to maintain such a connection useful requires both sides to post either continuously or regularly. It took lots of efforts and sometimes against some people's personalities to post out their personally information and feelings. Moreover, emotional bonds and closeness have not improved through the social media.

A few recent efforts dedicated to dealing with this remote communication based on computer mediated technologies. *ShareTable* [18] is designed to facilitate meaningful, two-way interaction that goes beyond video chat. It is a method mimicking a real communication environment. Through *ShareTable*, a parent and child can play a board game together, color in a coloring book, or work on that evening's homework assignment as if they are still physically in the same room [18]. *Good Night Lamp* [19] consists of several internet-connected lamps distributed in different locations. When the big central lamp turns on or off, the other little lamps react accordingly. The little lamp owners, partner, children or friends, anywhere around the world can be informed about the big lamp owner's statuses: awake at night, sleeping at night or daytime. It is an ambient approach that communicates information or status without interruption to others' lives.

Inspired by these two projects, we want to propose and design a communication method that can facilitate the connections in the newly empty nest family based on immersive and transparent interaction through the ambient display. It should support the emotional bonding through a kind of "physically accompanied" and inform status in a non-intrusive manner.

3 Employ the User Studies to Identify Design Objectives

This project started from a series of semi-structured paired interviews with five international students and their newly empty nest parents to gather their experience of current communication methods and the essential information they exchange during the verbal communication. During the interviews, we encouraged the participants to brainstorm and describe their “ideal” experience to share their feelings and information with the distanced family members. The interviews were audio recorded and transcribed before analysis (Fig. 1). To filter out more explicit opinions from the shared information, we used a follow-up survey as a supplement method to identify subjects’ preferences.

Interview Data Collection & Analysis						
	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5	
A. General Questions	1. How do you feel they have your parents? How long is it?	18 years old, Miss, China 7 years so far.	20 years old, Miss, China 7 years so far.	20 years old, Miss, China 7 years so far.	20 years old, Miss, China 7 years so far.	
	2. What's your emotional changes compare to the time while you were progressively closer?	Spoke in different ways people. Used to being reserved to use a sentence long and simple.	My parents gave me more control. They want to know everything. I don't want to be so close because I don't want to talk much.	The last 6 months, I talked more with my parents. They're interested to know how I feel time to myself.	My parents were not close to me in the past. They were more like a friend. They were together but not close. They were together but not close. They were together but not close.	My parents were not close to me in the past. They were more like a friend. They were together but not close. They were together but not close.
	3. What's your parents' emotional changes compare to the time while you were progressively closer?	My mother wanted to talk to me more frequently.	Had many changes. They had me in the house. They were about my health condition, school, relationships with others.	Not that they had me in the house, the frequency of contacts and stay time.	My parents were not close to me in the past. They were more like a friend. They were together but not close. They were together but not close.	My parents were not close to me in the past. They were more like a friend. They were together but not close. They were together but not close.
B. Communication Methods	4. How often do you communicate with your parents? What's the way?	Every morning when I don't have classes. Sometimes in the evening too. I don't have the necessary because nothing new. One just wants to talk.	2-3 times a week.	Once every 2-3 days for video chatting. Talking to the everyday.	Everyday.	
	5. What methods do you usually use to communicate with your parents? Which one of them do you prefer most? Why?	QQ has been common and you can do the video chatting but it's a little bit boring. I like using WeChat. Some things I don't want to say. WeChat is more convenient. I like using WeChat. Some things I don't want to say. WeChat is more convenient. I like using WeChat. Some things I don't want to say. WeChat is more convenient.	We use a WeChat group. We all talk in the group. It's not too boring. I like using WeChat. Some things I don't want to say. WeChat is more convenient. I like using WeChat. Some things I don't want to say. WeChat is more convenient.	WeChat is convenient because we can send pictures and voice. And it's also convenient. I like using WeChat. Some things I don't want to say. WeChat is more convenient. I like using WeChat. Some things I don't want to say. WeChat is more convenient.	WeChat is convenient because we can send pictures and voice. And it's also convenient. I like using WeChat. Some things I don't want to say. WeChat is more convenient. I like using WeChat. Some things I don't want to say. WeChat is more convenient.	WeChat is convenient because we can send pictures and voice. And it's also convenient. I like using WeChat. Some things I don't want to say. WeChat is more convenient. I like using WeChat. Some things I don't want to say. WeChat is more convenient.
	6. Who usually initiated the communication?	My mother started QQ and then my father followed. And it became a common action.	I initiated WeChat. My parents always initiated WeChat but always the father initiated. I have to let them know I'm available. And they always initiate. I have to let them know I'm available.	My parents.	My mom.	My mom.
	7. Do you make plans for the communication before a topic?	No. I have no idea.	Yes. My mother has a plan of what she'll talk. I'll talk to her about it. I'll talk to her about it. I'll talk to her about it. I'll talk to her about it. I'll talk to her about it.	My mother has my schedule. And she'll talk to me about it. I'll talk to her about it. I'll talk to her about it. I'll talk to her about it. I'll talk to her about it.	My mother has my schedule. And she'll talk to me about it. I'll talk to her about it. I'll talk to her about it. I'll talk to her about it. I'll talk to her about it.	My mother has my schedule. And she'll talk to me about it. I'll talk to her about it. I'll talk to her about it. I'll talk to her about it. I'll talk to her about it.
	8. If you started the communication, what method you use to inform your parents to start?	Did suggestions. Show photos of their children. Ask them to talk to me. I'll talk to her about it. I'll talk to her about it. I'll talk to her about it. I'll talk to her about it. I'll talk to her about it.	My mother has my schedule. And she'll talk to me about it. I'll talk to her about it. I'll talk to her about it. I'll talk to her about it. I'll talk to her about it.	My mother has my schedule. And she'll talk to me about it. I'll talk to her about it. I'll talk to her about it. I'll talk to her about it. I'll talk to her about it.	My mother has my schedule. And she'll talk to me about it. I'll talk to her about it. I'll talk to her about it. I'll talk to her about it. I'll talk to her about it.	My mother has my schedule. And she'll talk to me about it. I'll talk to her about it. I'll talk to her about it. I'll talk to her about it. I'll talk to her about it.

Fig. 1. Data analysis of semi-structured interviews with empty nest families

After integrating our findings from the literature review, existing technologies analyses, and user interview studies, we conclude our design objectives as follows:

- The system should *amplify the communication and connection* between empty nest parents and their children. Existing technologies have provided enough synchronous communication. Instead of reproducing the experience from the current tools, we want to focus on rebuilding the connection, implying the presence, increasing the emotional bond, and maintaining their overall connection.
- The interaction with the system should be *effortless*. The system can collect the data and learn the user’s behavior patterns without inputting information manually. For example, through the smartphone’s GPS, calendar, audio sensors, and motion sensors, the system would identify the user’s location and roughly what the user is doing. Users’ relative status and availability would be estimated and displayed.
- *Privacy* is one indispensable consideration in this design. The young adult wants the parents to know his/her availability but not everything in his/her life. The system can track lots of detailed data and activities, such as location, routine, personal events, etc. However, it does not display them directly to the other side. Instead, the data will be generalized into a relatively abstract visual display.

- The system should *share the information in an ambient approach*. Ambient information displays provide an alternate method of displaying information that does not require the constant attention of the user [20]. These displays may be of many forms such as lights, sounds, and physical objects. We choose to employ the ambient display as the primary communication method since the non-intrusive information it provides is suitable for settings of family connection.
- The system should display the information in a *straightforward and efficient* way. The user can read the information at a glance. Ambient information display indicates the information in general, simplified visual patterns rather than overwhelming texts. Because it is in real-time, users efficiently understand the information through just one glance. However, whether or not users pay attention to the information is voluntary.

4 Iterative Concept Development

The agile software development method has become a new trend to deliver faster, better, and cheaper solutions in the software engineering circles for decades [21]. Williams and Cockburn [22] argue that agile development is “about feedback and change,” that agile methodologies are developed to “embrace, rather than reject, higher rates of change.” We started to employ the method in the process of designing a repository to support authoring learning objects since 2008 [23]. The agile development method was introduced to this project for engaging potential users in the design process and adjusting the design on the way to maintain the match between user requirements and system design. During all the design stages, we show the new system structure and design ideas to the five families of participants and gather their feedbacks on the way. Based on the design objectives, we started sketching initial design ideas. In this section, we want to report three major iterations during the concept development process.

4.1 Round One

Figure 2 shows the illustration of system structure in the first round. There are two sides A & B to note the users on the two sides: the young adult and his/her parents. The system can collect the data such as calendar and GPS location from A’s smartphone, analyze and calculate A’s availability and physical location, and transfer into an ambient display to Side B. We sketched different possibilities of the ambient display. For example, right image in Fig. 2 shows A’s availability through a circular stream graph. The center text shows the current location and the width of stream hint how busy A is. The display can be on the smartphone or a digital display on of the appliances in the kitchen or furniture in the living room. However, such an abstract screen display is neither exciting nor innovative. Some interview participants also expressed that the stream graph visualization is difficult to read and understand.

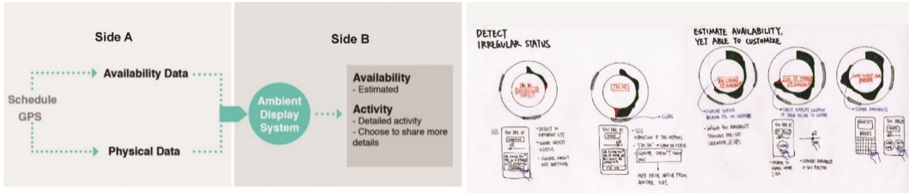


Fig. 2. Round one: system structure and one of the design ideas

4.2 Round Two

In the second round of concept development, we tried to introduce new elements to both the Side A (child data collection) and Side B (information display for the parents). On the one hand, we considered to incorporate a biosensor to collect emotional data and enrich the information about Side A. On the other hand; we proposed to present two layers of information in the ambient display system. At the first layer, only the general condition of A (positive/negative emotion) and essential status (busy, sleeping, entertaining, driving) would be displayed as a pattern. The vagueness of the information to maintain the privacy. If the display pattern looks regular from side B, parents know the child has a safe and ordinary day, the display will be merged into the surroundings. When any unusual patterns shows up from the display, parents can get alert and request more detailed data from Side A. Based on such a system structure (Fig. 3), we explored several ideas using different physical metaphors and patterns to indicate various emotional and availability status. The potential physical metaphors range from a lamp, a vase, a water bottle to a pen (Fig. 4).

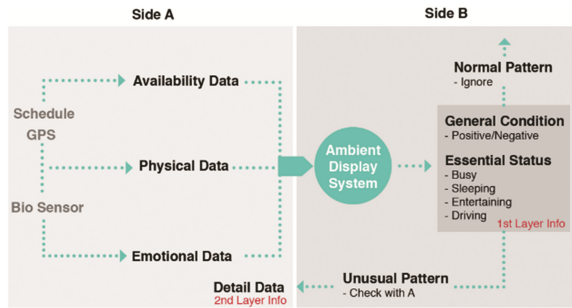


Fig. 3. Round two: system structure

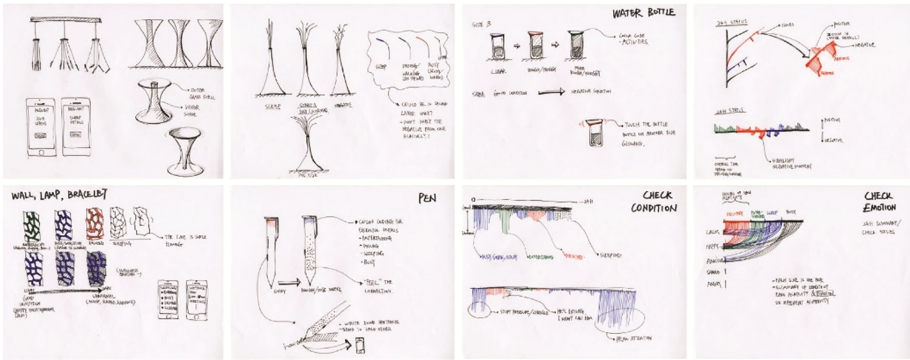


Fig. 4. Round two: design concepts of physical metaphors and display patterns

4.3 Round Three

The agile development methods [22] helped us to collect feedbacks and input from potential users and design experts quickly and led to a more refined system structure in round 3. Emotional data of Side A was eliminated based on potential users’ choice. The system will only Side A’s availability data and physical data from the calendar and GPS detection. Correspondingly, the availability status and an essential status of Side A would be showed to Side B through the ambient display system. The system would analyze an estimated availability (free to talk) through Side A’s current schedule or location. Furthermore, side A can share a clear availability to Side B. Apart from the availability, only four essential statuses of A would be displayed in consideration of privacy (Fig. 5).

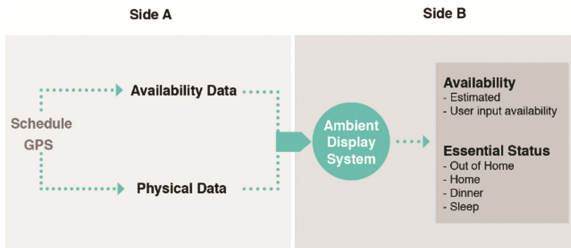


Fig. 5. Round three: system structure

Based on the 3rd round system structure, we proposed a new group of ideas to explore the possible experiences of carrying the ambient communication device. For example, the portable board concept (left image in Fig. 6) uses a mobile device to collect data and display the status through patterns on the physical screens. To imitate the analog of the family circle, the tangent rings model (right images in Fig. 6) is a representation concept using the location interactions between a larger ring (e.g. parents) and several small rings (e.g. children) to indicate the availability status in one family. These concepts have

suggested more ambient representations than the previous two rounds. However, we are not confident if these concepts are intuitive enough that can enhance the bond between empty nest parents and children.

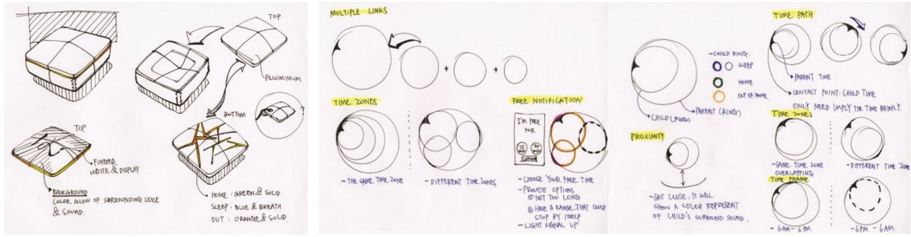


Fig. 6. Round three: design concepts

5 Prototype Development and Usability Testing

5.1 Integration of Family Dining Experience

The design solutions from previous three rounds of iteration focused on ambient information design to build up the information exchange. According to design experts’ feedbacks, it is a very creative solution to build the communication through ambient information design. However, it only fulfills one of the design objectives we set up. The overall goal is to amplify the emotional bond between empty nest parents and children who are living in long distance. Thus, we started another round of interview to investigate what the actual bonding among family members is. Several of our participants mentioned their memories of dining together, and some described some details, which drew our attention to the family dining experience. Everywhere around the world, it is nearly the most common and an essential activity for all the family members to sit together and enjoy the dinner after a busy day. During the dinner time, family members chatted about what they met and heard, how they felt, and what they think during the daytime. That is the moment they can feel the bond noticeably. However, dining activity is a lost experience for empty nest parents and their children. We decided to virtually indicate the family members’ presence and rebuild the dining experience.

5.2 The High Fidelity Prototype System FAMILINK

FAMILINK consists of a hologram projector and a phone app as the system setting that provides the cohesive communication experience. The hologram projector is suggested to place on the edge of a dining table to project dining pattern. Figure 7 indicates the system configuration and setting presented by a conceptual framework.

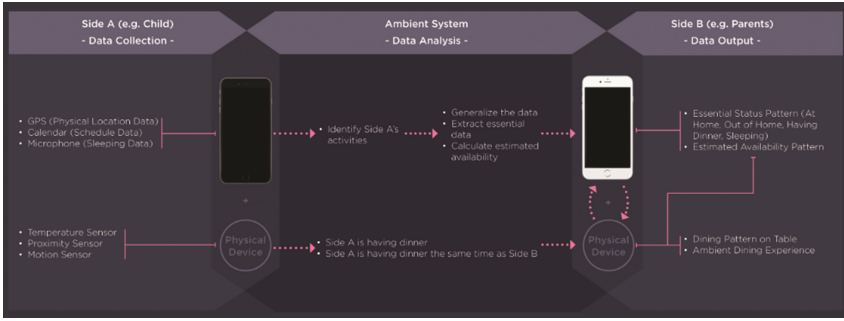


Fig. 7. Conceptual framework

Both of side A (child) and side B (parents) have the correlating hologram projector easily paired to the phone App. On A’s side, they are used for data collection. In A’s phone, the embedded GPS collects the physical location data, and the calendar provides schedule data and microphone gather the sleeping data. The hologram projector detects the dining activity through a temperature sensor, proximity sensor, and motion sensor. Even though the system can collect all of the detailed information from A, it will not transfer it directly to B. Instead, FAMILINK will extract critical status (out of the home, being home, having dinner and sleeping) from the data, estimate availability and dining activity as fuzzy ambient patterns. Thus, on Side B, the phone and hologram projector will display the abstracted visual patterns.

The core system of the app is “smart” enough to identify the user’s behavior. For an instance, if the GPS detects A is at a school department building, or the calendar shows A is having a class, the app presents that A is busy and unavailable to talk. If the GPS detects A is in a park, and the calendar shows a blank slot, the app knows A is possibly in a high availability to chat. Thus, the availability status is estimated and calculated in the smart system through multiple resources. Regarding the essential statuses, it also relies on the GPS, sensors and pre-input home address to identify if A is at home, out of the home, sleeping or having dinner. Other than the availability and four essential statuses, none of other information would be sent to B for privacy consideration.

5.3 Physical Hologram Projector

In the physical design of the hologram projector (Fig. 8), there are three key components. The top and bottom shells are the primary displays of the holograms to indicate the status. The middle part incorporates functional portions such as LED indicator, power button, and heat dissipation grids. Proximity, motion and temperature sensors are embedded inside to detect the dining activities. A mini projector on the outside would project dining patterns on the dining table. Two hologram projectors are facing up and down inside to project hologram patterns.



Fig. 8. Hologram projector design and essential status display patterns

The right image of Fig. 8 shows the ambient hologram patterns. Each pattern with identifying color code represents individual family members. Fluid motions are used to indicate the status information. The dynamicity of the pattern correlates to the family member's estimated availability. The pattern will pulse with breathing rhythm to show that A is sleeping. The sleeping status is detected by analyzing the breathing data through the microphone of A's phone. Estimated availability would be analyzed and calculated through multiple factors altogether intelligently, such as schedule, location, motion, etc. Then the availability will also be indicated through the dynamicity of the pattern. For example, if A is relatively free, B will see a slow and subtle motion on the pattern. If A is relatively busy, B will see a fast changing motion. The overall pattern appearance is fluid and continuous. As a matter of fact, the dynamicity of the pattern doesn't indicate the very accurate information. However, the consideration of the pattern dynamicity is to demonstrate a lively entity to remind B of the A's presence.

Having dinner status is displayed through the projection on the dining table to rebuild the shared dining experience. If A is having a dinner, A's projector detects his/her dining activity. And the data is analyzed and transfer to B. On B's dining table; the projector projects a dining pattern on the edge of the table in the corresponding color, which is from tracking A's dining activity. If by any chance, B is having dinner at the same time of A. The white dining pattern projected by B's projector starts to track B's dining activity. Then dining patterns from the two sides begin to merge gradually (Fig. 9). The overall dining experience not only strongly implies the presence of A, but also arouses the emotional bond and intimacy. Mentally the connection of A and B will be rebuilt and get amplified under the long-distance situation.

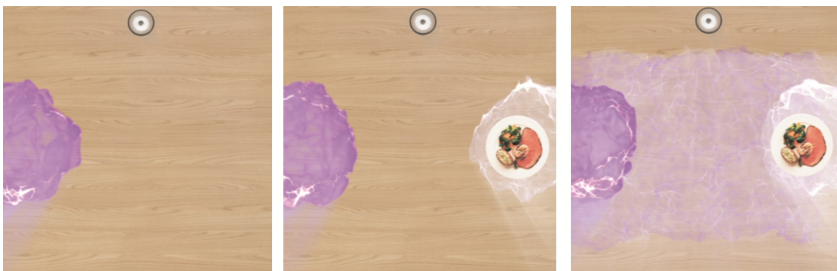


Fig. 9. Dining status and experience through projection

5.4 App Interface Design

The interface design of FAMLINK app is consistent with hologram projector setting and hologram pattern design. In the connection page, there are two areas in the interface: at home (bottom) and out of home (top). Such a location arrangement is consistent with the hologram project design. The app has the same pattern demonstration of out of home, at home and sleeping status as the projector. The purpose of repeating the ambient display on both of the project and the App is to allow the users to get access to the information anytime and anywhere. The projector is mainly used at home where dining activity would happen, while the phone App is in a portable environment. Secondly, having dinner status on the App displays as a fluid dining pattern behind the status pattern. When the user taps the pattern on the App, it will jump to a page with contact shortcuts including phone call, video call and messaging, which are synced to the corresponding apps (Fig. 10).

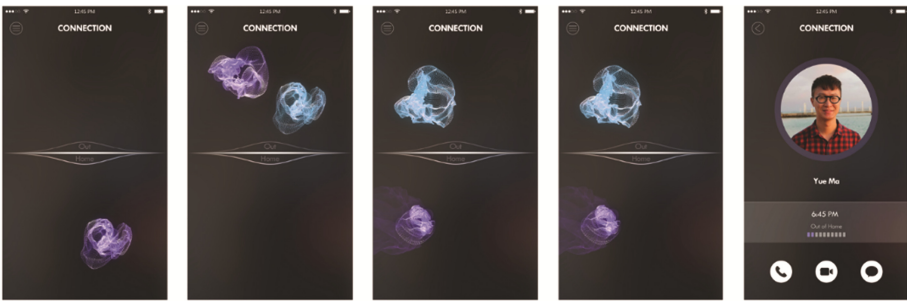


Fig. 10. Interfaces of connection menu

5.5 User Assessments in a Gallery Settings

FAMILINK design was exhibited at the Patti and Rusty Ruff Gallery for one week (Fig. 11). The topic of the exhibition is “Stay Connected in an Ambient Way.” Instructional posters are for demonstrating the development of system structure and design concepts. Aside from the posters, three prototypes indicate the work scenario and user experience of the system. A video to introduce the prototype of the mobile App and pattern design was projected to the wall. The hologram prototype through an iPad and pyramid reflection rack were set up on a pedestal (bottom images in Fig. 11). We also moked up a dining environment with the dining pattern through a projection on the dining table.

During the exhibition week, audience were invited to sit at one end of the dining table, looking at the video demonstration, observing the flowing patterns on the tabletop, and filling up a survey to provide their thoughts. Most of the audience are undergraduate or graduate students who are living away from their parents. By the end of the show, we were able to collect 67 pages of survey answers. Here are some insights we concluded from these notes. People who appreciated the design mentioned that:

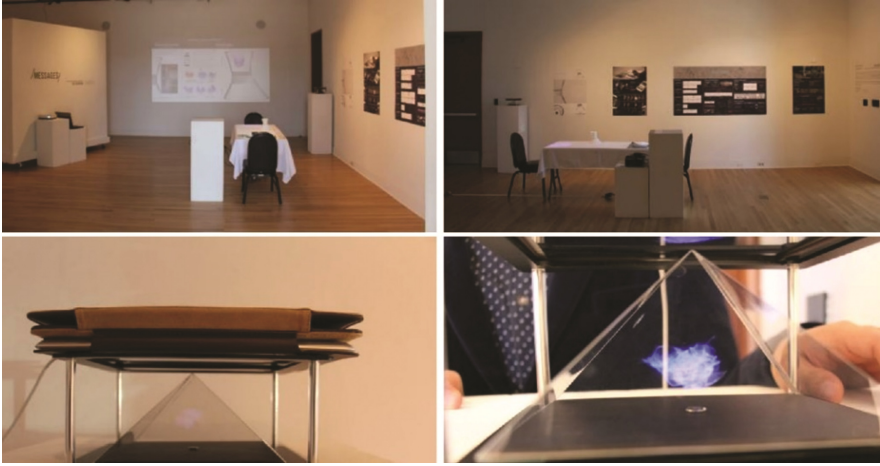


Fig. 11. Photos of final exhibition settings

- Ambient patterns are useful to strengthen the emotional bond with the loved ones. Their merging motion during the dining experience makes the connection closer.
- The ambient pattern would arouse some diverse emotions such as fulfillment, spiritual, contemplative, happy, sad, and relieved. This feeling relates to different family members.
- Ambient information design is a unique experience used in communication between family members in long distance situation. It is more about the feeling and emotion rather than direct verbal communication.
- This design could be used in any relationships that are in long distance situation, such as a couple or a pair of good friends.

However, there are also some negative feedback and suggestions:

- More information on another side could be displayed according to users' needs. Otherwise, the patterns may also arouse sadness, anxiety and afraid.
- Users could customize the pattern appearance as a preference instead of "accepting the appearance objectively."
- Lots of college students do not always "sit down" to have a formal dinner. The design could be tailored to accommodate such a condition.

6 Conclusion

Ambient information design is a method that contributes to a subtle and non-intrusive digital experience. Although new technology and methods have been developed for enriching communication, visual representations through ambient patterns have never been explored in the context of long-distance communication. This communication could be non-verbal, asynchronous, and ambient. Knowing each other's status through an at-a-glance display redefines a new way to communicate. Our study aims to push the

boundaries of how ambient communication amplify the connection and emotional bond between empty nest parents and their children. We employed an iterative design approach and agile software development method to ensure the quality, developing the system structures, and polishing the design outcomes based on potential users' feedbacks. A mobile application and a hologram projector construct a cohesive system FAMILINK, in which sensor collected data were abstracted into an ambient hologram display and projection. The first level interaction focuses on at-a-glance display of the fuzzy and essential status of another side including out of home, at home, having dinner, and sleeping statuses. The second level interaction focuses on creating a dining experience that implies the presence of another side to increase the emotional bond. The use of ambient information as the design solution for empty nest phenomena is a bold, innovative experiment.

We will continue the current research in three directions: (1) consider the feedback from exhibition audience and tailor the system to fit other kinds of users. (2) develop and testify a proper evaluation framework to assess ambient information system design, and (3) introduce and integrate more ambient design approaches in other projects to explore the potential domain.

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